



# Next Generation Science Standards

An Introduction to Implementation...

OR

How do I do this in the classroom?



Science Professional Learning  
March 2015



# Next Generation Science Seminar

## Today's Agenda

- Instructional Support
- Sample Instructional Sequence
- Model-Based Inquiry Process



# What Is Going On Here?



## 1. Incorporating Anchoring Events into Classroom Instruction

<https://www.youtube.com/watch?v=x1SgmFa0r04>



# 2. Unpacking A Standard

## SS3-4 Earth and Human Activity

Students who demonstrate understanding can:

**HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.\*** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

### ESS3.C: Human Impacts on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

### ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*secondary*)

### Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

### Connections to Engineering, Technology, and Applications of Science

### Influence of Science, Engineering, and Technology on Society and the Natural World

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to

Connections to other DCIs in this grade-band:

**HS.LS2.C ; HS.LS4.D**

Articulation of DCIs across grade-bands:

**MS.LS2.C ; MS.ESS2.A ; MS.ESS2.E ; MS.ESS3.B ; MS.ESS3.C ; MS.ESS3.D**

Common Core State Standards Connections:

*ELA/Literacy -*

**RST.11-12.1**

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-4)

**RST.11-12.8**

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-4)

*Mathematics -*

**MP.2**

Reason abstractly and quantitatively. (HS-ESS3-4)

**HSN.Q.A.1**

Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS3-4)

**HSN.Q.A.2**

Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS3-4)

**HSN.Q.A.3**

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS3-4)

# Evidence Statements

Modeling

Explanation

Revision

Reasoning

Analysis

3. Evidence Statements can guide instructional planning.

<http://www.nextgenscience.org/ngss-high-school-evidence-statements>

<http://education.vermont.gov/pbgr>

# Scientific Modeling

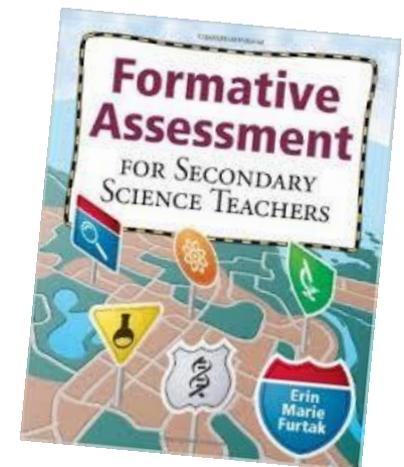
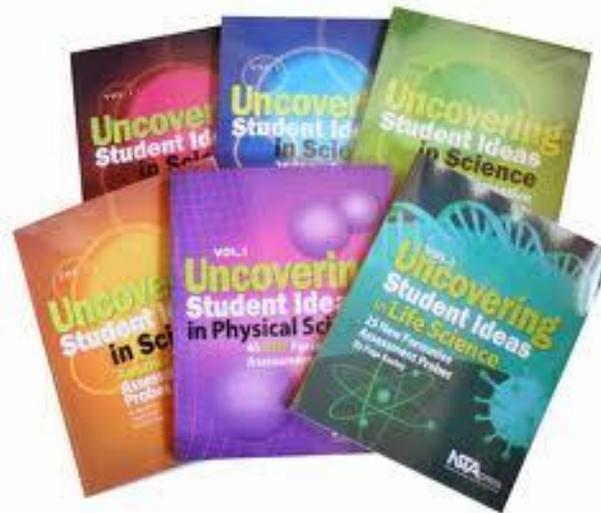
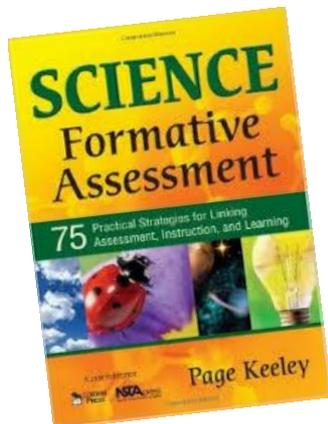


