Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching

Facilitator's Guide

Summer 2019

Modified from Penuel, W. R., Bell, P., Neill, T., Morrison, D., & Tesoriero, G. (2018). *Selecting Anchoring Phenomena for Equitable 3D Teaching*. [OER Professional Development Session from the ACESSE Project] Retrieved from http://stemteachingtools.org/pd/sessione

Contents:

Module Overview:

The *Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching* contains materials to be used in sessions at the district, school, or department level. These sessions are intended to provide guidance in a process for selecting phenomena that can anchor a unit of instruction that supports three-dimensional student learning.

The duration and scope of the sessions may be customized to accommodate local needs and conditions. As each session builds upon one another, however, it is recommended that the sequence of the sessions be maintained as skipping parts may result in less effective learning about how anchoring learning in phenomena can support coherence and equity.

Materials:

The following materials are part of this module:

- *Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching* Facilitator's Guide
- *Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching* slide presentation
- Phenomenon Game easy cut-out (Session B)
- Phenomenon Game key (Session B)
- Slide deck of bundled performance expectations (Session C)

The following materials are optional resources for facilitators and participants to provide further background information:

- STEM Teaching Tool 28: Qualities of a Good Anchor Phenomenon for a Coherent Sequence of Science Lessons
- STEM Teaching Tool 42: Using Phenomena in NGSS-Designed Lessons and Units

Materials that are not hyperlinked are available at KYStandards.

Goals:

The goals of the *Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching* Module are for participants to:

- Explain to a peer the role of phenomena and design challenges in science teaching, with a particular focus on equity and justice
- Generate working definitions of phenomena, design challenges and disciplinary core ideas
- Identify phenomena related to a bundle of performance expectations
- Experience how phenomena can be introduced at the start of a unit in order to launch a student-driven series of questions.

Intended Audiences:

Participants

Module participants include, but are not limited to, instructional specialists/coaches, intervention specialists, department chairs, special educators, classroom teachers and preservice teachers.

Facilitators

Module session facilitators may include, but are not limited to, district leadership, instructional specialists/coaches, intervention specialists, department chairs, special educators, classroom teachers and preservice faculty.

Using This Facilitator's Guide:

This facilitator's guide provides suggestions for structuring each session within this module. This includes recommended learning experiences to prompt thinking and meaningful discussions, as well as guidance on talking points to use with the provided slides. Also included are background notes for facilitators to assist in guiding discussions among participants.

Throughout this module participants may have questions that will be addressed in future sessions. Use these moments to encourage participants to attend future sessions where those questions will be addressed. If participants ask questions you were not prepared to answer, offer to follow up on that during the next session.

Planning Ahead:

- Determine who to invite as participants. In the invitation, describe how the work sessions will benefit them.
- Reserve adequate space and equipment. Tables should be set up to support small-group discussion.
- Consider how you might handle participants who may not be in attendance at all work sessions. It may be worthwhile to consider how those participants might access missed sections of the module between sessions in order to feel as prepared as the other participants.

Preparation:

Participant Documents Needed:

There are many opportunities for participants to engage on an individual level, engage in collegial discussions and reflect on their learning. It is, therefore, recommended that participants have access to a small notebook, either supplied or brought by the participants, to capture ideas and thoughts during the learning experiences.

Facilitator Work Session Supplies Needed:

These items will be needed consistently throughout each section of the overall module. Supplies needed for specific sessions within this module will be listed prior to the facilitator's notes for that section.

- Computer with access to the *Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching* slide presentation
- Technology with projection capability
- Issues Bin
  The Issues Bin can be used by the participants to note ideas, questions, or concerns while the group continues to focus on the learning. This may be a poster or a digital parking lot (i.e., a Google document) where participants can post these issues. The purpose of the Issues Bin is to provide participants with a safe way of asking questions or suggesting ideas. Participants should feel free to add to the Issues Bin throughout the module.
- Chart paper
- Post-It Notes
- Colored markers

Work Session Consideration:

Building a Community

Building a community is important for any group that will work together, especially if participants have not worked together before. The concept is the same as building a safe, respectful, productive classroom climate. Incorporating community-building into each session builds trust, shows participants that they are valuable as individuals and engages them in the learning process. It is also useful for creating a professional learning network where participants can be supported in their work. Community-building can be as simple as allowing participants to introduce themselves and their role in the school/district, developing or refining group norms, allowing for questions and/or the sharing of answers to personal reflections or new learning that are included in the module sessions. Time allotted for community-building will allow participants to have a voice and be engaged as active contributors and learners in the sessions.

Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching

Preparation for Session A: Experiencing and Anchoring Phenomenon

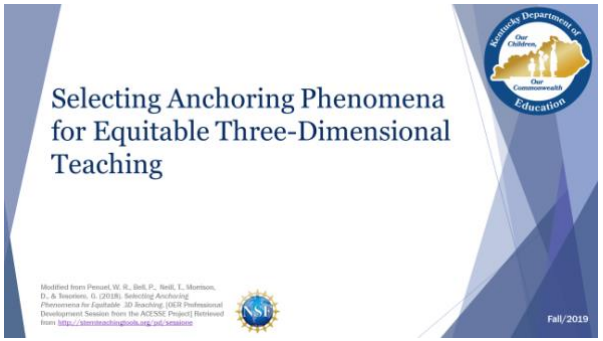
Posters to Make Ahead of Time:

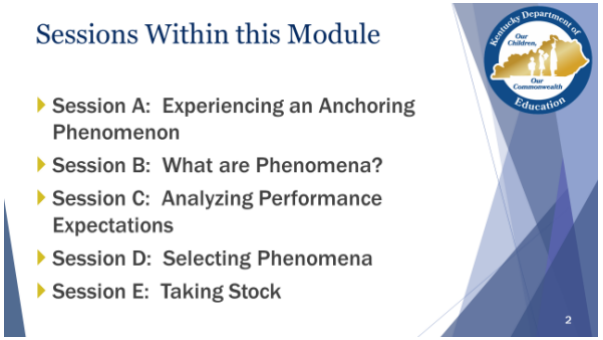
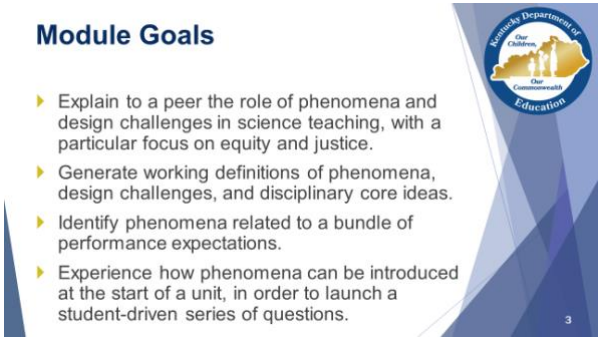
- Issues Bin Poster:
    - Poster can just be labeled "Issues Bin". The Issues bin can be used by the participants to note ideas, questions, or concerns while the group continues to focus on the learning. This may be a poster or a digital parking lot (i.e., a Google document) where participants can post these issues. The purpose of the Issues Bin is to provide participants with a safe way of asking questions or suggesting ideas. Participants should feel free to add to the Issues Bin throughout the module.

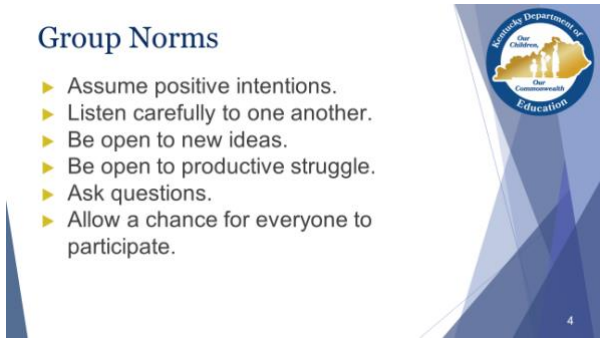
Material Needed:

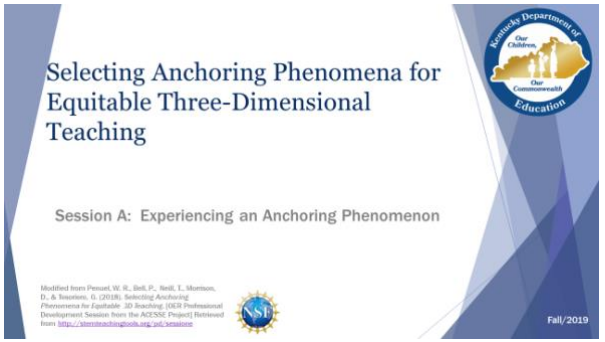
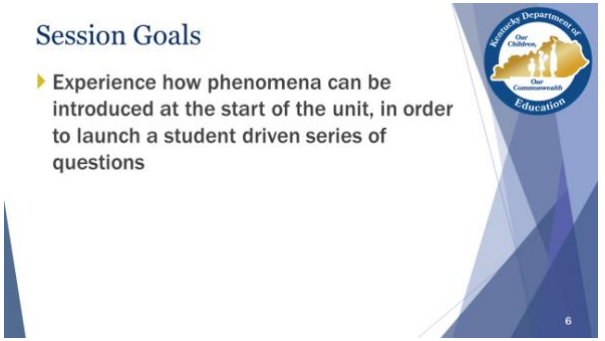
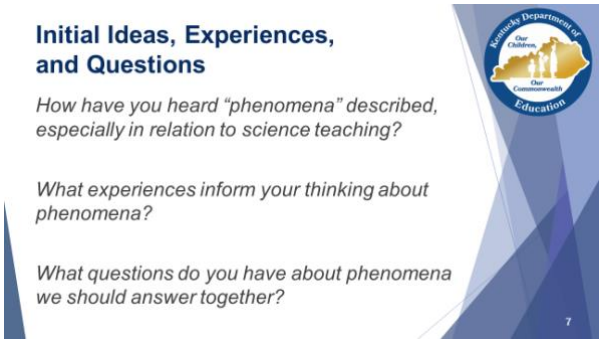
- Chart Paper
- Markers

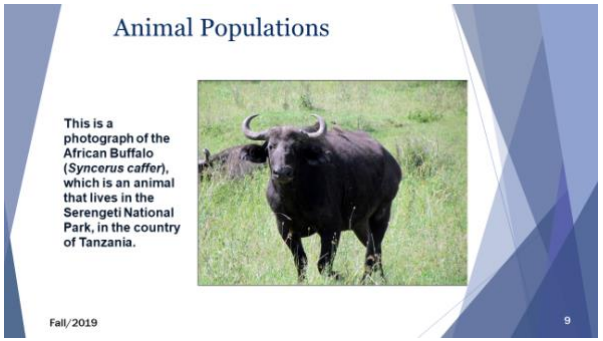
Session A: Experiencing an Anchoring Phenomenon

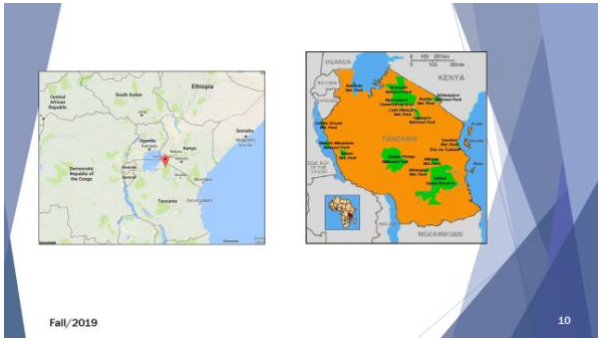
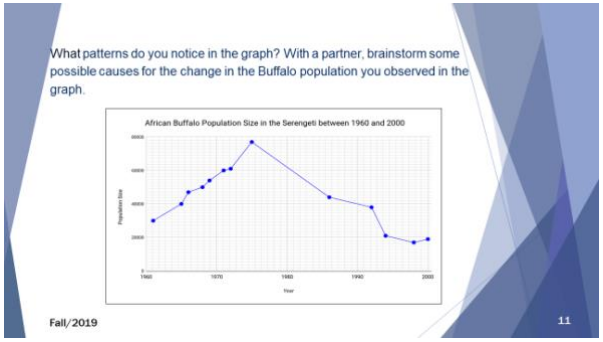
Facilitator Notes	Accompanying Slide(s)
Explain: "This module is to introduce you to how to select phenomena that can anchor an entire unit and support students' 3-dimensional science learning. You may have heard a lot about phenomena, but you may also be wondering what exactly they are and whether using phenomena is any different from how teachers teach today already. This module will provide you opportunities to explore what phenomena are and experience a process that has been developed and tested for selecting good phenomena to anchor a unit. *Facilitator Notes:* *The process that participants will be using was used for selecting anchoring phenomena through a partnership with Colorado University Boulder, University Corporation for Atmospheric Research (UCAR) and Denver Public Schools. Participants will also experience a simulation of an anchoring*	

