



Using Phenomena to Drive Student Learning in a Unit of Instruction for Middle School Students




Holly Hereau
Thurston High School
Redford, MI
@hhereau


Wayne Wright
Thurston High School
Redford, MI
@wewright1234

 nextgenstorylines.org


Figuring out Phenomena



How does phenomena help us support a classroom culture of figuring out for all students?


 nextgenstorylines.org

Anchoring and Investigative Phenomena




We will show how we use an Anchoring Phenomenon to drive learning of a complex idea in a Middle School Unit

We will show how we use Investigative Phenomena to support a culture of “figuring out” - so all students participate in knowledge building while explaining the complex idea

 nextgenstorylines.org


Using the Middle School Storyline Example



We will familiarize ourselves with the Performance Expectations we are building toward in the Middle school Matter and Energy example unit “Fog”

We will examine the anchoring phenomenon in this unit

We will figure out the key characteristics that make the anchor and investigative phenomena effective

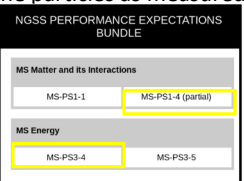
 nextgenstorylines.org

What do we want students to be able to explain?

The first part of this unit gets students to explain matter and energy:

MS-PS1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3.4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.



nextgenstorylines.org

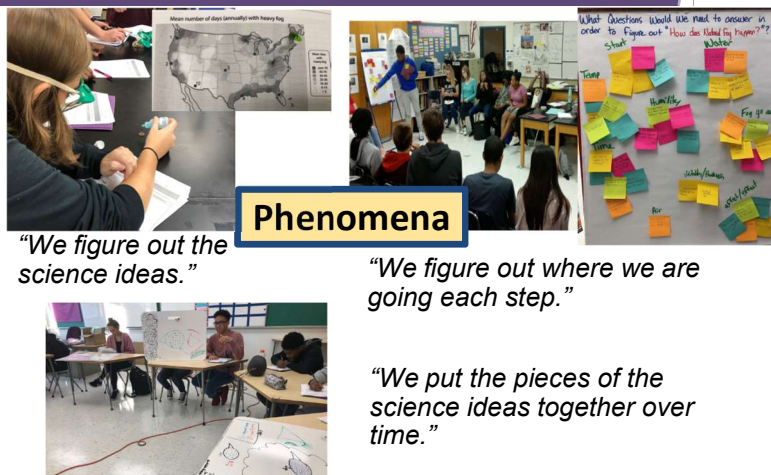
Why is the use of phenomena important to get to these performance expectations?

To explain the phenomena students will use:

Science and Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Asking Questions and Defining Problems	PS1.A Structure and Properties of Matter	Energy and Matter
Developing and Using Models	PS3.A Definitions of Energy	Cause and Effect
Planning and Carrying Out Investigations	PS3.B Conservation of Energy and Energy Transfer	Scale, Proportion, and Quantity
Engaging in Argument from Evidence		

nextgenstorylines.org

Students as partners in knowledge building



Phenomena

"We figure out the science ideas."

"We figure out where we are going each step."

"We put the pieces of the science ideas together over time."

nextgenstorylines.org

Thinking about the Matter and Energy Storyline and how to employ phenomena

- How can we use an anchoring phenomenon to motivate developing a complex model of matter and energy.
- Can we use student questions to motivate investigations that look at new phenomenon that will be helpful in developing our ideas about matter and energy?
- Can students construct a model of fog step by step by building up from their explanations of their investigations of phenomenon?

nextgenstorylines.org

Middle School Matter and Energy Unit Target PEs



MS-PS1-1 (partial) Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

What key elements are necessary to ensure the anchoring phenomenon can carry the unit?



Students Explore the Anchoring Phenomenon - *What do we notice?*

Students attempt to make sense of the Phenomenon - *How can we explain this? Do our explanations agree?*

Students Identify Related Phenomena - *Where else does something like this happen?*

Develop Questions & Next Steps - *What do we need to figure out?*

What makes a scene spooky?



The teacher introduces unit by asking a question:
What makes a scene spooky?

we watch a bunch of spooky clips and students agree in a spooky scene we need fog... but we're not sure what fog is...



Effective Anchoring Phenomena...



- Are immediately (or progressively) interesting to explore

To understand fog we decided to take apart a broken fog machine... maybe this will help us when we eventually make our own fog machine 😊

Students notice that there is a container for liquid...there is some tube that goes to an element that gets hot... students then model how they think it works.

