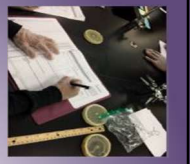
Using Phenomena to Drive Student Learning in a Unit of Instruction for High School Students



Holly Hereau
Thurston High School
Redford, MI
@hhereau

Wayne Wright
Thurston High School
Redford, MI
@wewright1234

Figuring out Phenomena

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

Anchoring and Investigative Phenomena

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

Using the High School Storyline Example

We will familiarize ourselves with the Performance Expectations we are building toward in the high school Natural Selection example unit "Why don't antibiotics work like they use to?"

We will examine the anchoring phenomenon in this unit

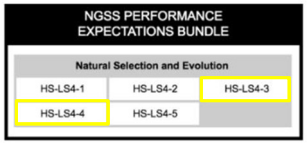
We will figure out the key characteristics that make the anchor and investigative phenomena effective

What do we want students to be able to explain?

The first part of this unit gets students to explain Natural Selection only:

HS-LS4-3: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

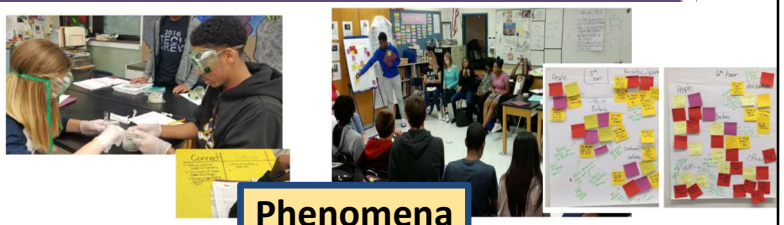


Why is the use of phenomena important to get to these performance expectations?

To explain the phenomena students will use:

Science and Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Obtaining, Evaluating, and Communicating Information **Constructing Explanations and Designing Solutions** **Analyzing and Interpreting Data** **Engaging in Argument from Evidence**	**LS4.B: Natural Selection** **LS4.C: Adaptation**	**Cause and Effect** **Patterns**

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."

Thinking about the Natural Selection Storyline and how to employ phenomena

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

High School Natural Selection Unit Target PEs

HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-3: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

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

Elements of the Anchoring Phenomenon Routine

- 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?*

Why don't antibiotics work like they used to?

The teacher introduces unit by asking a question: Can you recall a time you were really sick? If so, what happened

?

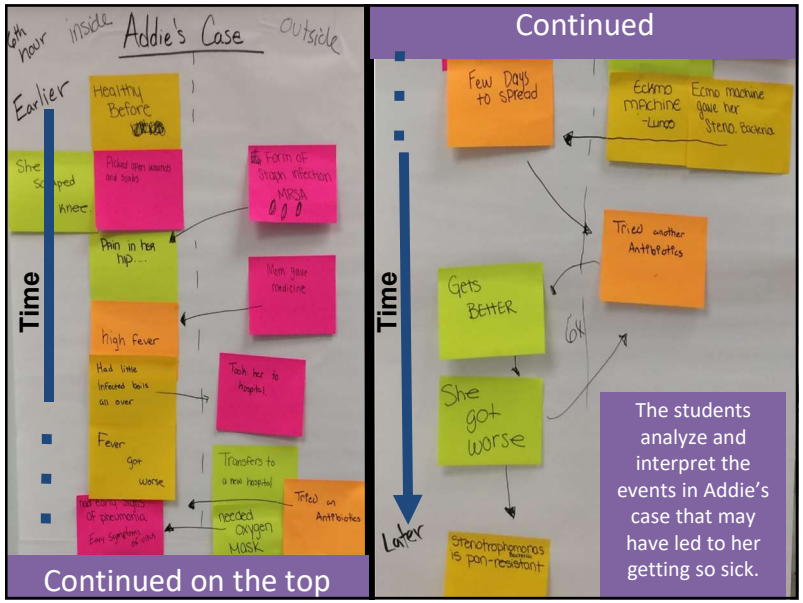
The teacher introduces students to a case of a young girl who had a pan-resistant infection.