4. Provide opportunities for students to develop models to make their thinking visible.

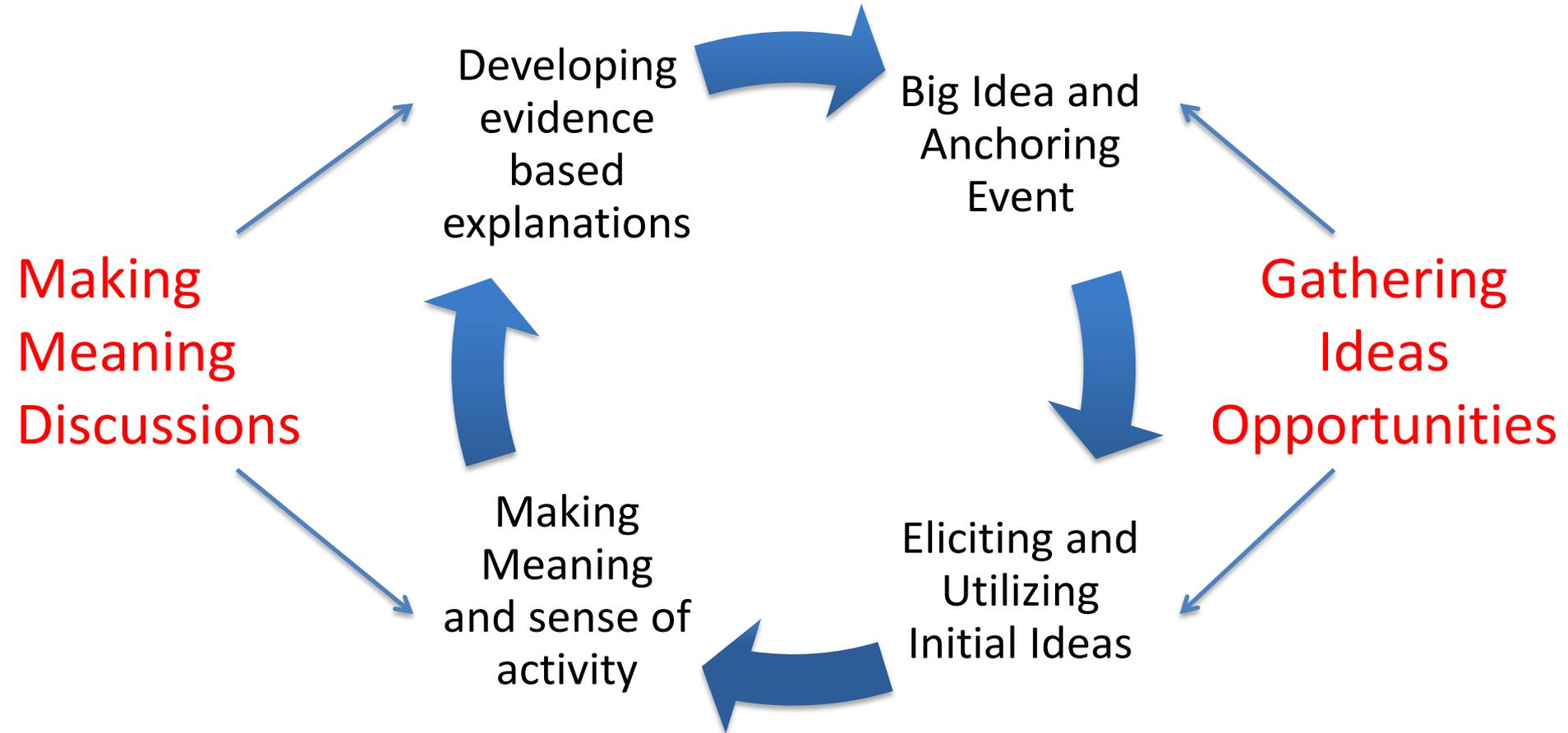
[Developing and Using Models Video](#)