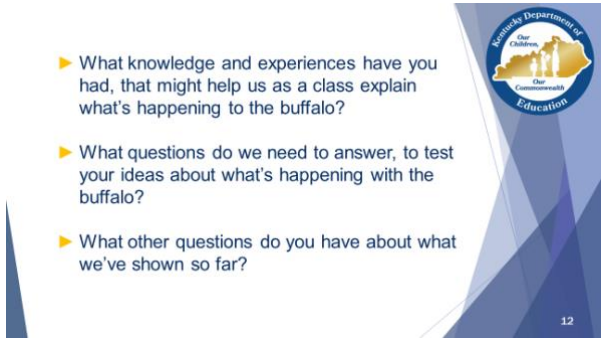
Facilitator Notes	Accompanying Slide(s)
phenomenon routine developed and used by Northwestern University in the development of science storylines.	
Explain: "We will work sequentially through a process as we come to a common understanding of what phenomena area, how we can identify candidate anchoring phenomena and make plans for further instruction."	
Explain: "In this module, we will explore what the *Framework* and research have to say about how phenomena and design challenges can support three dimensional, equitable science teaching. We will investigate how design challenges can support students in seeing how engineering practices can be used to work together for justice aims in their communities. We will also generate together a definition of what a phenomenon is, and how it is different from an engineering design challenge or a disciplinary core idea. We will identify a set of candidate or possible phenomena that could be used to teach a bundle of performance expectations.	

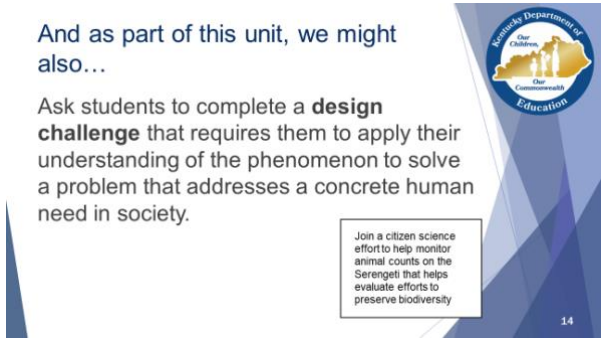
Facilitator Notes	Accompanying Slide(s)
Finally, we'll experience what might be called a "launch" of a phenomenon-based unit where students have a chance to generate questions that can help organize a sequence of lessons that are genuinely guided by students' own ideas and questions."	
Explain: "Group norms can help to create a safe space where participants feel comfortable sharing their ideas and experiences. This slide is a starter. Take a moment to read the norms." *After people are finished, ask if anyone would like to revise, edit or add any norms to the list. If so, make changes on the slide; if not, move on to your discussion of the Issues Bin.* **Explain:** "I realize you may not want to pose every question to the whole group, or we may not have time in the session to get to every question. Therefore, I want us to have a place for to address those issues." *Introduce participants to the Issues Bin. The Issues bin can be used by the participants to note ideas, questions, or concerns while the group continues to focus on the learning. This may be a poster or a digital parking lot (i.e., a Google document) where participants can post these issues. The purpose of the Issues Bin is to provide participants with a safe way of asking questions or suggesting ideas. Participants should feel free to add to the Issues Bin throughout the module.* *Remember that you may not know all of the answers to the questions and that is okay. Some issues may be addressed in future sections of this module. If the question is pressing and doesn't appear to be addressed in this module, talk to your district team and determine who would be the best person to contact at the KDE. You may also e-mail questions or feedback to KDEScience@education.ky.gov*	

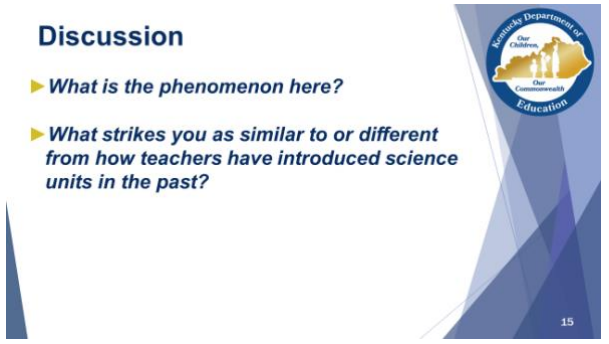
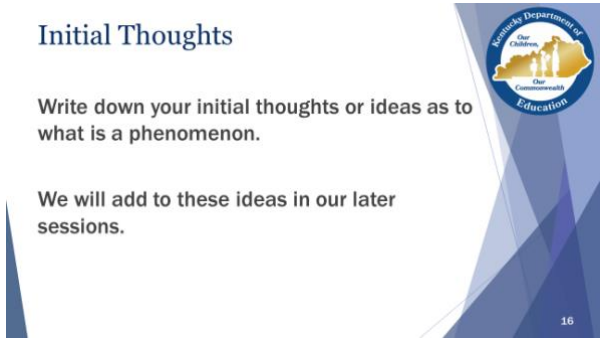
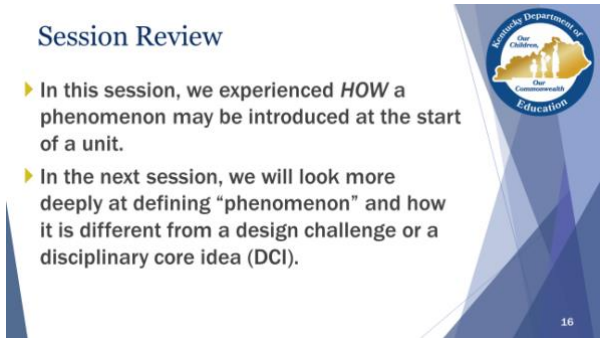
Facilitator Notes	Accompanying Slide(s)
	
Explain: "As we begin our journey in identifying possible phenomena to anchor a unit, we will first experience what we're referring to."	
Explain: "I'd like to begin by asking about your ideas about phenomena. What are they? How have you heard them described by others? What experiences inform your thinking about phenomena? What questions do you have about 'what counts' as phenomena? *Facilitator Notes:* *Write down participants' questions on chart paper. Keep these questions to refer back to during the course of the modules. As questions are addressed, they can be "marked off." Take in ideas, ask for clarification, but don't judge initial ideas. This first learning experience is intended to elicit prior knowledge and experiences to surface both problematic and useful ideas to build on in the*	

Facilitator Notes	Accompanying Slide(s)
session. Later, we will encounter some examples of phenomena that can ground the discussion. The aim is to solicit initial ideas and experiences that participants in this session can bring to help them make sense of what will take place. *This part of the session provides a critical immersive experience for participants where they are introduced to a phenomenon that could anchor a unit of instruction. Rehearsing these slides is critical. The goal is to present and "problematize" an event that involves a rather simple dataset. The point is not to arrive at complete explanations for this phenomenon, but rather to engage participants in generating questions about the phenomenon and some initial hypotheses that could be explored in a unit.*	
Facilitator Notes: *The following slides present a beginning point for the session. Participants are invited to play along as if they were students engaging with the phenomenon for the first time. The phenomenon chosen relates to what happened to the African buffalo population on the Serengeti between 1960 and 2000 (HS, LS2)*	
Explain: "Let's pretend now that we are middle or high school students, and you are in a life sciences class. I want us to experience what it is to be introduced to a phenomenon as a class, so that we can begin to get a sense of what a good phenomenon is that can anchor a set of lessons." *Facilitator Note:* *If time, you can visit www.google.com/maps/ to find Tanzania and the Serengeti National Park, located in the northeastern part of the country. Although it is located just outside of the Serengeti, this is an amazing aerial view of a herd of African buffalo. Copy and paste the following coordinates into Google Maps (satellite view) to see: 4°17'21.49" S 31°23'46.46" E*	

Facilitator Notes	Accompanying Slide(s)
Explain: "The maps presented here show the area we are speaking about. Water buffalo are known to herd with blue wildebeest, plains zebra and Thompson's gazelle. Although populations fluctuate, there are an estimated 1.3 million blue wildebeest, 200,000 plains zebra and 400,000 Thompson's gazelle migrating between the grassland ecoregion and the Southern Acacia-Comminphora bushlands ecoregion each year (Campbell & Borner 2995, WCMC 2001). These ecoregions are found within the Serengeti. *Facilitator Note:* *You may need to point out the Serengeti National Park on the map on the right. You may also wish to write out this information as participants may use it when developing initial hypotheses or questions for further investigation.* *Image comes from Google Maps and* *https://upload.wikimedia.org/wikipedia/commons/5/59/Tanzania_parks_map.jpg*	
Facilitator Notes: *Have pairs of participants analyze the graph and write down the patterns found on the graph and brainstorm some possible causes for what they see in the graph. Remind participants to be specific and mention the years.* *Listen for the following participant responses:* ● *From 1961 to 1975, the population of African buffalo is increasing. The population increases from about 30,000 to nearly 80,000.* ● *From 1975 to 1998, the population of African buffalo is decreasing. The population decreases from about 80,000 to 18,000.*	

Facilitator Notes	Accompanying Slide(s)
• *The population of African buffaloes increases between 1998 and 2000.* • *There are sections of the graph where there are no data points. This could be because data was not collected during these years.* • *I think there might have been a drought.* • *Maybe there was a change to the predators in the area.* • *Maybe the population had been suppressed by disease before 1960, but the disease ended.* • *Maybe there was a war.* ***Suggested Prompts:*** • *What years was the population of African buffaloes increasing/decreasing?* • *By how much was the population changing?* *Data comes from: Packer, C. et al. (2005). Ecological Change, Group Territoriality, and Population Dynamics in Serengeti Lions. SCIENCE, 307. Retrieved July 11, 2017, from http://izt.ciens.ucv.ve/ecologia/Archivos/ECO_POB_2005/ECOPO2_2005/Packer%20et%20al%202005.pdf*	
Facilitator Notes: *Have participants now work in pairs or small groups to identify knowledge or experiences they've had that might be useful for the class, to help us test our hypothesis. Have them use this information to generate questions they think we need to answer to come up with an explanation for the phenomenon. Also, invite people to consider questions that personally interest them that are related to this phenomenon. Provide participants an opportunity to share out their ideas.* *This debriefing discussion will allow participants to take stock of the experience and make a first pass at thinking more deeply about how to name phenomena as well as relate it to their past experience. It is critical to refrain from evaluating participants' ideas directly but to highlight different ideas and encourage participants to see how their ideas relate to others'. People are*	

Facilitator Notes	Accompanying Slide(s)
likely to have experience of introducing phenomena in a unit like this as a "hook" for engaging students but then dropping the phenomenon. Some potential talk moves to facilitate this discussion include: • *"How does [participant's name] name for this phenomenon compare to [participant's name]?"* • *"If you've used a phenomenon like this in the past, how long have students engaged with it?"*	
Explain: "If we were to continue with this simulation, we might take each of your questions elicited from your own experiences and based on what you already know and build a public record of them. Some people call this record a Driving Questions Board, because the questions help to "drive forward" the lessons in a unit anchored in a phenomenon. To really begin to investigate what's going on here, though, we need to prioritize the questions together, based on an order that we agree upon as a class. As we get started, we'd decide together on an investigation to address the question we decided to answer first." *Facilitator Notes:* *These next steps will be more fully experienced in Session E.*	
Explain: "In a unit, there may also be a design challenge that requires students to apply what they've learned about the phenomenon they are studying to solve a concrete human need and address some societal or community concern. If students were studying the Serengeti ecosystem, they might contribute to an ongoing citizen science endeavor to monitor efforts to preserve biodiversity."	