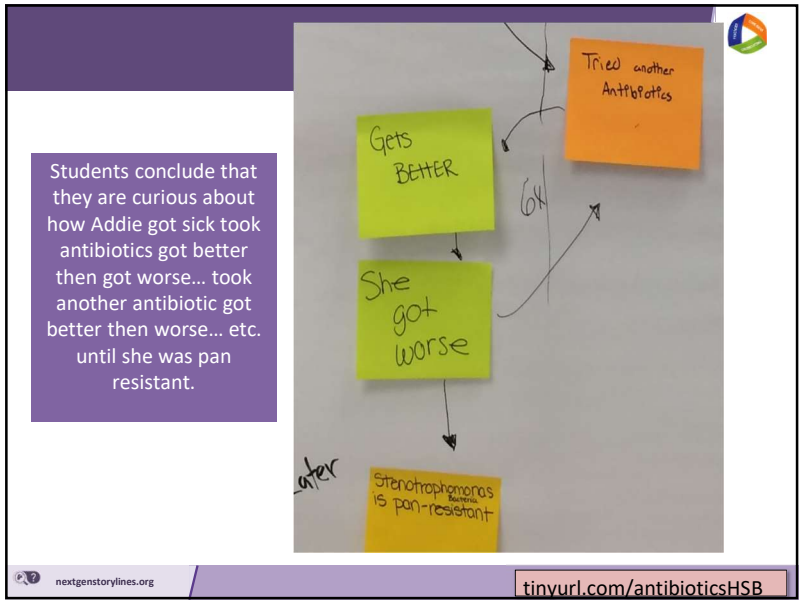
tinyurl.com/antibioticsHSB

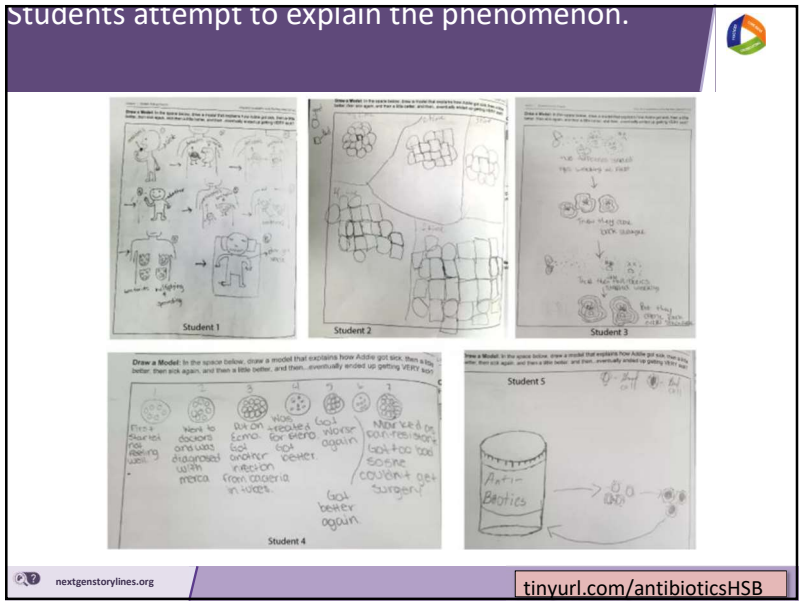
Effective Anchoring Phenomena...

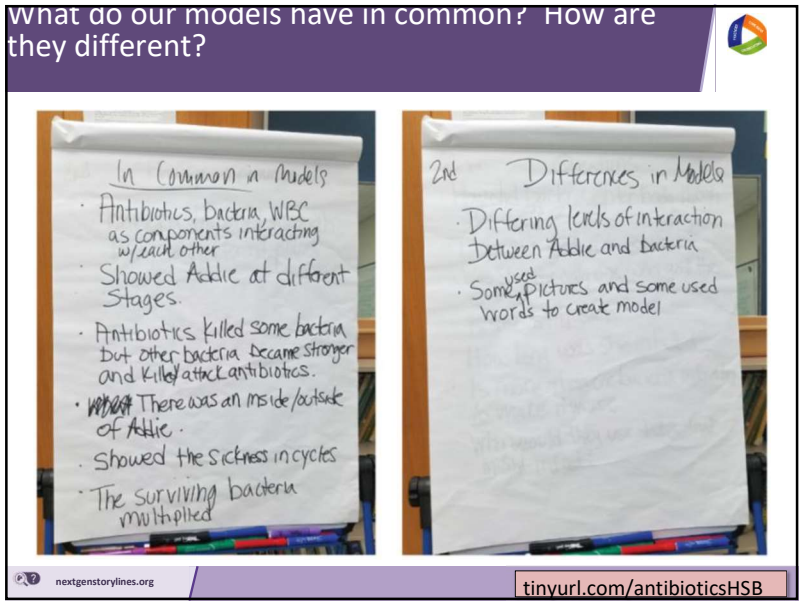
- Are immediately (or progressively) interesting to explore