# Formative Assessment

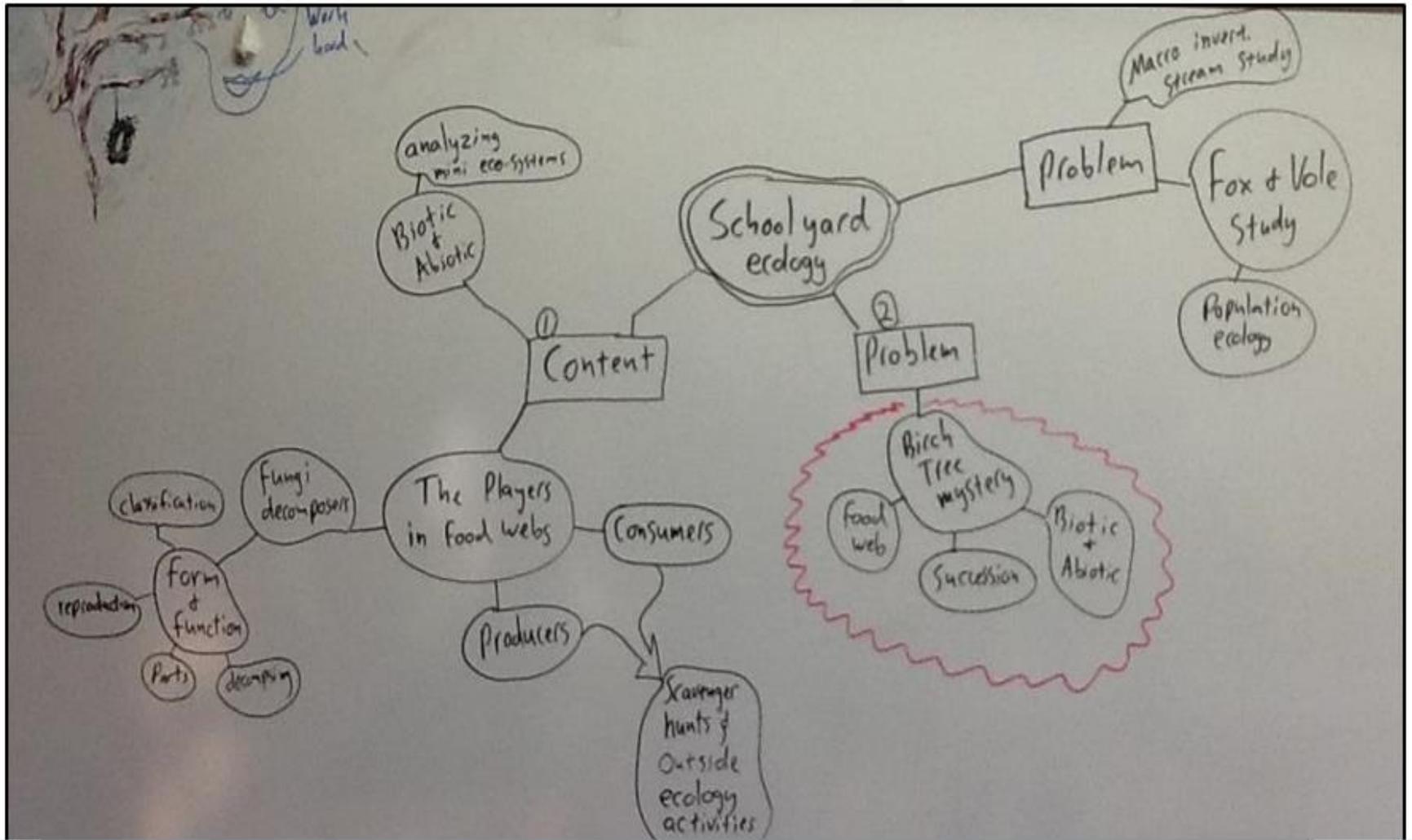
5. Incorporate formative assessment and feedback into classroom instruction.



# Model Based Inquiry



# 6. Instructional Sequence -- Context



# Big Ideas...

**MS-LS2-1** Analyze and interpret data to provide evidence for the **effect of resource availability** on organisms and populations of organisms in an ecosystem. (PBGR 4a)

**MS-LS2-3** Develop a model to describe the **cycling of matter and flow of energy** among living and nonliving parts on an ecosystem. (PBGR 4c)

**MS-LS2-4** **Construct an argument** supported by empirical evidence that **changes** to physical or biological components of an ecosystem **affect populations**. (PBGR 4d)

- **Stability and Change:**--Students learn that small changes in one part of a system might cause large changes in another part.
- **Cause and Effect:** -- Students classify relationships as **causal or correlational** and recognize that correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems.

# An Example...

Highlights of a MS Instructional Sequence...

**-Scene of the Crime:  
A Forest Mystery!-**



Birch Tree

# Culminating Activity/Performance Task

On the basis of evidence gathered through multiple sources (observations, investigations, multi-media, discussions, text), students individually **construct an argument** supported by evidence for the **probable cause of the vegetative demise**, including the role of other organisms in the process. The individual written analysis should also include:

- **claim** (final claim after considering all evidence)
- **evidence** (as collected through individual and group learning experiences)
- **reasoning** (that conveys the scientific understandings for why this occurred)
- **rebuttal** (describe alternative explanations and provide counter evidence and reasoning for why other alternatives are not appropriate)

Dear Forensic Scientists,

I am writing to you with utmost urgency! Over the past season we have discovered that the leader of the local Betula - Papy gangland family has been murdered!