Facilitator Notes	Accompanying Slide(s)
Explain: "Let's take some time to discuss what we've just experienced. We might call this a "launch" of a phenomenon. That is, a first introduction to a sequence of lessons that launch a series of investigations that will help students explain the phenomenon. What is the phenomenon here? What strikes you as similar or different from how teachers have introduced science units in the past?" *Facilitator Notes:* *The phenomenon is an observation, not the set of questions that are posed. Those questions, though, are important, because they help problematize the event for students. That is, questions make it worthy of students' sustained interest and attention. In this instance the phenomenon may be "the African buffalo populations decreased rapidly between 1975 and 1986."*	
Facilitator Notes: *Have participants record their initial thoughts or ideas as to what a phenomenon is. Remind them that they will continue to add to their understanding in subsequent sessions. At this point we are not determining a definition, but are capturing thoughts.*	
Facilitator Notes: *Use the information presented in this slide to bring the session to an end. You may wish to address any questions that arose in the Issues Bin or that participants may have. Remind participants that the purpose of this session was to introduce HOW a phenomenon may be introduced at the start of a session and that subsequent sessions will provide a way in which an anchoring phenomenon may be identified.*	

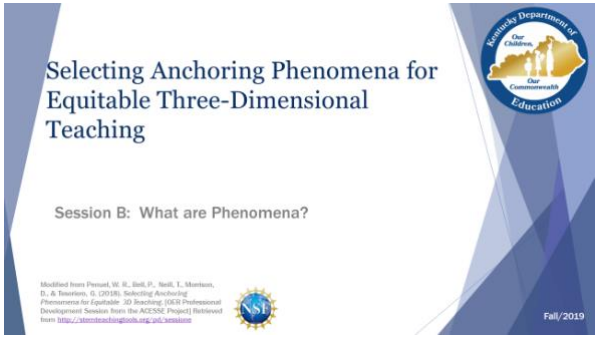
Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching

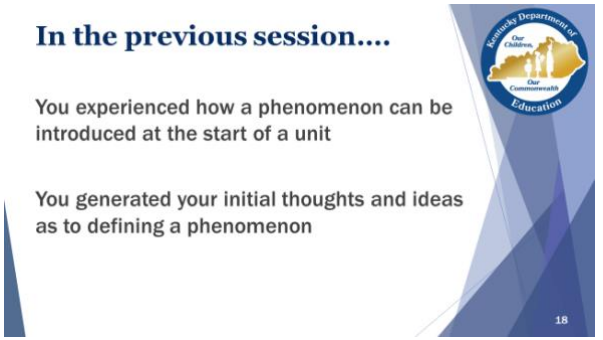
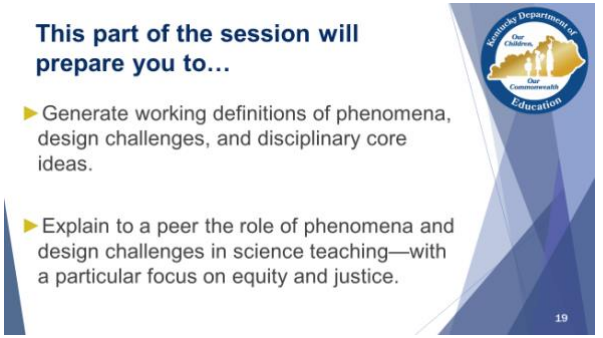
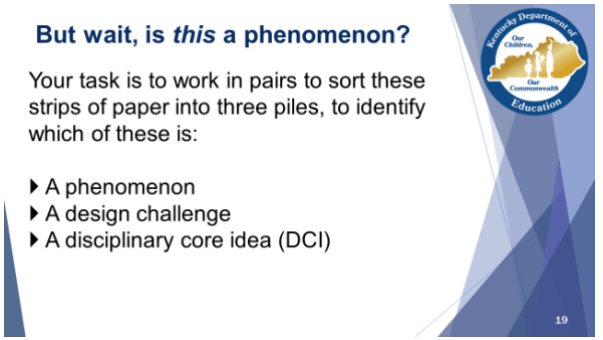
Preparation for Session B: What are Phenomena?

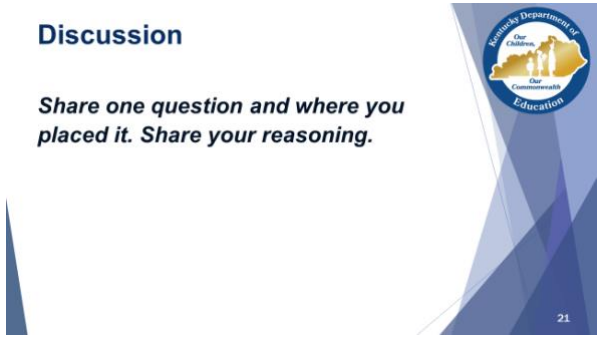
Materials Needed:

- Phenomenon Game easy cut-out (Plan for one set of cards for every three participants)
- Phenomenon Game key
- Chart Paper
- Markers

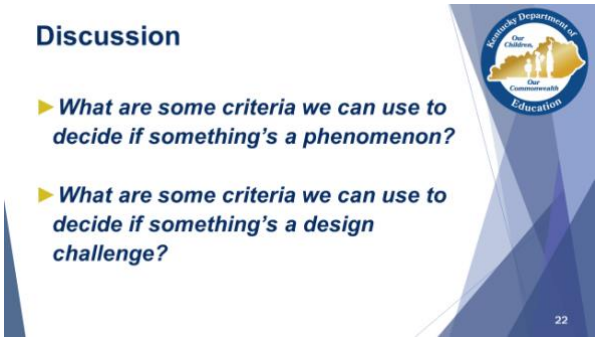
Session B: What are Phenomena?

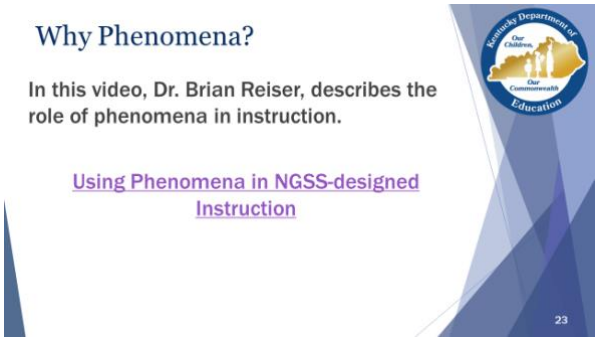
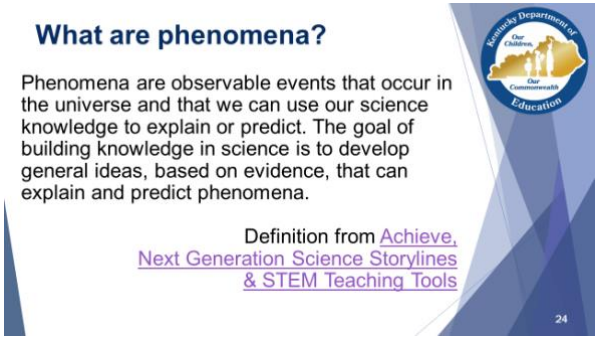
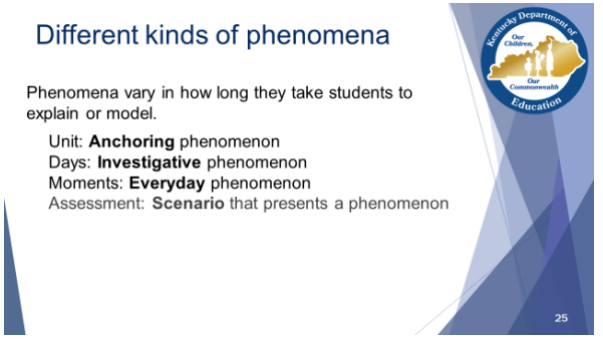
Facilitator Notes	Accompanying Slide(s)
	

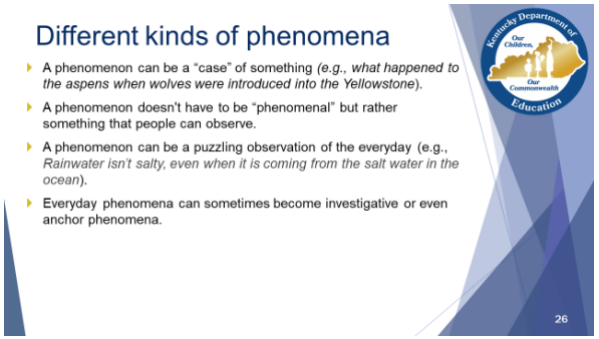
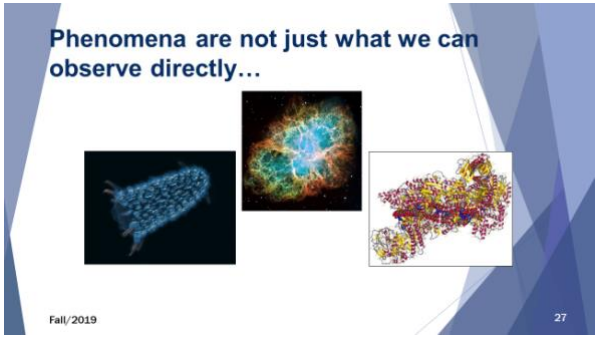
Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Use the information in this slide, and any observations from the last session, to remind participants of the discussions and learning addressed in the previous discussion. You may also wish to remind participants of the group norms, agreed upon during Session A.*	
Explain: "The purpose of this session is for us to work together to generate a working definition of phenomena, design challenges, and disciplinary core ideas by playing the Phenomenon Game. During the game you will uncover some principles that can distinguish the three that will be useful for developing a working definition of each. This will ultimately help us in selecting anchoring phenomena.	
Explain: "In the last session we experienced what it's like to engage with a phenomenon, but now let's see if we can identify phenomena when we see them. To do so, we've devised a game called the Phenomenon Game. Your task is to work in pairs, sorting these cards into three piles, based on whether you think the card is: a) a phenomenon, b) a design challenge or c) a disciplinary core idea. These are all framed as if they were potential driving questions for a sequence of lessons in a unit. They're framed as driving questions because the idea is to see if we can tell the three apart, and to develop a shared definition for when something is a "phenomenon" that we can use to guide us as we work through the module. Later, we'll talk about how we develop descriptions of	

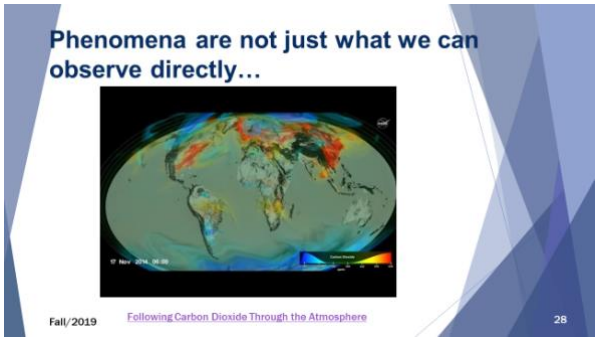
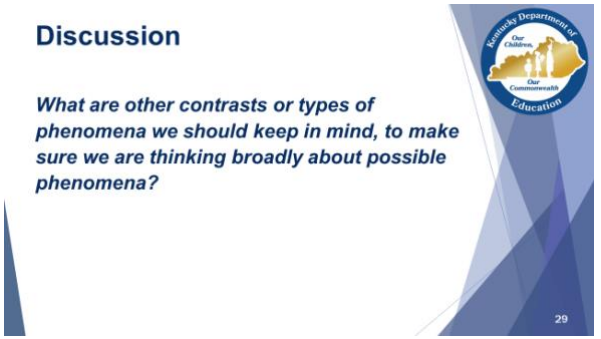
Facilitator Notes	Accompanying Slide(s)
phenomena that we can use to select good ones for a unit. As you work, be sure to discuss your thinking with your partner: What makes this a phenomenon, design challenge or disciplinary core idea?" *Facilitator Notes:* *The card sheets for this game need to be cut into individual cards ahead of time. You should look at the facilitation guide for the Phenomenon Card Game for the reasoning behind each of the categories in the key. Choose between 12-16 cards from among those provided for the game. Refrain from providing answers to the game, but when people seek answers, ask questions like "How are you deciding?" or "What's the decision you are trying to make?" and "What's guiding your thinking in calling this a phenomenon?" The purpose is to identify criteria for developing a definition of phenomena, design challenges, and their differences from a disciplinary core idea <u>from</u> the game play, rather than ahead of time. For many groups, this is a challenging activity, and it is only later in the discussion with the whole group that a consensus emerges as to the definition.*	
Explain "This is the most important part of this learning experience, where we will share out what we've concluded as a group. I'll ask each of you to share one question and what category you put it in along with your reasoning about **why** you put it there." *Facilitator Notes:* *Ask each pair to present one idea at a time and discuss it before going on to the next one, until all the cards have been sorted into one category. When a group presents their card, ask "Does anyone agree with their placement? If so, can you add to their reasoning as to why the card is in this category?" Also, be sure to ask "Does anyone have this in a different category? If so, what category did you put it in? What is your reasoning?" When all cards to categorized ask "Which one did you have the most trouble placing in a group and why?"*	