tinyurl.com/antibioticsHSB


6th hour
Addie's Case
Inside
Outside
Earlier
Time
Healthy Before
Picked open wounds and scabs
Form of Staph infection MRSA
Pain in her hip....
Mom gave medicine
High Fever
Had little infected boils all over
Took her to Hospital
Fever Got worse
Transfers to a new hospital
Tried an Antibiotics
Had early signs of pneumonia
Early symptoms of sepsis
needed oxygen MASK
Continued on the top
Continued
Few Days to spread
Ecmo machine -Lungs
Ecmo machine gave her Strep. Bacteria
Tried another Antibiotics
Gets BETTER
64
She got worse
Later
Stenotrophomonas is pan-resistant
The students analyze and interpret the events in Addie's case that may have led to her getting so sick.

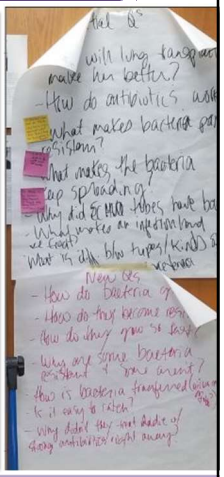

Students conclude that they are curious about how Addie got sick took antibiotics got better then got worse... took another antibiotic got better then worse... etc. until she was pan resistant.
Gets BETTER
Tried another Antibiotics
64
She got worse
Later
Stenotrophomonas is pan-resistant
nextgenstorylines.org
tinyurl.com/antibioticsHSB


Students attempt to explain the phenomenon.
Student 1
Student 2
Student 3
Student 4
Student 5
nextgenstorylines.org
tinyurl.com/antibioticsHSB


What do our models have in common? How are they different?
In Common in Models
Antibiotics, bacteria, WBC as components interacting w/each other
Showed Addie at different stages
Antibiotics killed some bacteria but other bacteria became stronger and killed/attack antibiotics.
There was an inside/outside of Addie.
Showed the sickness in cycles
The surviving bacteria multiplied
2nd Differences in Models
Differing levels of interaction between Addie and bacteria
Some used pictures and some used words to create model
nextgenstorylines.org
tinyurl.com/antibioticsHSB

Students' Initial Questions

- *Why does some MRSA live harmlessly?*
- *How do antibiotics work?*
- *What makes the bacteria keep spreading?*
- *Why did ECMO tubes have bacteria?*
- *What makes an infection hard to treat?*
- *How do bacteria grow?*
- *How do they become resistant?*
- *Why are some bacteria resistant and some aren't?*
- *Does being around antibiotics make it easier for bacteria to become resistant?*
- *Is it [MRSA] easy to catch?*
- *Why didn't they treat Addie w/ strong antibiotics right away?*

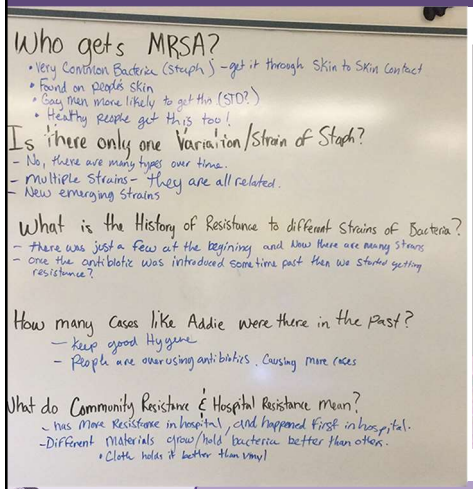


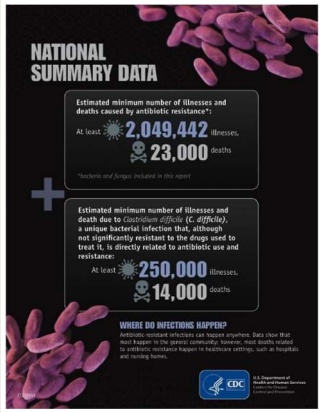
tinyurl.com/antibioticsHSB

Effective Anchoring Phenomena...