What is worse is that the body of this gangland Boss has been found in various states of decay! Some of his body parts were almost alive, and others appear to have been dead for several years. During surveillance of this Boss over the past few years, our field detectives noticed that his tops appeared to have turned brown, while the leaves on his lower branches were still green. By the time the detectives arrived on the scene it was too late, and the Boss was completely dead!

It is your task to discover who or what is responsible for this crime. We were able to collect the remains of this casualty and bring them to your laboratory. Please review all of the evidence and other resources provided in order to recommend a solution for this "whodunit" mystery.

Thank you for your hard work. The Agency looks forward to seeing your recommendations for a solution to this mystery!

Sincerely,

**Carl R. Betz**

**Detective Inspector General,**  
Interpol, FBI, KGB and NSA

Anchoring Phenomenon

# Observations...

## Forensic Stations—Observation Sheet

Name \_\_\_\_\_

<p><b>STATION</b> For each Station—record observations in your Laboratory Notebook—(sketches or diagrams with labels, written descriptions)</p>	<p><b>What is the evidence</b> at this Station that other organisms are obtaining nutrients from the birch tree?</p>	<p>At this Station <b>who</b> are the <b>suspect organisms</b> that may have 'damaged' the birch tree or that may be dependent upon the birch tree for nutrients? (Hint: In your Team review resource Articles.)</p>	<p>Cite <b>supporting evidence</b> from the Birch resource Articles to support your claim for each Station.</p>
<p><b>A</b></p> 			
<p><b>B</b></p> 			
<p><b>C</b></p> 			

Eliciting and Utilizing Initial Ideas

# Create a Food Web



# Paper Birch

# Close Reading Worksheet

## Model for Explicit Instruction of Complex Text

Text "Chunked"	Vocabulary	Text-based Questions/Expected Responses
<p><b>Climate:</b></p> <p>Paper birch is a northern species adapted to cold climates. It seldom grows naturally where average July temperatures exceed 70°F.</p> <p>Paper birch tolerates wide variations in the patterns and amounts of precipitation. In general, the climate where paper birch is found has short cool summers and long cold winters during which the ground is covered with snow for long periods.</p> <p>Paper birch grows on almost any soil and topographic situation ranging from steep rocky outcrops of the mountains to flat muskegs of the boreal forest. The poorest site-index values were obtained for the driest and wettest sites of the range sampled, whereas higher values were obtained for the moist and nutrient enriched habitats. In New England paper birch tends to be more abundant on the dry sites than on the wet or poorly drained soils.</p> <p><b>Growth and Yield</b></p> <p>Young paper birch grows rapidly. Individual trees often have a diameter of 8 inches after 30 years. With age, the growth rate declines, and in old age it becomes</p>	<p>adapted</p> <p>tolerates</p> <p>abiotic</p> <p>topographic</p> <p>muskeg</p> <p>boreal</p> <p>diameter</p> <p>negligible</p>	<p>What temperature range allows for the best birch growth?</p> <p>Describe the ideal precipitation and climate for birch tree growth</p> <p>What are the key soil conditions that contribute to the overall growth of the birch trees?</p> <p>How wide will a birch tree be after 60 years?</p>



Gathering Ideas Opportunity

# Accusations Worksheet

What is the role of each Organism?



Suspect organism	INNOCENT? GUILTY? ACCOMPLICE?	What is the evidence to support your accusation? <u>From the stations</u>	What is the evidence to support your accusation? How does this organism get its nutrients? <u>From the clue cards/resources</u>
Lichen			
Birch polypore			
Bronze birch borer			
<u>Lezites betulina</u>			
Downy Woodpecker			
<u>Chaga</u> Mushroom			