Model of our FOG MACHINE

Students explore some information about fog and uncover related phenomena

Students wonder is natural fog made the same way as our broken fog machine?we then watch a series of clips of natural fog in different locations.

nextgenstorylines.org

students attempt to explain the phenomenon.

nextgenstorylines.org

what do our models have in common? How are they different?

Similarities	Differences
- Particles	- Some had no.
- Condensation	- Some called it fog others Water vapor.
- humidity getting thinner (visibility)	- Some had the humidifier phged in
	- Keys
	- Close together & Far apart (particles)
	- Other particles involved

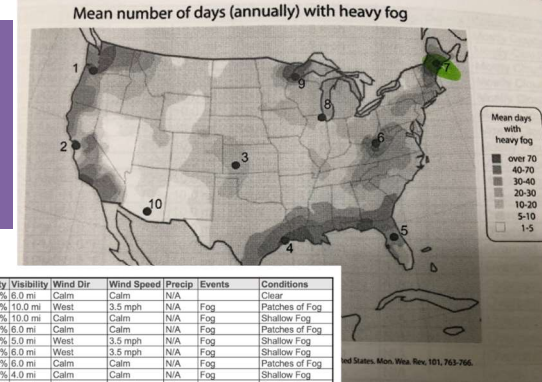
nextgenstorylines.org

Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
- **Lead us to wonder**
- **Generate controversy (competing explanations)**

Students explore some information about fog

Students wonder is natural fog found everywhere? Are some places more foggy than others? what is the weather like at these places?



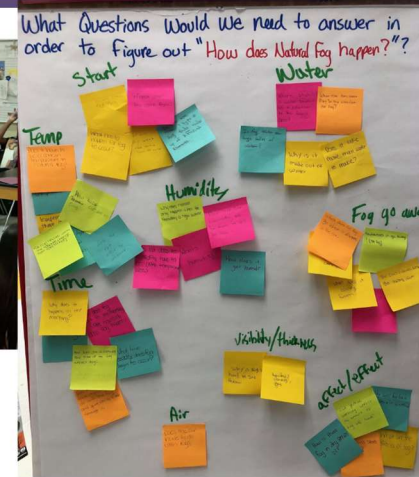
Portland, OR: October 5th, 2013

Time (PDT)	Temp.	Humidity	Visibility	Wind Dir	Wind Speed	Precip	Events	Conditions
12:53 AM	48.9 °F	93%	10.0 mi	Calm	Calm	N/A		Clear
1:53 AM	46.9 °F	97%	10.0 mi	West	3.5 mph	N/A	Fog	Patches of Fog
2:53 AM	46.9 °F	93%	10.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
3:36 AM	44.6 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Patches of Fog
3:53 AM	45.0 °F	97%	6.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
4:53 AM	44.1 °F	100%	6.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
5:53 AM	43.0 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Patches of Fog
6:22 AM	42.8 °F	100%	4.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
6:36 AM	42.8 °F	100%	6.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
6:53 AM	41.0 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
7:53 AM	45.0 °F	97%	10.0 mi	WNW	4.6 mph	N/A		Scattered Clouds
8:28 AM	46.4 °F	93%	6.0 mi	WNW	4.6 mph	N/A		Mostly Cloudy
8:39 AM	44.6 °F	100%	0.5 mi	WNW	5.8 mph	N/A		Mostly Cloudy
8:41 AM	44.6 °F	100%	0.2 mi	WNW	5.8 mph	N/A		Mist
8:53 AM	46.0 °F	100%	0.2 mi	West	3.5 mph	N/A	Fog	Fog
9:51 AM	48.2 °F	93%	6.0 mi	WNW	5.8 mph	N/A		Scattered Clouds
9:53 AM	48.0 °F	96%	7.0 mi	WNW	4.6 mph	N/A		Scattered Clouds
10:53 AM	53.1 °F	74%	10.0 mi	NW	6.8 mph	N/A		Partly Cloudy

Effective Anchoring Phenomena...

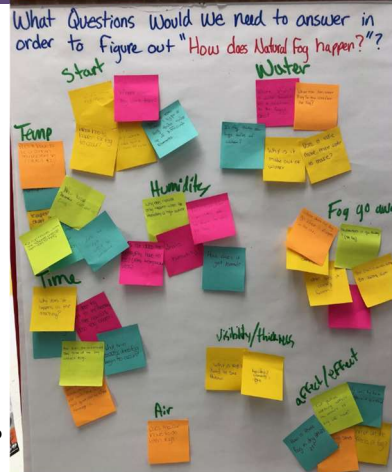
- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- **Connect to other experiences that students have had with related phenomena in the world.**

Students generate questions



Here are some of the students questions.