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

Students explore some information about antibiotic resistance and uncover related phenomena





tinyurl.com/antibioticsHSB

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 doesn't everyone get MRSA if it's on your skin?*
- *Why does some MRSA live harmlessly?*
- *Why is it easy to contract MRSA even from hospitals?*
- *Why is CA-MRSA easier to treat?*
- *How did two strains of MRSA form?*
- *How long does it take for a bacteria (sic) to become resistant to antibiotics?*
- *Does MRSA branch off into different types as it becomes more resistant to antibiotics?*
- *Does being around antibiotics make it easier for bacteria to become resistant?*
- *Why did staph have more antibiotics to treat it than others?*
- *How many variations of staph are there?*

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

Initial Question Board

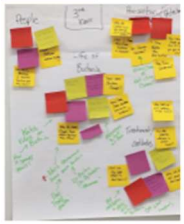
- *Why does some MRSA live harmlessly?*
- *How do antibiotics work?*
- *What makes the bacteria keep spreading?*
- *Why did ECMO tubes have bacteria?*
- *What makes an infection hard to treat?*
- *How do bacteria grow?*
- *How do they become resistant?*
- *Why are some bacteria resistant?*
- *Does being around antibiotics make it easier for bacteria to become resistant?*
- *Why didn't they treat Addie w/ strong antibiotics right away?*

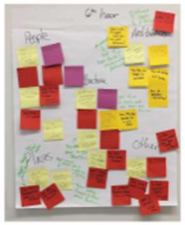
Driving Question Board

- *Why doesn't everyone get MRSA if it's on your skin?*
- *Why does some MRSA live harmlessly?*
- *Why is it easy to contract MRSA even from hospitals?*
- *Why is CA-MRSA easier to treat?*
- *How did two strains of MRSA form?*
- *How long does it take for a bacteria (sic) to become resistant to antibiotics?*
- *Does MRSA branch off into different types as it becomes more resistant to antibiotics?*
- *Does being around antibiotics make it easier for bacteria to become resistant?*
- *Why did staph have more antibiotics to treat it than others?*
- *How many variations of staph are there?*

Students brainstorm ways to investigate their questions

- Watch videos on bacteria - (to figure out) how it spreads / grows?
- Microscopes to look at them - See which environment have more bacteria
- See how many people go to a place, check bacteria — how often cleaned & how much bacteria
- Put antibiotics in Petri dish with bacteria and see what happens.
- Try using cleaner vs. not using cleaner
- Use different doses of antibiotics.
- Put (bacteria) in a dish and see how long they live.
- Change temp with bacteria - see what happens.





tinyurl.com/antibioticsHSB

Effective Anchoring Phenomena...

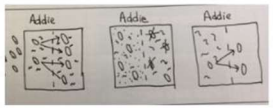
- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations

What have we accomplished so far?

Students Explore the Anchoring Phenomenon

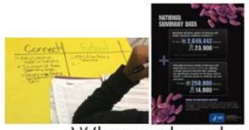
What do we notice?

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?

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.