Making Meaning Activity



# The Trial...



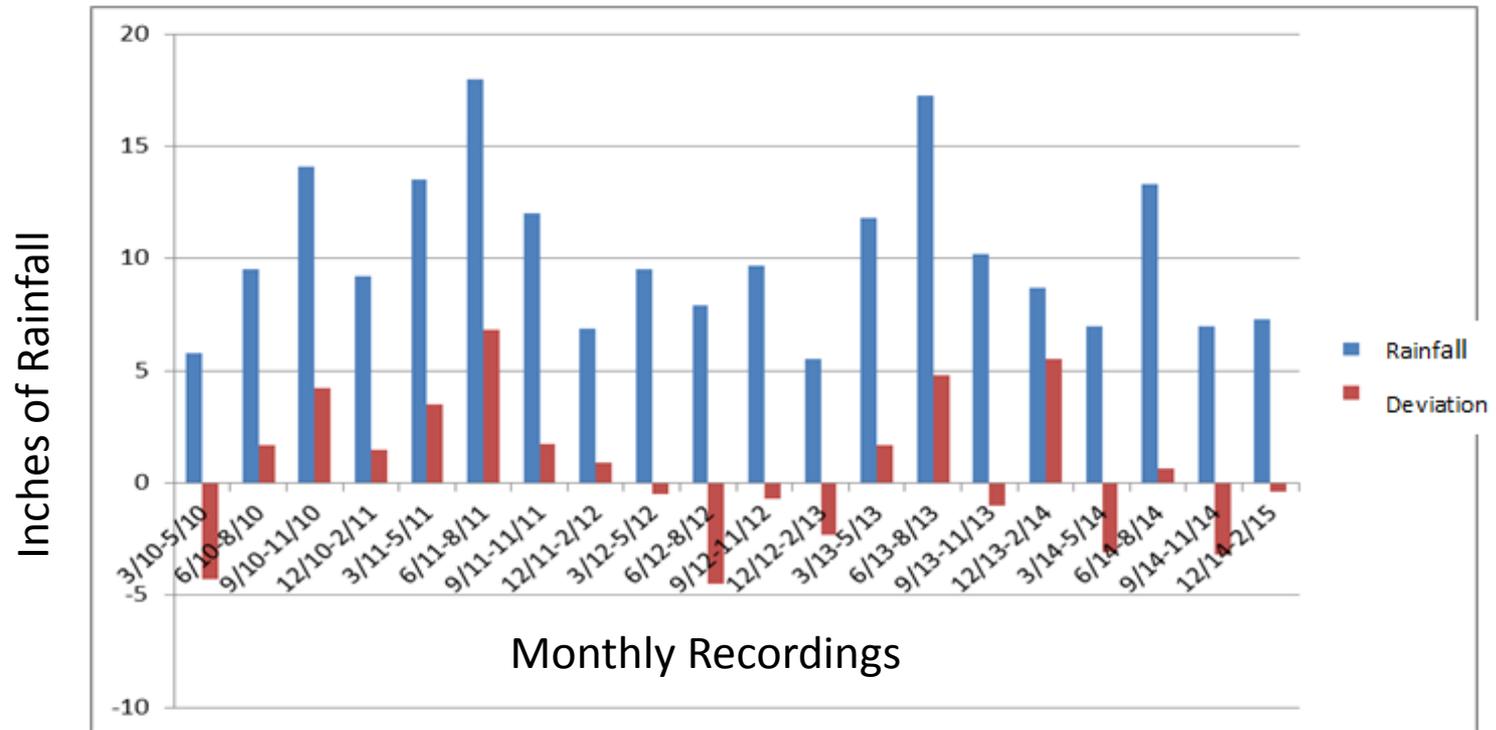
- Students gather into 'Prosecution Groups' for each organism.
- Each Group presents their argument in support of a selected organism as the 'Culprit' in this crime.



Who  
is guilty???

**What if NONE of these organisms  
seems to be the CULPRIT?**

# Additional Information-- Local Rainfall Data



Gathering Ideas Opportunity

# Incorporating KLEWS

What do we think we <b>K</b> now?	What are we <b>L</b> earning?	What is our <b>E</b> vidence?	What are we <b>W</b> ondering?
Air is everywhere. Air has oxygen. We need air to live. Airplanes use engines to help them fly.	Air is strong  Air takes up space	→ We lifted a computer, a bin of books, and a teacher with our air bags.  → When we blew in the bags we could see the air made the bags get larger.	How do jets take off? How many math books can we lift with one bag of air? How many students can we lift using 10 air bags?



# Reaction to Competition:

(from Reading)

Paper birch is classed as a shade-intolerant tree... In a study of drought response, paper birch saplings had higher water potential than other trees growing under the same soil moisture conditions.

The birch trees reached water stress conditions sooner than other trees.

The birch trees responded to stress by losing leaves, whereas other trees were not severely stressed by conditions of the study

## POLICE REPORT

It is time to write your police report. In this report you will be identifying the cause of the murder of ~~Betula-Papy~~ (the birch tree). This is a huge responsibility, so be sure to have enough strong evidence to support your argument. The last thing you want to have happen is to put an innocent organism in jail!