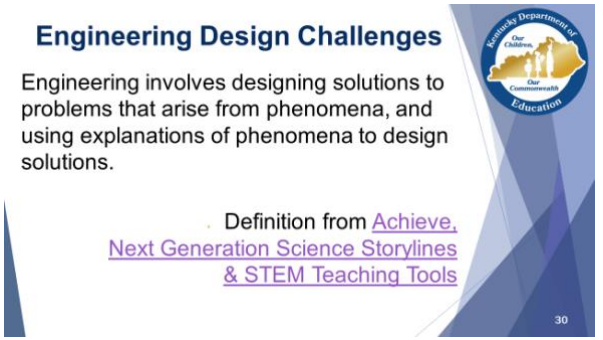
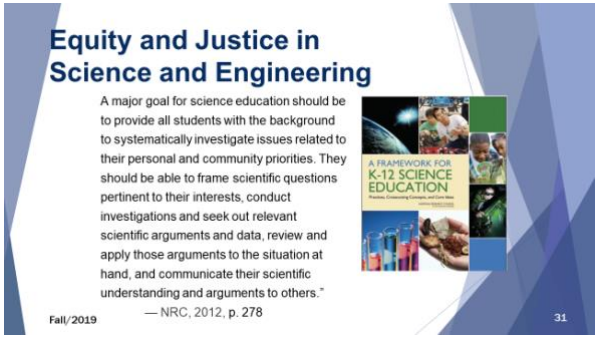
Facilitator Notes	Accompanying Slide(s)
There are a variety of ways to facilitate this particular portion of the game. Having pairs present one at a time and then offer their rationale for putting the question in a particular category is one good way to facilitate this. After each person presents, asking if others agree or disagree is key. The aim is to get to consensus and to encourage debate to help people arrive at consensus. This requires some trust on the facilitator's part that the group will arrive at consensus. If the group is not converging, the facilitator can start modeling the reasoning halfway through. It is useful to hang with the difficulties. Some possible talk moves to throw the discussion back to the group includes: • *"Who agrees that this is a phenomenon? What about the DCI? Let's hear the reasoning for both?"* • *"Are you convinced by [participant's name] reasoning? Why or why not?"* • *"Who can summarize where you think the group is one on this one: phenomenon, design challenge or DCI?"* *Possible ways of setting up to share whole group:* • *Large versions of each card used are arranged and attached to a wall* • *Cards available electronically moved around in a program and projected* • *Individual tables manipulate their own cards as consensus is reached* *The purpose of this is so that participants may discern patterns and identify characteristics that can be used when a consensus definition is developed.* *This discussion is crucial to building a shared understanding of what phenomena are. Facilitators can trust that through this discussion, however, participants will come to some agreements that are consistent with the definition that Achieve offers, and this is presented in a subsequent slide. For now, it is important to build up participants' thinking from their ideas and to let them struggle.*	

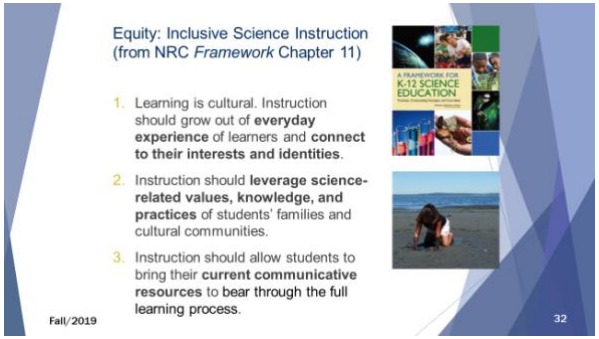
Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *At the conclusion of the game, ask participants to generate a list of criteria that they and others might use to help decide whether something is a phenomenon, design challenge or DCI. Write the criteria on a piece of chart paper that can be referred back to throughout this session and subsequent sessions.* *A DCI can be studied using a variety of phenomena. Below are some possible criteria participants may generate or questions they might ask themselves when trying to decide whether something is a phenomenon, design challenge or disciplinary core idea (DCI).* • *Does it happen in nature? (Almost a phenomenon)* • *Are students solving a problem? (Design challenge)* • *Is it focused on a specific event in nature or is asking a general question? (Distinguishing between DCI and phenomenon)* • *A DCI is something students should know and be able to do but isn't framed in terms of something that takes place in nature.* *This is an opportunity at the conclusion of the discussion to summarize what counts as a DCI, a phenomenon and a design challenge. Record their definitions on a piece of chart paper that can be referenced for the remaining sessions. At this point, participants usually want to identify criteria for a good phenomenon. When they do so, call this out and add to the lists you have begun.*	

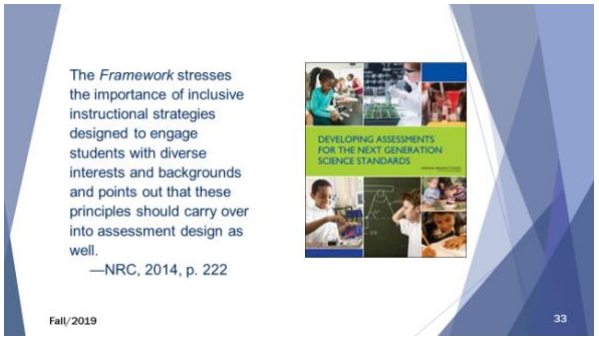
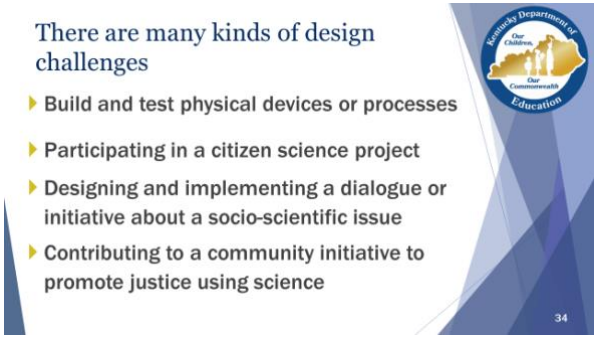
Facilitator Notes	Accompanying Slide(s)
Explain: "We will now listen to Brian Reiser, one of the writers of the *Framework for K-12 Science Education,* talk about phenomena and their role in instruction. *Facilitator Notes:* *After the video, you may wish to briefly debrief, asking participants to summarize what Dr. Rieser was saying in regards to phenomena as related to science instruction.* *The video may be accessed at https://youtu.be/Jyiv1Lc0dng.*	
Explain: "Let's compare our criteria for identifying a phenomenon to the description of a phenomenon developed by Achieve and allied projects. Is there anything in our criteria that is not present in this description? Is there anything in this description that is not in our criteria?" *Facilitator Notes:* *Point out that this definition highlights the way that phenomena support students in applying their understandings of disciplinary core ideas and crosscutting concepts to explain and predict in the context of engaging in science and engineering practices. This definition explicitly relates phenomena to the three-dimensional science learning goals emphasized in the Framework.*	
Explain: "There is more than one kind of phenomenon used in instruction. Some phenomena can be used to anchor a long sequence of instruction because they are likely to take many class periods to explore. Other phenomena, though, become the focus of a single lesson of instruction—or a small number of lessons. They might be phenomena that help students gain understanding of some aspect of a bigger phenomenon they are investigating. Yet other phenomena are everyday examples that students may have a strong experience with but not realize that science ideas can be used to explain them. The focus of this module is on the phenomena that take many class	

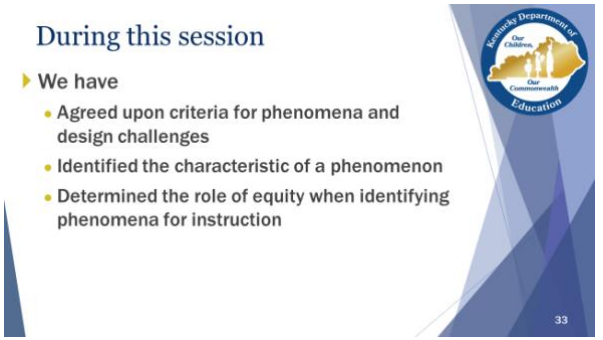
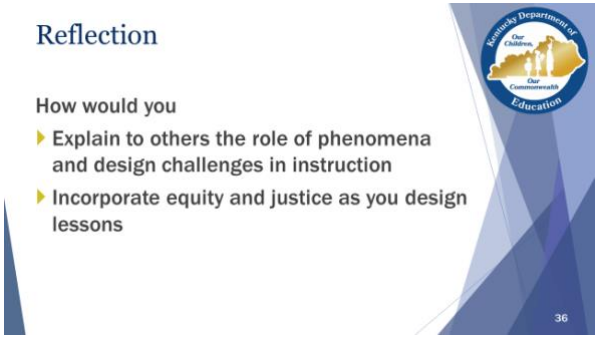
Facilitator Notes	Accompanying Slide(s)
periods to complete."	
Explain: "Lots of deliberation goes into identifying phenomena for instruction that fits the focal learning goals. An anchor phenomenon may not be the best investigative phenomenon and vice versa. Sometimes a phenomenon can become focal because it captures the attention of students or is local and salient to a current event. A phenomenon doesn't have to be "phenomenal" but rather something people can observe. And phenomena aren't just an opening hook that gets dropped as you proceed with a unit. They really do help us focus three-dimensional instruction. Also, sometimes we must use tools to make our phenomenon observable because what students need to explore is at a spatial scale too large or too small to observe directly, or processes occur over timescales we cannot observe directly. In all cases, though, we want to try and find phenomena that are in some sense **observable** and focus on developing an explanation for what it is we "see"—even if we cannot see it all at once."	
Explain: "It's valuable to think beyond Earth's surface and atmosphere and consider phenomena in outer space and in the deep ocean. Phenomena may be on a macroscopic scale too vast for us to see without the aid of instruments and models. Or they may be on the microscopic scale in which they are too small to observe without powerful microscopes to see them." *Image sources:* *Bioluminescent Tunica:* *https://upload.wikimedia.org/Wikipedia/commons/5/5f/Tunicate_off_Atauro_island.jpg* *Crab nebula: https://upload.wikimedia.org/Wikipedia/commons/0/00/Crab_Nebula.jpg* *CRISPR-protein: https://upload.wikimedia.org/wikipedia/commons/c/cd/4qyz.jpg*	

Facilitator Notes	Accompanying Slide(s)
Explain: "As an example of something that is 'observable' only when we look from afar and speed up time, consider this potential anchoring phenomenon for an Earth science unit: What are we 'seeing' in this animation? How are science tools magnifying this, so that we might make it a phenomenon worth of student investigation?" *Facilitator Notes:* *The video may be accessed at https://www.youtube.com/watch?v=syU1rRCp7E8*	
Facilitator Notes: *Engage groups in a discussion of other possible contrasts like micro-and macro-, that they should keep in mind as they brainstorm possible phenomena. Some possible contrasts include:* • *Natural vs human-induced* • *Local vs global* • *Recent vs ancient* *It is critical that people think broadly about phenomena. It is too easy to get the idea that phenomena cannot involve people or are associated with events we can directly observe. This particular discussion is intended to generate a list of possible ways phenomena can vary. Record the responses on chart paper so that it can serve as a resource when participants brainstorm phenomena in Session D.*	