Anchoring and Investigative Phenomena

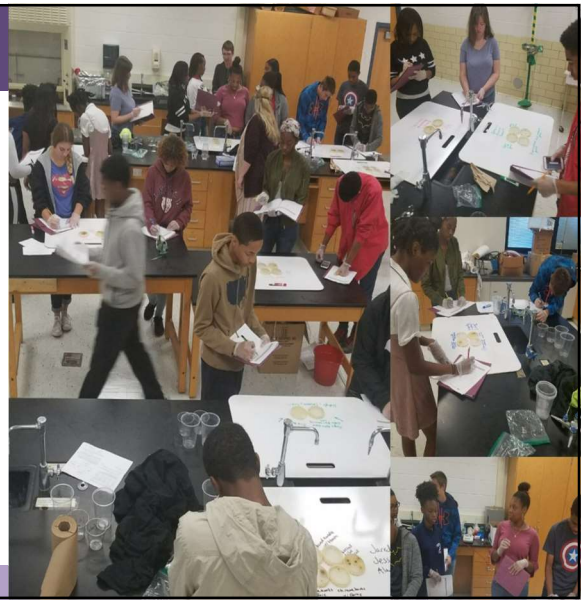
We will show how we use an Anchoring Phenomenon to drive learning of a complex idea in a High School Unit

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

What did students decide to test first?

- Watch videos on bacteria - (to figure out) how it spreads / grows?
- Microscopes to look at them - See which environment have more bacteria
- See how many people go to a place, check bacteria — how often cleaned & how much bacteria
- Put antibiotics in Petri dish with bacteria and see what happens.
- Try using cleaner vs. not using cleaner
- Use different doses of antibiotics.
- Put (bacteria) in a dish and see how long they live.
- Change temp with bacteria - see what happens.

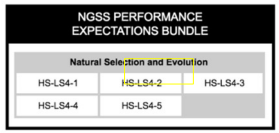
Where are bacteria in our environment? How do they grow?



Effective Investigative Phenomena bridge both of these

We need to find out where bacteria are and what they need to grow because...

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



Kids' Perspective: We're trying to see where in our school we can find bacteria and what cleaning supplies get rid of them.

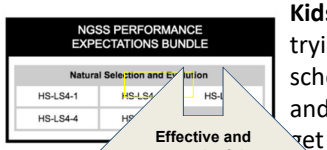
HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

Because we're trying to answer our Driving Question **"How do bacteria grow and how do we get them on us or off of us?"**

Effective Investigative Phenomena bridge both of these

We need to find out where bacteria are and what they need to grow because...

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



Effective and meaningful investigative phenomena

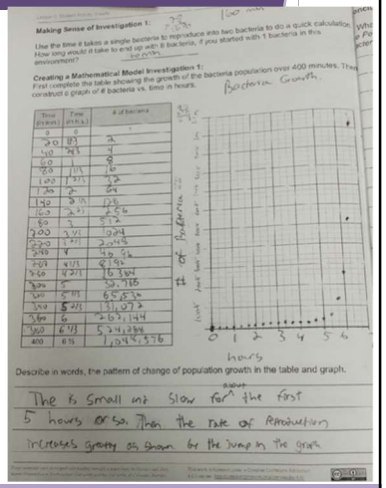
HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

Kids' Perspective: We're trying to see where in our school we can find bacteria and what cleaning supplies get rid of them.

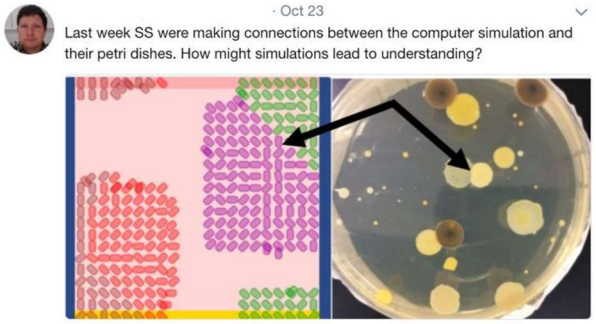
Because we're trying to answer our Driving Question **"How do bacteria grow and how do we get them on us or off of us?"**

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

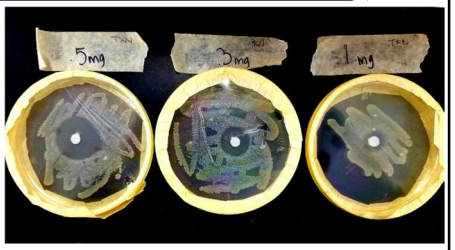
Students decide they want to "zoom in" to understand if bacteria were growing larger or if they were growing in number on their petri dishes. They find out by watching this video and then created a mathematical model to show this.