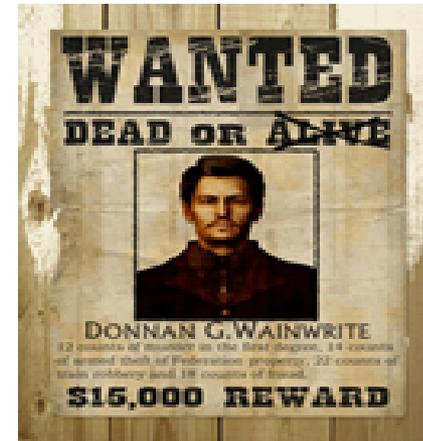
**THE BIG QUESTION:** What was the cause of the death of the birch tree? Use evidence from the observations you made at the stations as well as evidence from the Clue Cards and other notes to support your response.

Include the following in your final report: *Remember to start each section restating the question!*

(When you write up your report, Place the number next to where you are answering each question in parenthesis in your text.)

Set up your two column notes on a separate piece of paper. Handwrite or type your answer **GUIDING QUESTIONS:**

1. What do you suspect caused the killing? (This is your claim)
2. What was your initial suspicion/observation that led to this accusation? (This is also part of your claim—the because portion) Include at least two observations/clues from the stations, two temperature readings and a discussion of how they support the claim (This is your evidence) Explain what you think may have been responsible for the death of ~~Betula-Papy~~. This is your conclusion.  
Describe at least two alternative claims that you heard that could NOT represent accomplices to this crime. Provide evidence and an explanation for why each other alternatives are not probable. (This is your analysis)
6. Use evidence from the readings and discussions to explain the information that was discovered to explain how the environment contributed to your thinking about the claim.
7. Create a model of the cycling of energy and matter in this local system. (Include a discussion of the role of biotic and abiotic factors that are part of this system.)
8. When the press interviewed several specialists after the trial of the birch mystery, two foresters offered up their opinions on national TV. Here is what they said:



MS-LS2-4  
Changes affect populations

Cause and Effect

Stability and Change

MS-LS2-3  
Cycling of matter and energy

MS-LS2-1  
Effect of resource availability



Developing Evidence Based Explanations— Making Meaning

Forester Stephen claimed that the death of the birch tree was a tragedy. The loss of this tree