- Why is fog so hard to see through?
- Why does fog only happen in the morning or at night?
- Why does natural fog only happen when it is humid outside?
- How does it get humid?
- How does temperature affect fog?
- Where does fog come from?
- Is there more than one type of fog made from different elements?
- What role does water play in the creation of fog?
- Where does fog go when it disappears from the air?
- What does air have to do with fog?

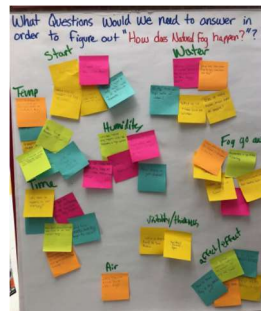


Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- **Generate questions**

Students brainstorm ways to investigate their questions

- Watch videos on fog - (to figure out) how it spreads / see how it forms?
- Looking at weather patterns in different areas.
- look at ways to increase humidity.
- talk to a weather experts.
- boil water?
- investigate what happens with fry ice.
- go to the beach/ water sources



Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and **ideas for investigations**

What have we accomplished so far?



Students Explore the Anchoring Phenomenon



What do we notice?

Students attempt to make sense of the Phenomenon



How can we explain this? Do our explanations agree?

Students Identify Related Phenomena



Where else does something similar happen?


Develop Questions & Next Steps



What can we do to figure out how to explain all this?

nextgenstorylines.org

Effective Anchoring Phenomena...




- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations
- **Becomes our goal to try explain (by some later point in the unit).**

*In this role we refer to such a phenomena as an **anchoring phenomena** as it anchors the launch of the unit and is something we will revisit in future lessons.*

nextgenstorylines.org

Anchoring and Investigative Phenomena


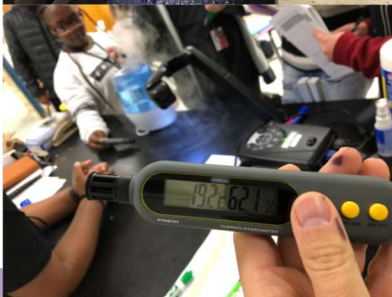


We will show how we use an Anchoring Phenomenon to drive learning of a complex idea in a Middle School Unit

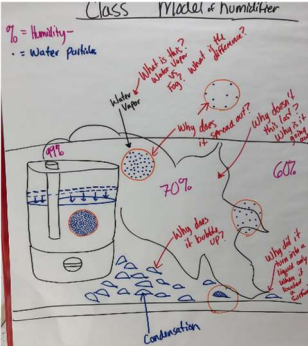
We will show how we use Investigative Phenomena to support a culture of “figuring out” - so all students participate in knowledge building while explaining the complex idea

nextgenstorylines.org

What is humidity? and how do we make air more humid?

Class Model of Humidifier



nextgenstorylines.org

Why are we doing this investigation?

We need to find out more about why humidity is so important in fog?

Teacher's Perspective:
Students need to build and use science ideas

Effective and meaningful investigative phenomena

Kids' Perspective:
We're trying to see What humidity is and how we can increase it in the air.

↓

MS-PS1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Because we're trying to answer our Driving Question "What role does Humidity play with fog and why does it need to be near 100% for fog to form?"

nextgenstorylines.org

Why are we doing this investigation?

We need to find out more about why humidity is so important in fog?

Teacher's Perspective:
Students need to build and use science ideas

Effective and meaningful investigative phenomena

Kids' Perspective:
We're trying to see What humidity is and how we can increase it in the air.




↓

MS-PS1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.


Because we're trying to answer our Driving Question "What role does Humidity play with fog and why does it need to be near 100% for fog to form?"

nextgenstorylines.org

Results of this investigation led to more questions....


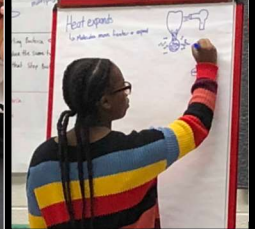
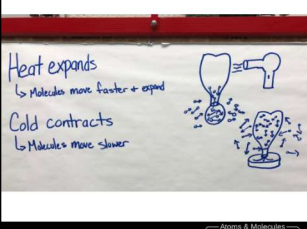




Students want to understand why they can see the humidity when the particles are close to the humidifier but they seem to disappear the further away the particles get.




nextgenstorylines.org

How Do We Push Students to Go Deeper and Revise Their Ideas?