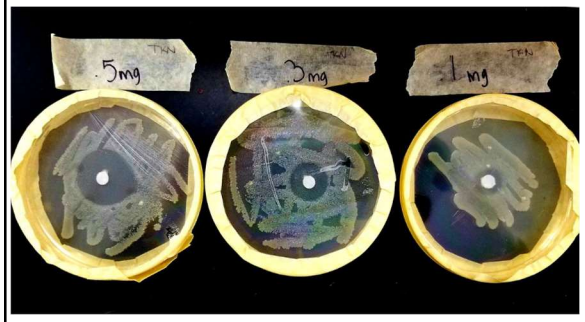
What else is going on?



How can we kill bacteria?



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



Wait, why aren't they all dead?

Investigations Can Center On Multiple Phenomena

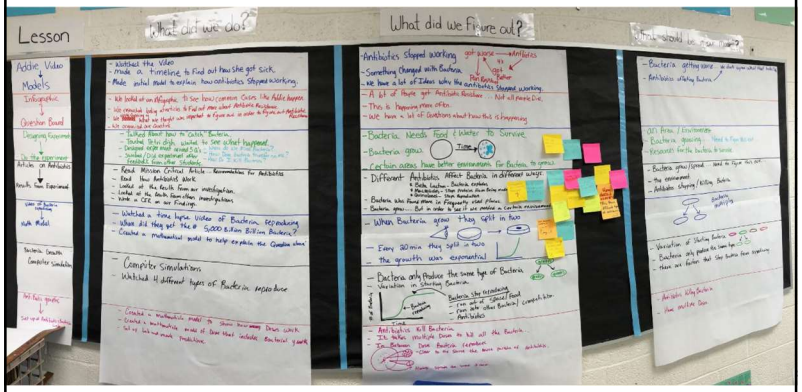
- Throughout the unit, students use multiple investigative phenomena. After the anchoring phenomenon, we use more phenomena to make progress on our questions...which often leads to more questions and more phenomena we need to explore

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

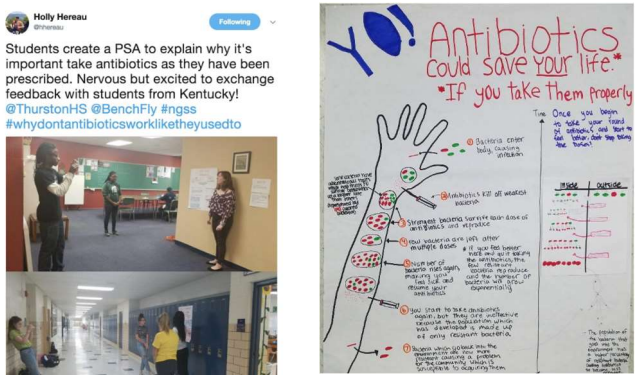
Effective Phenomena...

- 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).

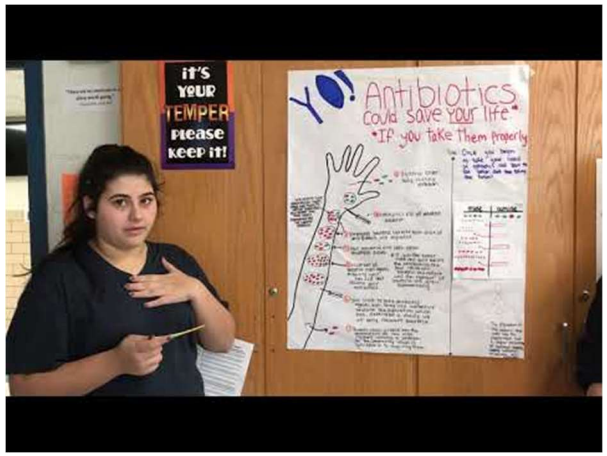
How do students put their ideas together?



How do students put their ideas together?