# NGSS Instructional Sequence Template

## MS/HS

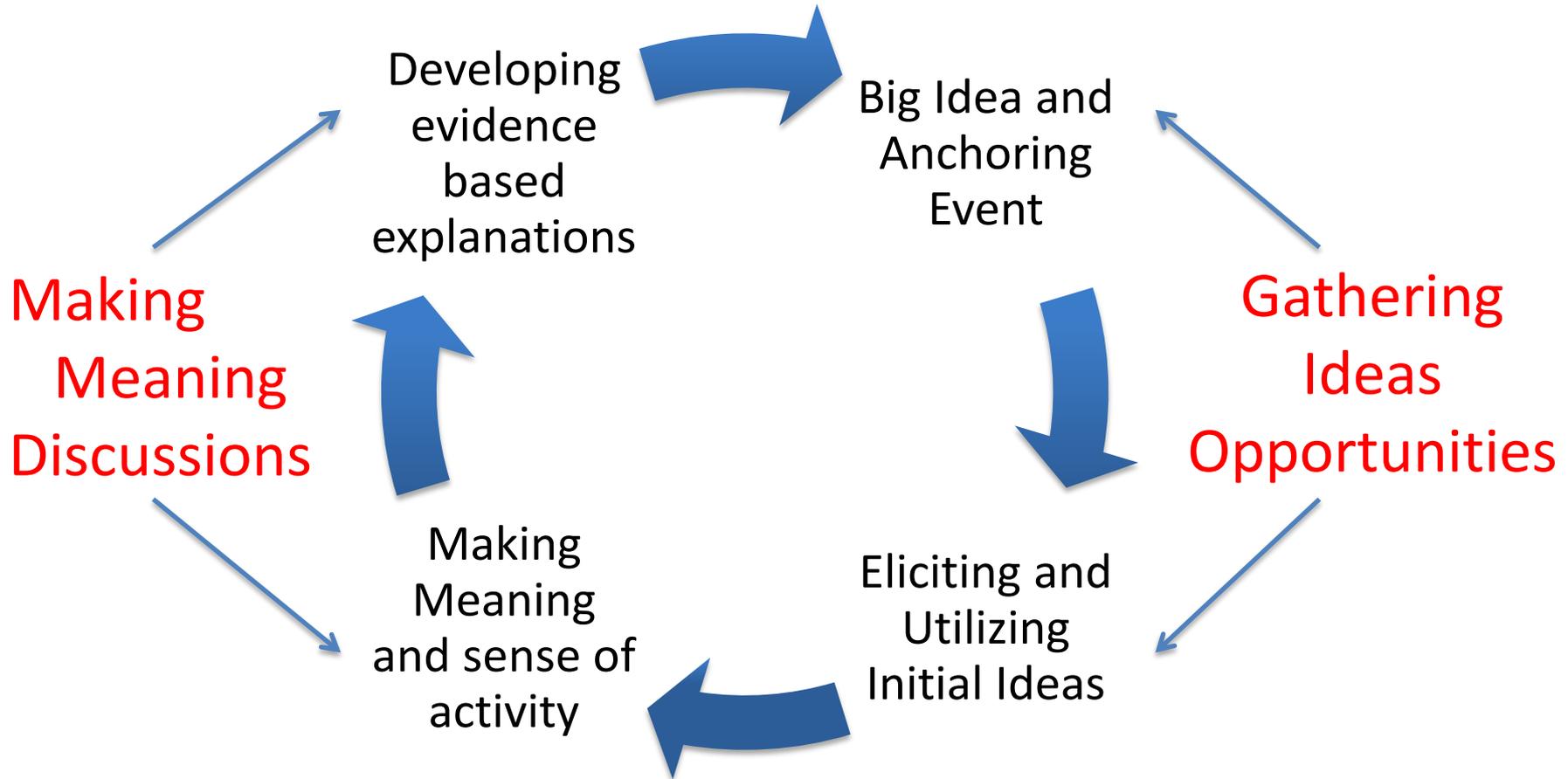
<b>Big Ideas/CCC/</b>	
<b>NGSS Standards/Performance Expectation(s) and PBGRs</b>	
<b>Essential Question/Driving Question</b>	
<b>Anchoring Event</b>	
<b>Culminating Performance/Product</b>	
<b>Science/Engineering Practices and Transferable Skills (TS)</b>	
<b>Common Core Standards</b>	
<b>Disciplinary Core Ideas</b>	
<b>Concept Connections to Driving Questions</b> The content understandings elicited by this instruction... (In teacher's own words—an explanation of the understanding of phenomena related to each Question. What do students need to know and understand to Hint: use the Framework as guide.)	
<b>What more might I need to learn. (local situation)</b> (Related to Driving Questions)	

# Instructional Sequence of Learning Experiences, Events, and Opportunities

Anchoring Event (for connection purposes , repeat event here)

Day 1	(Circle all that apply) Engage Explore Explain Elaborate Evaluate					
	What the Teacher is Doing	What Students are Doing	Formative Assessment			
Day 2	(Circle all that apply) Engage Explore Explain Elaborate Evaluate					
	What the Teacher is Doing	What Students are Doing	Formative Assessment			
Day 3	(Circle all that apply) Engage Explore Explain Elaborate Evaluate					
	What the Teacher is Doing	What Students are Doing	Formative Assessment			

# Model Based Inquiry



# Now—It's Your Turn...Brainstorm

Pick one: Consider what an anchoring phenomena could be

- Homeostasis
- Newton's Laws
- The Gas Laws
- The seasons



- 1) Kids have to find them comprehensible
- 2) It's complex to explain (it's "rich" in science content)
- 3) The phenomena is observable—it can be an event, or a process
- 4) The best puzzling phenomena have been "cases" of a specific event in a specific context
- 5) The questions you pose about the phenomena are important (not "What causes the seasons?" but "Why don't we have seasons near the equator?")
- 6) Investigate your anchoring phenomenon from a before-during-after viewpoint

# A Few Resources...

- National Research Council (2013) Next Generation Science Standards <http://www.nap.edu/catalog/18290/next-generation-science-standards-for-states-by-states>
- National Research Council (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. <http://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts>
- National Research Council (2007). *Taking Science to School*. <http://www.nap.edu/catalog/11625/taking-science-to-school-learning-and-teaching-science-in-grades>
- NGSS . 2013. Achieve. <http://www.nextgenscience.org/>
- NGSS. 2014. NSTA Hub. <http://ngss.nsta.org/>
- NGSS Frequently Asked Questions. 2013. Achieve. <http://www.nextgenscience.org/frequently-asked-questions>