Facilitator Notes	Accompanying Slide(s)
Explain: "Let's now return to what defines a design challenge, something else we explored in the phenomenon game. Here's the definition of design challenges from Achieve and allied groups. What do we notice that is similar or different from what we came up with as a group, for telling when something is a design challenge?" *Facilitate this discussion* "Design challenges are a context where students can apply engineering design practices to create and test solutions that arise from phenomena. As noted in the definition here, phenomena are starting places for identifying needs for which people can design solutions to problems they encounter. An understanding of the science that explains a phenomenon is central to what makes for a good design challenge."	
Explain: "Design challenges relate directly to a big idea in the *Framework for K-12 Science Education* about equity. A major goal for science education should be to provide all students with the background to systematically investigate issues related to their personal and community priorities. That is, students need to be able to see how science and engineering are relevant and can address goals and problems that matter to young people. They should be able to frame scientific questions pertinent to their interests." *Facilitator Notes:* *A core assumption is that science instruction should connect directly to students' experiences and interests, can help them develop identities as people who do science and engineering and, if desired, as people who are scientists and engineers. Students should have opportunities to conduct investigations and seek out relevant scientific arguments and data, review and apply those arguments to the situation at hand and communicate their scientific understanding and arguments to others.*	

Facilitator Notes	Accompanying Slide(s)
Promoting equity means students need to have direct opportunities to engage in science and engineering practices to investigate their questions and design solutions to problems they care about. These relate also to justice aims for science education. Design challenges especially present opportunities for students to see how science and engineering practices can support goals for citizenship and community improvements, like addressing gaps in where trees are planted in the city or creating forums for youth to design and participate in democratic debates about the ethics of genetic engineering.	
Explain: "Chapter 11 of the *Framework* specifically addresses inclusive instructional strategies that are needed to promote equity in science education. They address three that can be related specifically to phenomena and how students make sense of them. For the purposes of promoting equity, it crucially describes how science learning is always a cultural process. It is important that instruction make connections with students' everyday experiences instead of emphasizing discontinuities with their everyday lives. It needs to connect to the things young people care about and to how they see themselves. These are important for equity because it is too easy to communicate the idea that 'other people' do science, or to focus attention on aspects of experience that are remote from students' lives. We want to pick phenomena that meet the criteria of "being observable" to the students in our classrooms. If we are not careful, we can make wrong assumptions about what those are. Another place to emphasize continuity between science and everyday lives is to make specific questions to values and practices of students' families and cultural communities. For example, in some Native American communities, keen observation is a skill adults seek to cultivate in children. Instruction can help students build bridges between values (persistent looking over time, noticing small changes, etc.) and particular practices to those of scientific forms of observation and ideas that one might find in an ecosystems curriculum. We can choose phenomena that explicitly bring	

Facilitator Notes	Accompanying Slide(s)
these values and practices to bear on explanation or solutions to problems. Third, inclusive instruction begins with the premise that young people already possess ways to communicate their ideas about phenomena they encounter in their everyday lives. This is different from deficit about the linguistic resources of English learners, or when students don't use scientific terminology in their explanations. Vocabulary and scientific terminology emerges from efforts to make sense of phenomena and give a name to things that, for most of their investigations, should empower youth to use whatever means they have available to communicate their thinking, from their native language to drawing to gesture."	
Facilitator Notes: *Read this quote.*	
Explain: "Here are some examples of design challenges that could be included in a unit of study and associated with a phenomenon. Notice that design challenges don't necessarily imply building something." *Facilitator Notes:* *Depending on the understanding of your audience, you may wish to ask participants to identify other possible design challenges. If others are mentioned, ask if it meets the criteria previously identified.*	

Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Remind participants of the learning that participants experienced in this session.*	
Facilitator Notes: *Allow participants time to reflect on their learning by responding to these questions in their notebooks. If time allows, ask them to share in small groups, tables, or randomly with others.*	

Preparation for Session C: Analyzing Performance Expectations

Print Materials Needed:

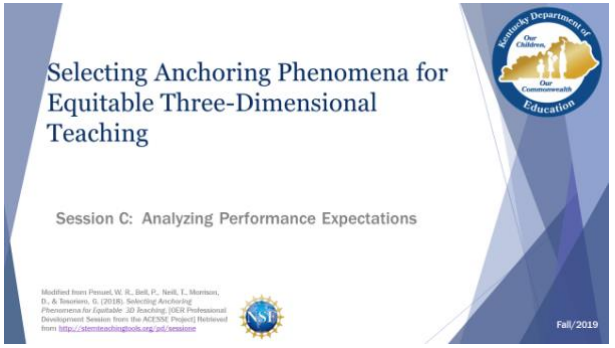
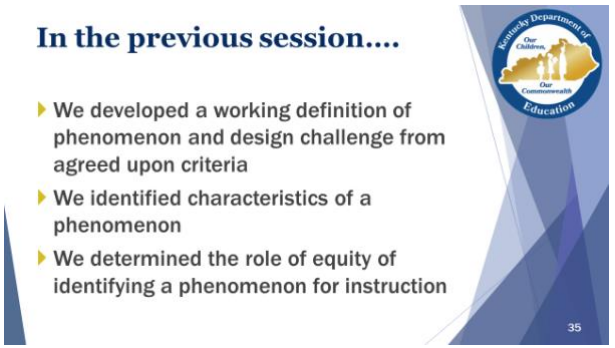
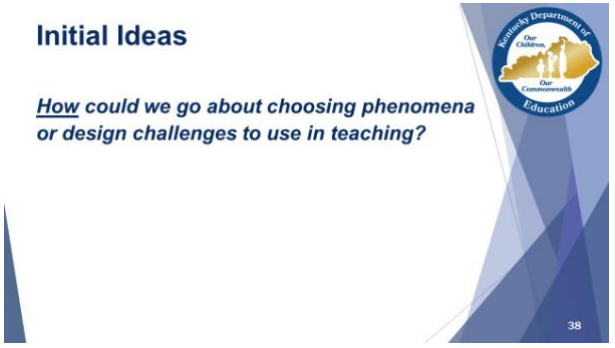
After identifying which bundle of performance expectations will be analyzed, participants will need access to the appropriate chapter in the *Framework for K-12 Science Education*. Downloads for these chapters are free from the National Academies Press. You can print copies of the materials at the links provided, have participants print their own copies or, if available, utilize hard copies of the book. If participants are responsible for printing their own copies, please specify that and provide necessary links within the invitation to the work session. If you are providing copies, ensure that you have a sufficient number for each participant.

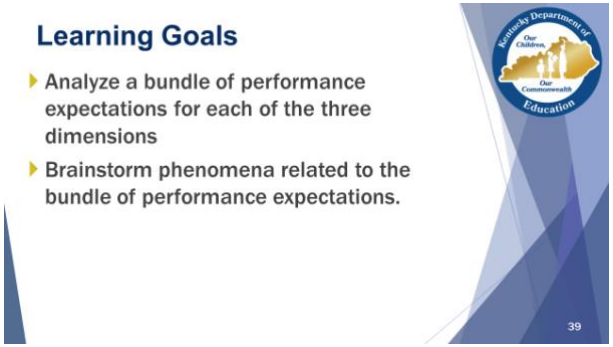
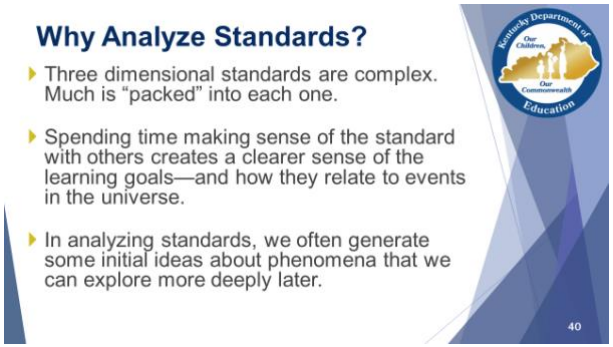
- Chapter 5 Dimension 3: Disciplinary Core Ideas—Physical Sciences
- Chapter 6 Dimension 3: Disciplinary Core Ideas—Life Sciences
- Chapter 7 Dimension 3: Disciplinary Core Ideas—Earth and Space Sciences

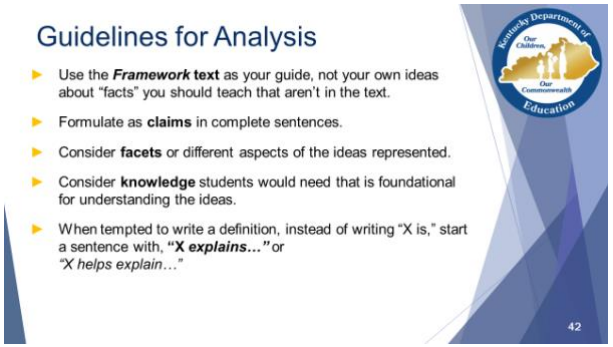
Materials Needed:

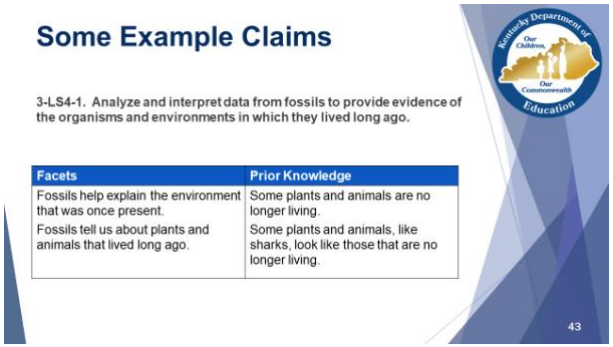
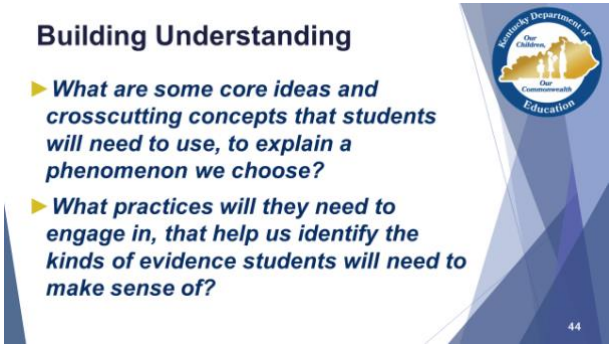
- Chart Paper
- Markers
- Slide deck of bundled performance expectations

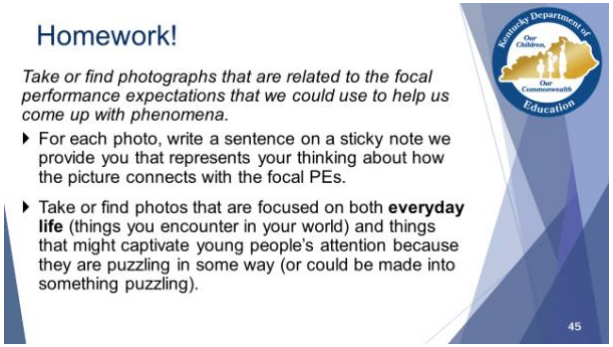
Session C: Analyzing Performance Expectations

Facilitator Notes	Accompanying Slide(s)
	
Facilitator Notes: *Use the information in this slide, and any observations from the last session, to remind participants of the discussions and learning addressed in the previous discussion. You may also wish to remind participants of the group norms, agreed upon during Session A.*	
Explain: "In this session you will gain practice with analyzing standards and exploring techniques for brainstorming phenomena. We will also generate together a definition of what a phenomenon is and how it is different from engineering design and disciplinary core ideas." *Facilitator Notes:* *This discussion is key to generating additional criteria for what make a good phenomenon. You can start by pointing out preliminary criteria but then emphasize that you are asking HOW they might go about the process. In a storyline unit, putting the students in charge of the direction for the process is important when thinking about equity. Participants will likely identify tasks that they have always used to engage students but may not be related to student interest or*	

Facilitator Notes	Accompanying Slide(s)
addressed through the standards. Record ideas and share that the process upon which they will embark is just one way phenomena may be identified. Emphasize that there can be other ways and that inspirations for phenomena can come up at any time	
Facilitator Notes: *These are the learning goals for this session.* *Some of your participants may have experienced a standards analysis process in the past. As such, you may ask them to assist participants not comfortable with this process. The process this session proposes is one method. The important point made here is that understanding the intent of the scientific concept is key to identifying a viable anchoring phenomenon for designing instruction.*	
Explain: "You might wonder why we are stopping to analyze standards and not taking them at face value to guide our brainstorming. We start with analysis for three reasons. 1. There is a lot "packed into" a single standard, especially as there are three dimensions within each standards that students need to master. 2. When we talk about these together, we get a shared sense of the learning goals. 3. We often come up with some initial ideas for phenomena. If we skip over this step, this short-circuits opportunities to deepen our understandings of the performance expectations. The process of selecting a phenomenon is an iterative process. It often comes back to this analysis, along with other considerations we have identified as key criteria for a good phenomenon, like personal or cultural relevance."	

Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Pairs of performance expectations (PEs) have been identified for each grade band (elementary school, middle school and high school) and each science domain (physical science, life science and earth systems science). It is recommended that all participants analyze the same pair of the PEs so that a larger group discussion may occur. Each pair is presented on a slide from the accompanying slide deck. Choose the pair you are using and insert into this presentation. Allow approximately 20 minutes for the analysis. The purpose of this session is to provide some experience in standards analysis so that phenomena appropriate for instruction may be identified. A full analysis of the standards will require more time than allotted here.*	
Explain: "Here are a few guidelines to help you get started with the analysis. First, use the *Framework* text as your guide and not your own ideas about what students "should" know. Sometimes those are in the *Framework*, but many times when we bring our own ideas we bring the "facts" and not the "big ideas behind the facts." The *Framework* emphasizes the latter, as well as relationships among those big ideas. Pay attention to those when unpacking. The *Framework* was trying to narrow content that is taught around specific topic and to create cohesive progressions of ideas. Second, don't just use single words or ideas when you analyze. Write full sentences and think of them as claims that students should be able to elaborate upon and defend with evidence. Each sentence in the *Framework* packs in a lot of ideas. Think about the different facets or aspects of the idea that go into understanding what the sentence means. Some of the knowledge is assumed students will bring from elementary school. Use the *Framework* text about grade band expectations to develop claims that go in the right hand column of the analysis.	

Facilitator Notes	Accompanying Slide(s)
Analyzing can take us backward from the vision of the *Framework* if we're not careful. We could wind up with a lot of definitions we think we are supposed to teach. Discipline yourself: every time you are tempted to write a definition, identify the concept or idea that would help you explain."	
Explain: "Here is a sample analysis from a third-grade performance expectation." *Facilitator Notes:* *This may not be a complete analysis. This sample is provided to help participants think about facets for understanding. Allow approximately 20 minutes for participants to individually analyze the pair of PEs.* *It is recommended that participants copy this 2-column organizer in their notebooks for their analysis.* *Insert the slide with the pair of PEs that participants will be analyzing and discussing after this slide.*	
After the 20 minutes individual analysis **Explain:** "Get together in small groups of 4 or 5. As a small group discuss and record your ideas to the questions listed here." *Facilitator Notes:* *Allow approximately 15 minutes for this discussion. Debrief the small group discussion.*	

Facilitator Notes	Accompanying Slide(s)
This discussion will surface what the group came up with in their analysis. At this point, it may be valuable to record ideas either on a Google doc that the group can use together or on chart paper. As much as possible, try to capture all of the ideas, big and small, from groups. Some talk moves that be helpful include: • *"Does any other group have this idea?"* • *"What other ideas are not up here that are important for students to master?"* • *"What aspects of the practice are really highlighted in these PEs?"*	
Explain: "We have homework for you. Take some photos of everyday processes or objects that are in some way related to the standards you have analyzed."	

Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching

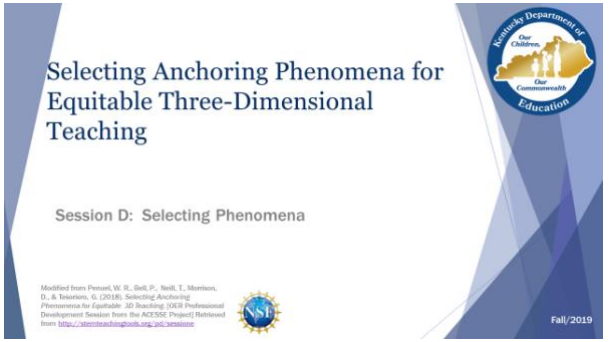
Preparation for Session D: Selecting Phenomena

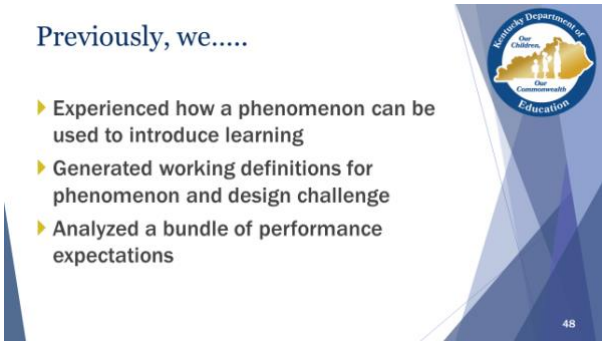
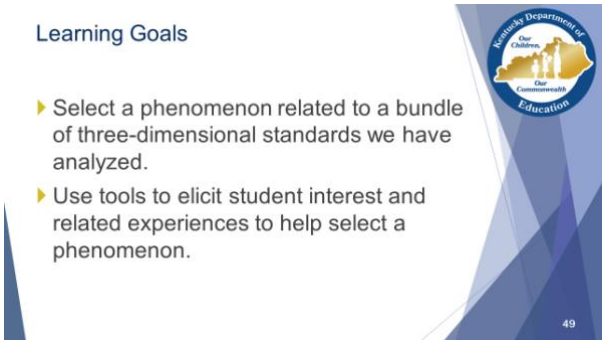
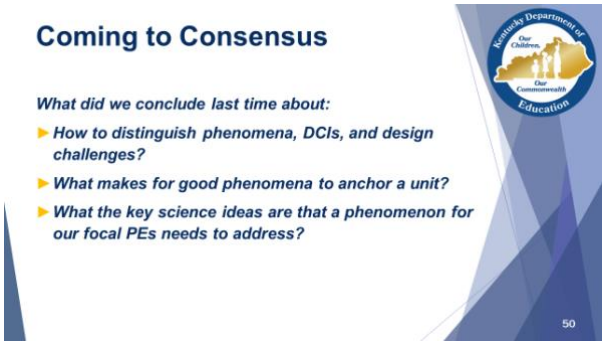
Materials Needed:

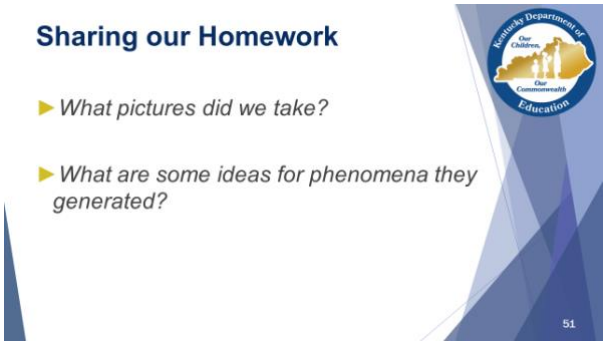
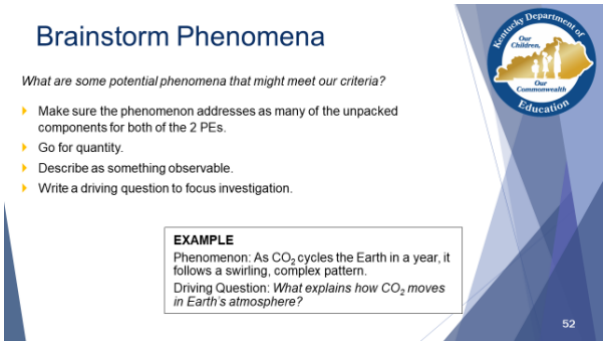
- Chart paper
- Markers
- Post-It Notes
- Previous charts with criteria for phenomena, design challenges and disciplinary core ideas

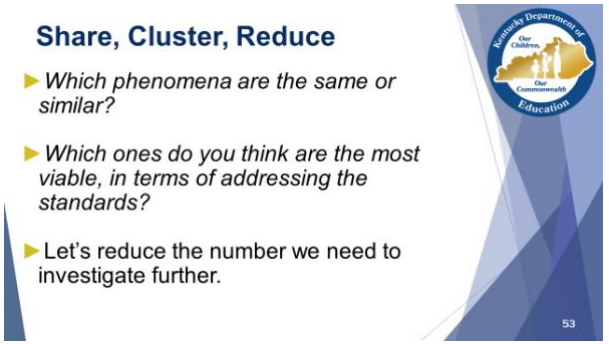
A component of this session is the sharing of the homework. In order to facilitate this sharing, participants can post their images and descriptions when they first walk in. In this way the "gallery" for the Gallery Walk is set up for easy review.

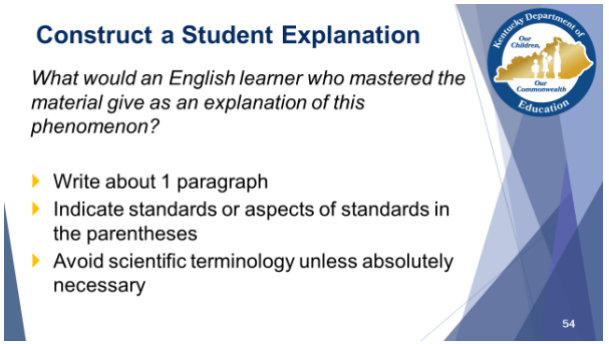
Session D: Selecting Phenomena

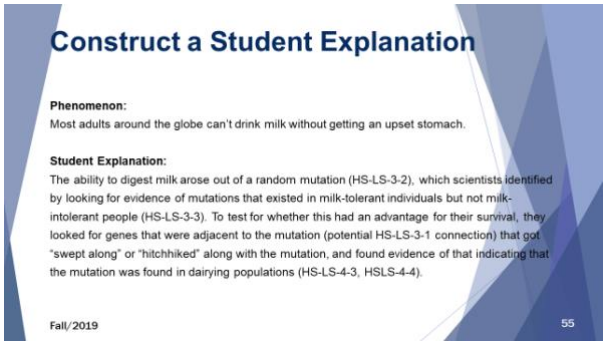
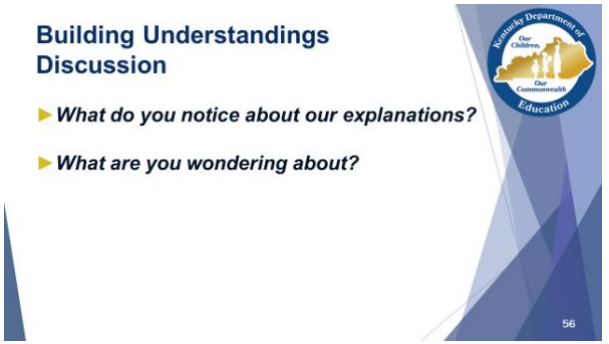
Facilitator Notes	Accompanying Slide(s)
	