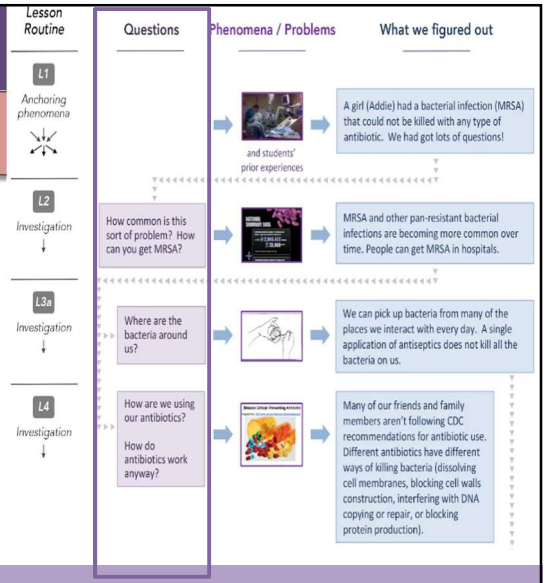


How do students put their ideas together?



Storylines

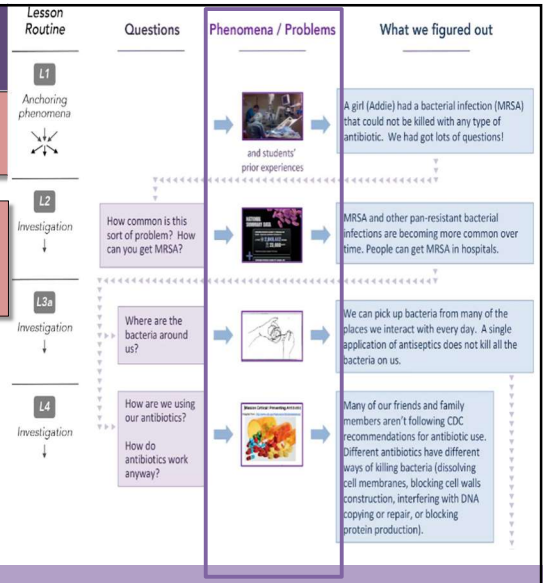
Student questions motivate each lesson



Storylines

Student questions motivate each lesson

Students use practices to make sense of phenomena

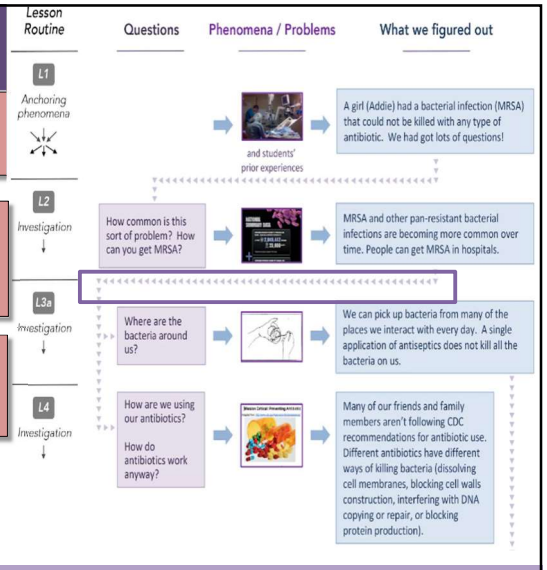


Storylines

Student questions motivate each lesson

Students use practices to make sense of phenomena

Questions arise from what students figured out so far



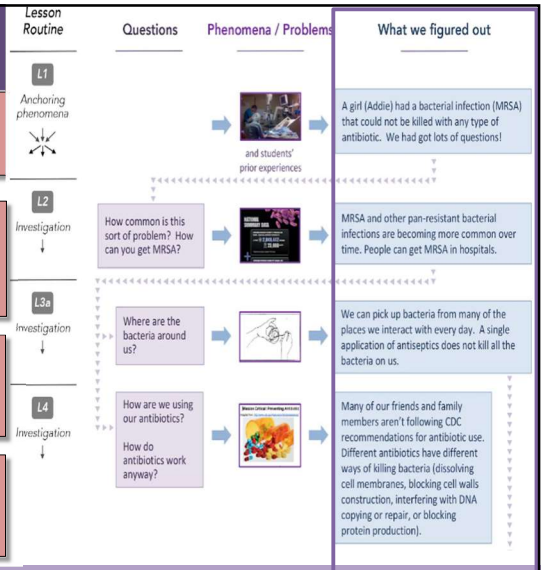
Storylines

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

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.