## And a Few More Resources...

- Black, P. and Wiliam, D. Inside the Black Box
- Brookhart, Susan (2008) How to give Effective Feedback to Your Students ASCD
- Keeley, Page (2008) Science Formative Assessment, NSTA Press
- McNeill, K. and Krajcik, J. (2012) Supporting Grade 5-8 Students in Constructing Explanations in Science. Pearson Education, Inc.: NJ
- Zembal-Saul, Carla et al. (2013) What's Your Evidence? Pearson Education, Inc.: NJ

# Vermont Next Generation Science Standards Implementation Timeline

2013

**PHASE 1  
AWARENESS**  
Awareness & Exploration  
Statewide Capacity  
Building

**PHASE 2  
SYSTEMS FOCUS &  
INSTRUCTIONAL SHIFTS**  
Classroom Transitions  
Materials Evaluation

**PHASE 3  
PROGRAM DEVELOPMENT**  
Curriculum Alignment  
Content Integration  
Resources Development

**PHASE 4  
IMPLEMENTATION**  
Statewide Application  
Statewide Assessment

2017

Elements and Tasks

## Communication (State Science Leadership)

- |  |   |   |
|--|---|---|
| <ul style="list-style-type: none"> <li>Develop messages</li> <li>Utilize WFM, List Serve &amp; VE<sup>2</sup></li> <li>Regional Awareness Meetings</li> <li>Administrator Awareness</li> </ul> | <ul style="list-style-type: none"> <li>Clarify NGSS shifts (PD)—Webinars, Other</li> <li>Share NGSS resource (exemplars)</li> <li>Support Administrators</li> </ul> | <ul style="list-style-type: none"> <li>Ongoing messaging</li> </ul> |
|--|---|---|

## Statewide Capacity/Network Building (State Science Leadership Team, Administrators)

- |  |   |   |
|--|---|---|
| <ul style="list-style-type: none"> <li>Identify potential NGSS support Networks (Non-formal Ed, State agencies)</li> </ul> | <ul style="list-style-type: none"> <li>Expand NGSS support</li> <li>Establish connections with higher-ed Pre-Service</li> </ul> | <ul style="list-style-type: none"> <li>Support and expand science leadership network</li> <li>Collaborate with higher-ed Pre-Service programs.</li> </ul> |
|--|---|---|

## Professional Learning (State Science Leadership Team, Teacher Leaders, Administrators, Non-formal/Community Educators, Higher Ed)

- |  |   |  |  |
|--|---|--|--|
| <ul style="list-style-type: none"> <li>Identify Awareness professional learning needs</li> </ul> | <ul style="list-style-type: none"> <li>Identify expertise and gaps</li> <li>Design Professional Learning for Science Teacher Leaders</li> <li>Participate in National NGSS Network</li> </ul> | <ul style="list-style-type: none"> <li>Identify ongoing professional learning for VT educators</li> <li>Clarify performance expectations' impact on curriculum</li> <li>National NGSS Network</li> </ul> | <ul style="list-style-type: none"> <li>Professional Learning for non-formal/community educators</li> <li>Provide ongoing adaptation of Professional Learning for all Teacher leaders</li> <li>National NGSS Network</li> </ul> |
|--|---|--|--|

## Instructional Materials/Strategies (Science Professional Learning Team, Science Teacher Leaders/Coaches, School Science Teams, Higher Ed)

- |   |  |  |   |
|---|--|--|---|
| <ul style="list-style-type: none"> <li>Focus on overall Awareness</li> <li>Introduce concept of CCSS Integration</li> <li>Pilot the NGSX Program (K-12)</li> <li>Evaluate existing materials</li> </ul> | <ul style="list-style-type: none"> <li>Continue CCSS Integration</li> <li>Provide professional Learning for all</li> <li>Continue NGSX Program</li> <li>Focus on equity</li> </ul> | <ul style="list-style-type: none"> <li>Continue integration of NGSS with CCSS</li> <li>Evaluate materials Q (EQUiP)</li> </ul> | <ul style="list-style-type: none"> <li>Clarify NGSS instructional shifts</li> <li>Develop/gather exemplars of NGSS/CCSS integrated instructional Sequences.</li> <li>Develop/evaluate new curricular and instructional materials</li> </ul> |
|---|--|--|---|

# What Are Your NGSS Questions?



# Exit Ticket...



Please tell us...

- One new idea you have had today.
- Two ways that you might include NGSS into your instruction.
- Three NGSS-related areas where you would like additional support.