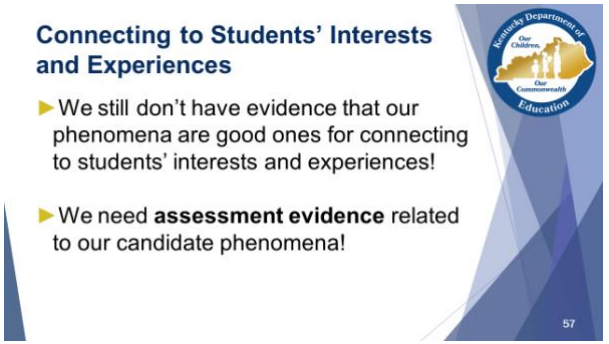
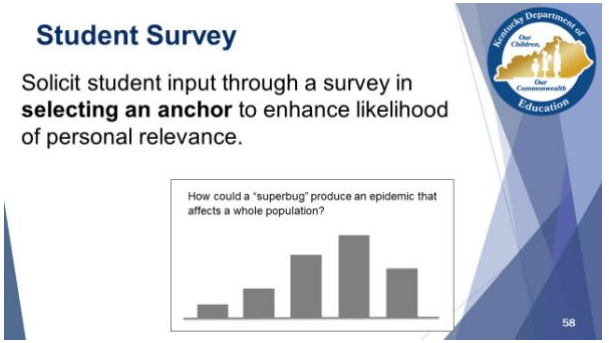
Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Use the information in this slide, and any observations from the last session, to remind participants of the discussions and learning addressed in the previous discussion. You may also wish to remind participants of the group norms, agreed upon during the previous sessions.*	
Explain: "In this session we will engage in learning experiences that prepare you to: • select a phenomenon related to a bundle of three-dimensional standards that have been analyzed; and • use tools to elicit student interest and related experiences to help select a phenomenon"	
Facilitator Notes: *Begin with taking stock of where the group left off in the last session. The answers to these questions may depend on going back to sheets posted on the wall during Session B. Before going on, make sure all participants have a chance to recall what the group came to consensus on last time.*	

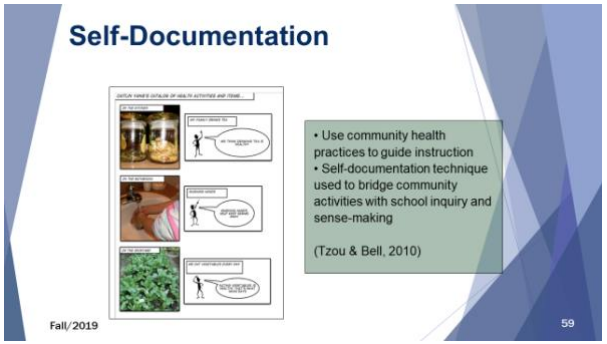
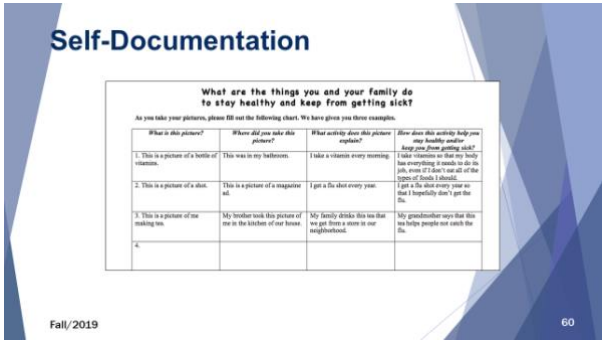
Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Provide participants with an opportunity to post their photos and sticky notes on a wall and let them do a "gallery walk" to look at the pictures. Hold a whole group discussion to get thinking started about phenomena. Record their ideas on chart paper.*	
Explain: "Now we will brainstorm a few more ideas for phenomena. Let's adhere to these rules for this brainstorming. • Make sure the phenomena address as many of the unpacked components for both PEs • Go for quantity • Describe as something observable • Write a driving question to focus investigation" *Facilitator Notes:* *Have people create half-sheet Post-It and post their ideas on the wall as they generate them. Alternatively, these could be written on index cards or cut up sheets of paper. The idea is to have the information in a form that is easily manipulated.* *After approximately 10 minutes* **Explain:** "Now is the time to go back and grab these from where you've written them down and put them in our shared space."	

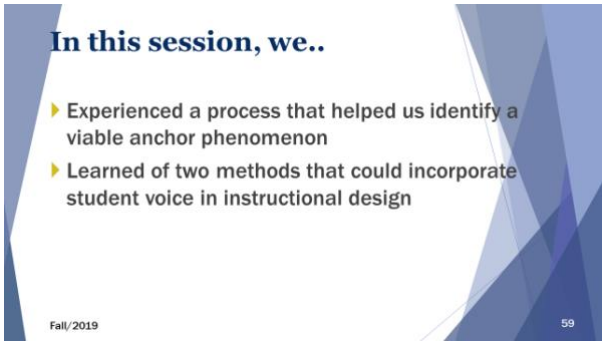
Facilitator Notes	Accompanying Slide(s)
Explain: "Now we need to share our best ideas in a common space. Put yours there then take 5 minutes to read them over." *After 5 minutes:* "Let's first cluster phenomena that are either the same or that we think could go together, meaning that we could combine some parts of them. We'll then narrow our list further into 2 or 3 ideas. In reducing the list, focus on viability, that is, the potential for students to need ALL THE IDEAS addressed in the standards we analyzed." *Facilitator Notes:* *To reduce the number, you can invite participants to indicate their preference by adding a star to the ideas they think is a good candidate phenomenon for the pair of PEs. The top 2 or 3 phenomena will be those that will be used in the next steps of this session.* *The reduction is necessary because the next step is to write student explanations of phenomena. It is typical for participants to take some time when constructing explanations to learn the science associated with a phenomenon. Therefore, leaving sufficient time for that requires a reduction in phenomena the group will consider. Leaving an idea behind doesn't mean it has to be abandoned completely. The full list of candidate phenomena could be a resource for participants to use on their own. Thus, there are two basic steps here: the clustering of ideas and voting on the 2-3 that will most likely require the use or application of the DCI in the bundled PEs to explain (i.e. viable).*	

Facilitator Notes	Accompanying Slide(s)
Explain: "For our narrowed list of candidate phenomena the next step is for you to write a brief student explanation, in student-friendly language, of one of the phenomena. Indicate in parentheses where the phenomenon connects with either some facet of understanding from the phenomenon or the PE as a whole. We suggest that you write these explanations using plain language, not scientific terminology, or imagine what an English learner would write as an explanation after a successful instructional experience with the phenomenon. By brief, aim to get the gist right. We'll write a more elaborated explanation later once we've picked our phenomenon. At this stage, we just want to use this as a further check on the viability of the phenomenon. If you have time you can also name possible design challenges that could be linked to your phenomenon. What is something students could do that is personally relevant and makes science instruction more meaningful to them because they have a chance to do something with the explanation of their phenomenon?" *Facilitator Notes:* *If there are three ideas identified, have participants number off 1-3. Participants will then write the explanation for the phenomenon associated with their number.*	

Facilitator Notes	Accompanying Slide(s)
Explain: "Here is a sample explanation from a different area of science. In this explanation there is little use of scientific terminology ("mutations") but does use a lot of kid friendly language ("swept along") to explain what happened such that some adults can drink milk into adulthood while others can't. Again, this is not a complete explanation, but it is a start. Notice how the PE is identified for specific aspects of those standards. *Facilitator Notes:* *Allow approximately 20 minutes for the writing of the explanations.*	
Facilitator Notes: *In order for participants to share with one another, those with the same phenomenon can get together to read their explanations aloud. Alternatively, you may wish to set up separate folders (one for each phenomenon) of which participants have access. Participants can upload their explanation, allowing each to read one another's explanations.* *The explanations are likely to include some common components and some unique ones. This discussion is an opportunity to construct a shared explanation for each of the 2-3 phenomena under consideration. At this point, groups sometimes realize the phenomenon is not as good as they thought. Some phenomena require science ideas that are more advanced than the grade level requires. Others require science ideas that are peripheral or unrelated to the disciplinary core ideas. Others, still, may be too simple and, therefore, be better as investigative phenomena.*	

Facilitator Notes	Accompanying Slide(s)
Explain: "From an equity perspective, it is important to gather evidence that a broad range of students in our classes might see some relevance to these phenomena. We want to know what boys and girls, students of color, students from different kinds of families might all find a point of connection to what we're studying. We also want to use this opportunity to identify additional candidate phenomena that students might help us generate now that we have a sense of what might or might not be viable. We will look at two methods for developing this evidence that can be used at this point in the process for accomplishing these aims: a student survey and self-documentation." *Facilitator Notes:* *Share that these are just two ways that teachers could get student input into the identification of phenomena within the unit of study. Participants may have other ideas that could be used. After sharing these, you may wish to probe participants about these other ideas.* *Note: Assessment in this case does NOT refer to testing. What is referred to here are methods by which we can "test" how well our candidate phenomena may be in the development of an instructional unit.*	
Explain: "One method is a student survey. In this method, a simple 8-10 item survey, taken from student driving questions and vetted phenomena, is developed. It askes students to rate interest on a Liker scale for each of the questions. A simple google form can be used and patterns in the results can inform you as to the viability of the selected phenomena. An interesting pattern to explore could include differences in gender: are there some phenomena that show a stronger interest in boys over girls."	

Facilitator Notes	Accompanying Slide(s)
Explain: "Another method, used by Carrie Tzou and Philip Bell, is self-documentation. This process can be used to expand our list of candidate phenomena, not just review what we have."	
Explain: "Similar to your homework, students were asked to take photographs of, in this example, health practices in their community. For each picture, students identified what was in the picture, where the picture was taken and what activity the picture explained. Students were also asked to write about how they understood the activity in the picture to be related to staying healthy or getting well."	
Explain: "The teacher took all of these photos, sorted them and generated a list of community health practices and topics that involved microorganisms. This list became a source of possible investigations students would carry out to learn more about microorganisms in their community."	

Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Use this slide to wrap-up this session and address any issues that have arisen.*	

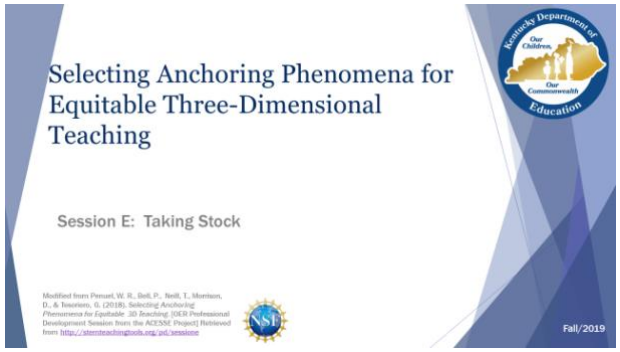
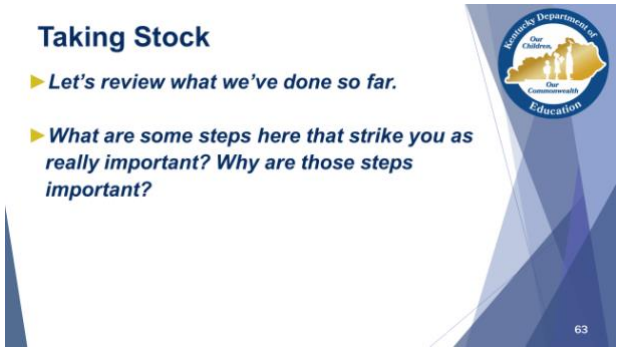
Selecting Anchoring Phenomena for Equitable Three-Dimensional Teaching