Students decide they want to see the role of temperature in the air. After a lab students in a circle discussion come up with a model to explain what they observed... needing more information they look to zoom in using a computer simulation



nextgenstorylines.org

Investigations Can Center On Multiple Phenomena

- Throughout the unit, students use multiple investigative phenomena. After the anchoring phenomenon, we use more phenomena to make progress on our questions...which often leads to more questions and more phenomena we need to explore

In this role we refer to such a phenomena as an investigative phenomena as it forms the basis for our investigations.

nextgenstorylines.org

Effective Phenomena...

- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations
- Advance our understanding of the key science ideas at our grade level as we work to explain it
- Become part of the puzzle we have figured out that is going to eventually help us explain other phenomena (e.g. the anchoring phenomenon).

nextgenstorylines.org

How do students put their ideas together?

Lesson

What did we do?	What did we figure out?	What should be in our model?
Spooky Scene - Looked at the inside of a fog machine. - Watched fog w/ fans. - Took off what made some things spooky. - Made some experiments with fog. - Made models of the fog making of a fog machine. - We were looking for patterns with fog.	- We have different ideas about how to make fog. - Fog Machine - used heat and - liquid to make fog. - All the same. Heat fog is made the same as fog machine. - How many different ideas.	- Liquid - Water - Heat / Temperature
Humidifier - Took apart a humidifier and took out the water. - Took out the water from the humidifier.	- Fog tends to happen in the morning. - Fog when it's cold when the humidity is low around 20%. - Fog when it's hot when the humidity is high around 80%. - Fog when it's cold when the humidity is low around 20%. - Fog when it's hot when the humidity is high around 80%. - Fog when it's cold when the humidity is low around 20%. - Fog when it's hot when the humidity is high around 80%.	- Humidity - Time of Day - Season of Year
Water Lab - Water Lab - Particles like in balloons. - Bubbles and springs lab. - Springs. What water is under cloud.	- Water is hard to separate. It has change to it. - Water is hard to separate. It has change to it. - Water is hard to separate. It has change to it. - Water is hard to separate. It has change to it.	- Water is hard to separate. It has change to it. - Water is hard to separate. It has change to it.

nextgenstorylines.org






Storylines

Student questions motivate each lesson

Lesson Routine	Questions	Phenomena / Problems	What we figure out
L1 Anchoring phenomena	What makes a scene spooky?		We figured out lots of things that make a scene spooky, but one thing that we really want in our spooky scene is fog! We really want a fog machine so we can take it apart and see how it works.
L2 Investigation	How does a fog machine make fog?		We took apart a fog machine and figured out some pieces that we think we need in our fog machine: some sort of liquid, heat, and a fan. But when we think about our own experiences with fog it's not always hot! We now have lots of questions about natural fog.
L3 Investigation	When and where does fog occur outside naturally?		Weather data patterns indicate temperature is important for fog formation but we're not sure how. They also indicate that being near a body of water and high humidity are critical, but high humidity doesn't seem to guarantee the formation of fog!
L4 Investigation	What is humidity and how do we make the air more humid?		Air near the humidifier is more humid than the air far from the humidifier. We think that we are putting water in the air which makes it more humid. But can water be in the air without us seeing it?
L5 Investigation	Can pieces of water in the air be so small that we can't see them?		We can see large clumps of water (even in the air) but we can't see water when it is broken up into really small pieces. We call the smallest piece of water we can get a molecule. But we're a little bit confused about how to represent air in our models.

nextgenstorylines.org

Storylines






Lesson Routine	Questions	Phenomena / Problems	What we figure out
L1 Anchoring phenomena	What makes a scene spooky?		We figured out lots of things that make a scene spooky, but one thing that we really want in our spooky scene is fog! We really want a fog machine so we can take it apart and see how it works.
L2 Investigation	How does a fog machine make fog?		We took apart a fog machine and figured out some pieces that we think we need in our fog machine: some sort of liquid, heat, and a fan. But when we think about our own experiences with fog it's not always hot! We now have lots of questions about natural fog.
L3 Investigation	When and where does fog occur outside naturally?		Weather data patterns indicate temperature is important for fog formation but we're not sure how. They also indicate that being near a body of water and high humidity are critical, but high humidity doesn't seem to guarantee the formation of fog!
L4 Investigation	What is humidity and how do we make the air more humid?		Air near the humidifier is more humid than the air far from the humidifier. We think that we are putting water in the air which makes it more humid. But can water be in the air without us seeing it?
L5 Investigation	Can pieces of water in the air be so small that we can't see them?		We can see large clumps of water (even in the air) but we can't see water when it is broken up into really small pieces. We call the smallest piece of water we can get a molecule. But we're a little bit confused about how to represent air in our models.

