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

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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:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Cross Cutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining, Evaluating, and Communicating Information</td>
<td>LS4.A: Natural Selection</td>
<td>Cause and Effect</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>LS4.B: Natural Selection</td>
<td>Patterns</td>
</tr>
<tr>
<td>Analyzing and Interpreting Data</td>
<td>LS4.C: Adaptation</td>
<td></td>
</tr>
<tr>
<td>Engaging in Argument from Evidence</td>
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Students as partners in knowledge building

“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.

Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
Continued on the top

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.

Continued

The students analyze and interpret the events in Addie's case that may have led to her getting so sick.

Students attempt to explain the phenomenon.

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

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

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

Effective Anchoring Phenomena...

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- 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.

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
Students attempt to make sense of the Phenomenon
Students Identify Related Phenomena
Develop Questions & Next Steps

Effective Anchoring Phenomena...

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

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

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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.
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- 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.

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?”
Effective Investigative Phenomena bridge both of these

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.

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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?

Last week 5th were making connections between the computer simulation and their petri dishes. How might simulations lead to understanding?

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?

Lesson

- What did we figure out?
- How do these ideas help us understand the anchoring phenomenon?
- How do these ideas help us understand other phenomena?
How do students put their ideas together?

Storylines

Student questions motivate each lesson

Lesson Routine

Chekler phenomenas

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<td>We can pick up bacteria from many of the places we encounter every day. A single application of antibiotic does not kill all the bacteria on us.</td>
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<td>How are we using our antibiotics?</td>
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<td></td>
</tr>
<tr>
<td>How do antibiotics work anyway?</td>
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<td></td>
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<tr>
<td>A girl (Alaska) had a bacterial infection (MRSA) that could not be killed with any type of antibiotic. We had set of questions!</td>
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Students use practices to make sense of phenomena

Lesson Routine

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**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

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