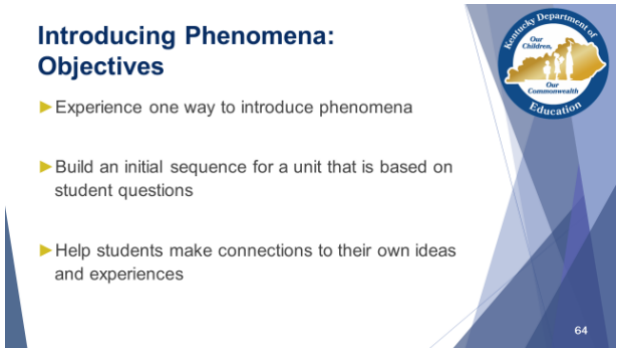
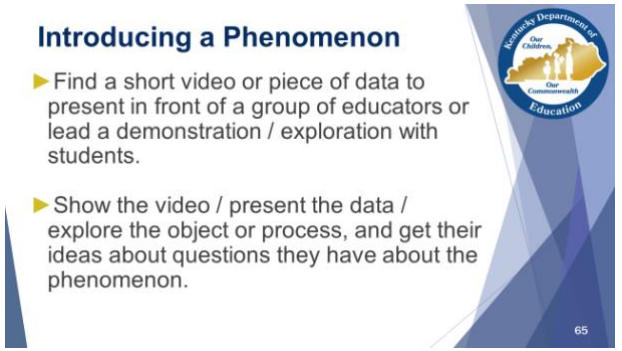
Preparation for Session E: Taking Stock

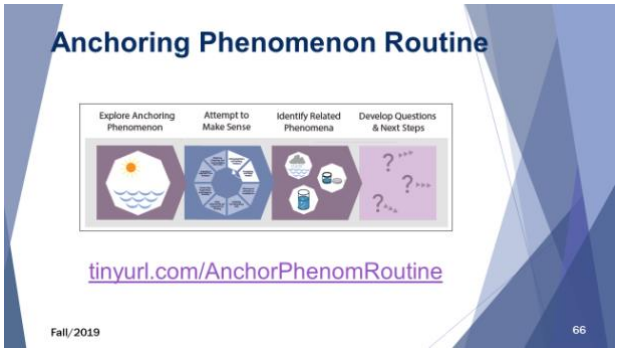
Materials Needed:

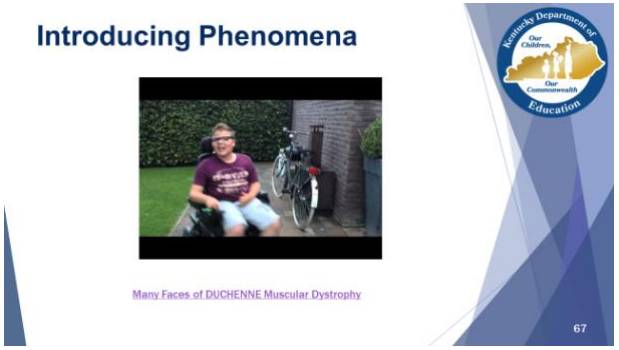
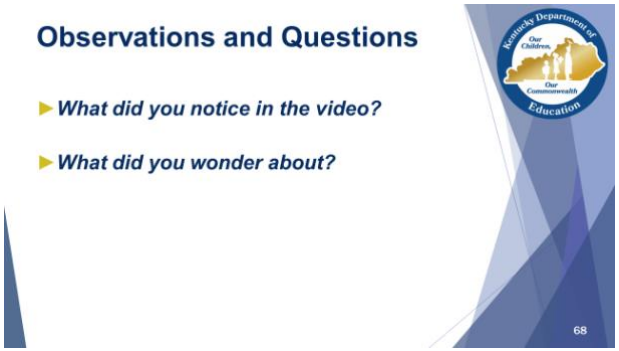
- Chart paper
- Markers

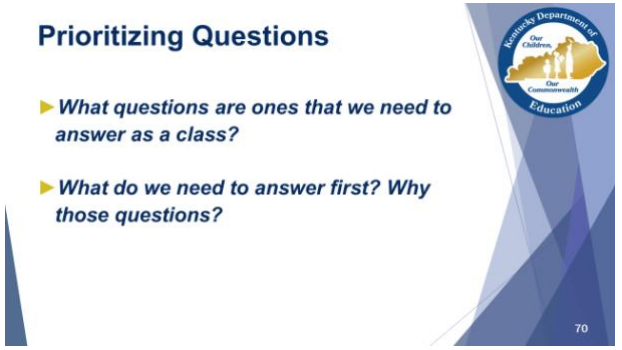
Session E: Taking Stock

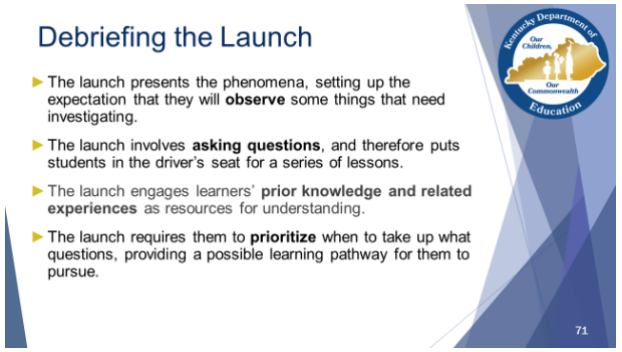
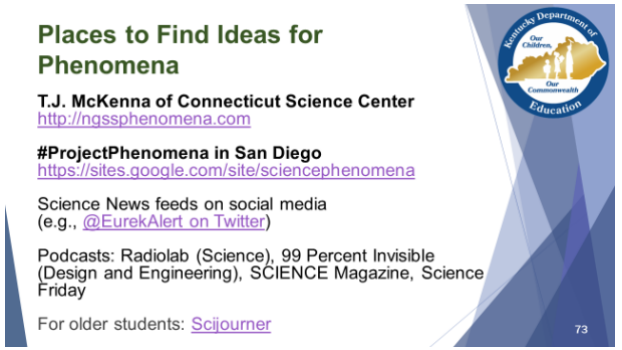
Facilitator Notes	Accompanying Slide(s)
	
Facilitator Notes: *Use this slide to review the learning and steps in identifying an anchoring phenomenon for instruction.* *After sharing the general review, ask participants to turn to a partner and talk for a minute about the questions posed in the second bullet. Ask participants to share out their ideas.*	

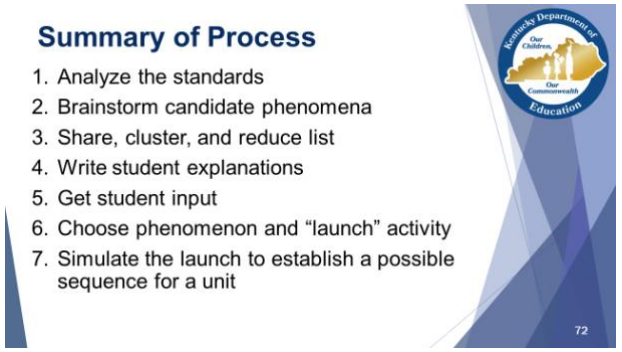
Facilitator Notes	Accompanying Slide(s)
Explain: "In this last session you will experience one way to introduce a phenomenon to a group of students. It will illustrate how an initial sequence of lessons can be built from student questions, as well as how to connect students' own experiences to the phenomenon you have chosen, in ways that make use of their own ideas and experiences to help set a direction for the class." *Facilitator Notes:* *More information about the Next Generation Storylines can be found at* http://www.nextgenstorylines.org/	
Explain: "It can be valuable to seek out some 'stimulus'—a video, a piece of data, a demonstration, a brief exploration of some physical design or phenomenon you bring into the classroom—and actually simulate with other educators an initial anchoring event or what we sometimes call a 'launch'. Running a launch can reassure us that the phenomenon we have selected will generate questions that, if students answer them, will require they engage in practices to develop understanding of the core ideas and crosscutting concepts targeted in the bundle of PEs. This involves a routine that we'll go through ourselves in a moment and that makes use of an anchoring video that launches a genetics unit. You'll notice there are no words in this video, just pictures and sounds. No science is given away, but hopefully as it does for students, it will provoke a lot of 'noticing and wonderings' we'll capture at the end."	

Facilitator Notes	Accompanying Slide(s)
Explain: "What we will simulate with you as participants is something the Northwestern Storylines team calls an Anchoring Phenomenon Routine. The steps of this routine are shown in the graphic. You can find a detailed template for developing such a routine for your phenomenon at their website. Now we'd like to invite you to participate as students would in the first day of our project-based unit in genetics."	
Facilitator Notes for the upcoming learning experience: *This part of the session parallels slides 8-10 from Session A, though it goes into greater depth and allows for participants to experience an anchoring phenomenon routine as developed by the Next Generation Storyline project. Reviewing this resource ahead of time will help you plan for this particular part of the session, as will going through the experience as a student might experience it.* *After watching the video, this routine always begins by creating a public record of individuals' noticings and wonderings. A good equity strategy is to use a think-pair-share approach and to get every group's ideas recorded on chart paper, with noticings on one sheet and wonderings, framed as questions, on a separate sheet. Generating initial ideas for an explanation or model of the phenomenon is key to helping students (participants) realize there is a lot they don't know about what's portrayed here. This initial explanations or models set the stage for students to propose investigations to test their initial ideas.* *Prioritizing questions is a critical step in building a shared mission for the class. It begins with writing more questions, posting all of the students' questions on the wall and then inviting participants to 1) group these questions, 2) argue for which ones should be taken up by the class, and 3) putting them in some order that makes logical sense.*	

Facilitator Notes	Accompanying Slide(s)
The facilitator can present that final prioritization as something of an outline of a storyline that can be used to devise a unit.	
Facilitator Notes: *While participants are watching the video, ask them to write down things they observe as they watch.*	
Facilitator Notes: *Write down on two chart sheets answer to the questions on the slide that participants give.* *Don't judge any ideas, but do ask for clarification.* *Listen for participant responses to the "notice" questions such as:* • *Young boys all around the world* • *Have trouble getting around/moving, not stable, seem weak especially in their legs and arms* • *Fingers and 'fine motor' skills worked OK.* • *We see ways they are being cared for. Care is different depending on where they are in the world.* • *Looked like they were going to Pt to help, move bodies, some involved water* • *There wren't any adults having problems.* • *There weren't any girls affected in the video.* • *The parents in the video (we think the adults were parents) seemed healthy.* *Listen for questions such as:*	

Facilitator Notes	Accompanying Slide(s)
• *Why is this happening to these boys?* • *What's happening to them?* • *Was it an accident?* • *Were they born this way?* • *Can it be fixed? Should it be fixed? (These 2 questions get at the idea of different opinions/values that can be discussed).* • *Are they going to die?* • *Why only boys? Why no adults?*	
Facilitator Notes: *Write down on chart paper answers to the questions on the slide that participants gives. Listen for ideas related to genetics, inheritance, as well as some ideas that are potentially off base. Be sure not to judge any ideas, not just because adults are playing as students but because we want to model at this point all ideas are plausible.* *Note: This priming of students is a good formative assessment moment to find out what they are bringing. By engaging them in initial hypothesis formation, this helps create a motivation to learn about the key ideas.*	
Facilitator Notes: *Take the group through a process of prioritizing questions. Seek to have participants justify why some questions must come before others. This will help to set out a storyline for the class to follow, to come up with an explanation for the phenomenon.* *Note: Sometimes we can also ask students to build an initial model of the phenomenon and then engage in yet another round of question posing before prioritizing the questions and building our class' storyline.*	

Facilitator Notes	Accompanying Slide(s)
Explain: "Notice three things that just happened in this activity. • The launch presented the phenomenon, setting up the expectation that they will observe some things that need investigating. • The launch engaged students in asking questions and, therefore, puts students in the driver's seat for a series of lessons. • The launch asked them to come up with initial ideas and related phenomena • The launch required students to prioritize when to take up what questions, providing a possible learning pathway for them to pursue. We use this process once we select a phenomenon to help us build a storyline. It is very successful in laying out a potential sequence of learning experiences where students are in the driver's seat, even though we do guess wrong sometimes. We use evidence from how things go in the classroom to make adjustments as we go."	
Explain: "Where can you find good ideas for phenomena after analyzing the targeted standards? Here just a few possible resources."	

Facilitator Notes	Accompanying Slide(s)
Facilitator Notes: *Use the information in this slide to summarize the process participants went through in identifying a potential anchoring phenomenon and next instructional steps.*	
Facilitator Notes: *This resource was modified from the NSF ACESSE Project grant. The developers would like feedback to help them improve this resource. Please ask participants to complete this 5 minute survey. Clarify that this is information for the ACESSE team to refine the module and not about you as the facilitator.* *http://tinyurl.com/ACESSEResource*