nextgenstorylines.org

Student questions motivate each lesson

Students use practices to make sense of phenomena

Storylines

Lesson Routine	Questions	Phenomena / Problems	What we figure out
L1 Anchoring phenomena	What makes a scene spooky?		We figured out lots of things that make a scene spooky, but one thing that we really want in our spooky scene is fog! We really want a fog machine so we can take it apart and see how it works.
L2 Investigation	How does a fog machine make fog?		We took apart a fog machine and figured out some pieces that we think we need in our fog machine: some sort of liquid, heat, and a fan. But when we think about our own experiences with fog it's not always hot! We now have lots of questions about natural fog.
L3 Investigation	When and where does fog occur outside naturally?		Weather data patterns indicate temperature is important for fog formation but we're not sure how. They also indicate that being near a body of water and high humidity are critical, but high humidity doesn't seem to guarantee the formation of fog!
L4 Investigation	What is humidity and how do we make the air more humid?		Air near the humidifier is more humid than the air far from the humidifier. We think that we are putting water in the air which makes it more humid. But can water be in the air without us seeing it?
L5 Investigation	Can pieces of water in the air be so small that we can't see them?		We can see large clumps of water (even in the air) but we can't see water when it is broken up into really small pieces. We call the smallest piece of water we can get a molecule. But we're a little bit confused about how to represent air in our models.






nextgenstorylines.org

Student questions motivate each lesson

Students use practices to make sense of phenomena

Questions arise from what students figured out so far

Storylines

Lesson Routine	Questions	Phenomena / Problems	What we figure out
L1 Anchoring phenomena	What makes a scene spooky?		We figured out lots of things that make a scene spooky, but one thing that we really want in our spooky scene is fog! We really want a fog machine so we can take it apart and see how it works.
L2 Investigation	How does a fog machine make fog?		We took apart a fog machine and figured out some pieces that we think we need in our fog machine: some sort of liquid, heat, and a fan. But when we think about our own experiences with fog it's not always hot! We now have lots of questions about natural fog.
L3 Investigation	When and where does fog occur outside naturally?		Weather data patterns indicate temperature is important for fog formation but we're not sure how. They also indicate that being near a body of water and high humidity are critical, but high humidity doesn't seem to guarantee the formation of fog!
L4 Investigation	What is humidity and how do we make the air more humid?		Air near the humidifier is more humid than the air far from the humidifier. We think that we are putting water in the air which makes it more humid. But can water be in the air without us seeing it?
L5 Investigation	Can pieces of water in the air be so small that we can't see them?		We can see large clumps of water (even in the air) but we can't see water when it is broken up into really small pieces. We call the smallest piece of water we can get a molecule. But we're a little bit confused about how to represent air in our models.

nextgenstorylines.org

Student questions motivate each lesson

Students use practices to make sense of phenomena

Questions arise from what students figured out so far

Students build ideas incrementally over time

Summary

- The teacher and unit design work together to support students in developing questions or identifying problems to solve about the phenomenon
- Students'** questions and problems become the motivation for each investigation or design challenge
- Students put their ideas together across lessons to make sense of phenomena and solve the problem.

nextgenstorylines.org

Nextgenstorylines.org



The examples we showed are open source materials developed by teams of teachers and are freely available, along with supporting teacher guides and lesson plans to try out. There are other K-12 examples available at this site too, and more are coming soon.

Questions?



Download this unit and other open-source storylines:
<http://www.nextgenstorylines.org>

This research was funded by grants from the Gordon and Betty Moore Foundation and the Carnegie Corporation of NY to Northwestern University; and training grant #R305B140042 from the US Department of Education, Institute of Education Sciences to the Multidisciplinary Program in Education Sciences, Northwestern University. The opinions expressed herein are those of the authors and not necessarily those of these foundations and other agencies.

GORDON AND BETTY
MOORE
 FOUNDATION

Carnegie
 CORPORATION
 OF NEW YORK

ies