How Do We Make NGSS Storylines Work by Pushing Students to Go Deeper?

Brian J. Reiser
Northwestern University
@reiserbrianj

Michael J. Novak
Northwestern University
@mnovakccl
### Coherent Storylines

**Shift from:**

- Teachers **give** students the question for each lesson.
- Each step in an investigation is something students do to apply science ideas they **already learned about**.
- Students engage in practices **as ends in themselves** or to demonstrate understanding of science ideas.

**To:**

- Teachers work with students to **co-develop** questions and ways to investigate them.
- **Student questions** from phenomena motivate each step; students build ideas by investigating these questions.
- Student engagement in practices helps the class make progress on questions they are trying to **figure out** or problems they are trying to solve.
How can we develop a storyline in which students are partners in managing investigations?

Five questions to guide our work:

1. How do we kick off investigations in a unit?

2. How do we work with students to motivate the next step in an investigation?

3. How do we help students use practices to figure out pieces of the science ideas?

4. How do we push students to go deeper and revise the science ideas we have built together so far?

5. How do we help students put together pieces of the disciplinary core ideas and crosscutting concepts?
Example 1 – How Can We Sense So Many Different Sounds From a Distance?

Middle School: sound waves

Sound Unit Design Team

- Brian Aycock, Curriculum Coordinator, West Aurora School District 129, Aurora, IL
- Lisa Brody, 6th-7th Grade Science Teacher, Park View School, Morton Grove, IL
- Malika Jones, 7th-8th Grade Science Teacher, Beach Park Middle School, Beach Park, IL
- Tara McGill, Curriculum Specialist, Northwestern University.
- Michael Novak, Senior Curriculum Developer, Northwestern University and, 7th-8th Grade Science Teacher, Park View School, Morton Grove, IL
- Amy Telford, High School Science Teacher, Salem Community High School, Salem, IL
- Keetra Tipton, 6th-8th Grade Science Teacher, Park View School, Morton Grove, IL
- Robert J. Wolfe, Professor of Education, Bradley University, Peoria, IL

tinyurl.com/NGSSsound
Student observe an unusual phenomenon
From Anchoring Phenomenon to Questions and Ideas for INvestigations

- What do we notice?
- How can we explain this?
- Where else have we seen something like this?
- What do we need to figure out?
- Do our explanations agree?
Student Questions

- How do sounds fade away?
- Why are some noises higher pitched than others?
- How do we hear underwater?
- Is sound a state of matter?
- Why do we feel vibrations when we play instruments?
- How does a sound go through walls?
- Does vibration cause sound?
- Why do some objects make only 1 sound?
- Can we hear amplified sound even if it is blocked?
- Does something need to touch another to make sound?
- Is sound made of particles?
- Why can’t some age groups not hear higher sounds with their ear, but some do, like a dog whistle?
Motivated investigations in the sound classroom

- Use different objects to observe their sounds
- Study the structure and function of each part
- Zoom in even closer to observe
- Get in touch with inventors or makers of speakers, megaphones
  so we can figure out how they work
- Place people in different areas and set up different tests (distance, volume, etc.)
- Bring in different instruments

Guys! Listen, the thing that’s in common for all four of these instruments — you have to do something in order for it to vibrate.
Motivated investigations in the sound classroom

 Ideas for investigations

- Use different objects → observe their sounds
- Study the structure & function of ear parts
- Zoom in even closer to disc
- Get in touch with inventors or makers of speakers, megaphones
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- Place people in different areas & set up different tests (distance, volume, etc.)
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Guitar Strings - Slow Motion
Modeling sound from instruments as vibration

1. The fork strikes and the fork bends
2. When the fork leaves the table, it bends the opposite way
3. The fork bends again and keeps on going until it stops to vibrate
Model so far

**Lesson Routine**

**L1**
Anchoring phenomena

**L2**
Investigation
What do the needle and record look like up close?

**L3**
Investigation
Do other things that make sound, like instruments, also move back & forth?

**Putting pieces together**
How can we model what is causing these instruments to vibrate?

**Questions**

**Phenomena / Problems**

Students' prior experiences
There are wavy grooves on the record that cause the needle to be pushed back and forth. We thought that different patterns in the grooves might be what makes different sounds.

The instrument is changing shape and moving back and forth after being struck or plucked.

Previous phenomena from L2
We developed a model for why instruments vibrate for a while after they are struck or plucked. They deform, spring back, overshoot their original position, and then repeatedly change shape back and forth for a bit.

In order to sense a sound, it needs to travel from a sound source to our senses. We had a lot of questions about related phenomena and some ideas for investigations to pursue.
A Question Emerges

Do all objects vibrate back and forth when they make sound?
Amelia: Yes, because um, you might be- not be able to hear a sound but when an object vibrates you can um, it does like make a sound.

Julio: Um I think that not everything vibrates when it makes a sound. ...because mostly things that make sounds are solids and some solids can be really sturdy and not move at all.

Oscar: I would think that there's like- when you hit it it doesn't change a lot but it still has a little vibration.

Aaron: It's like kind of, it's like, um if you had a chain saw in the floor it's gonna crack, but if just people stomp on it I don't think it will [vibrate]. Like it could have a little cracks maybe.
We have a partial model. But what about...? We should definitely test this!

Is it X or Y?
Example 2 – What is Happening to Our Corn?

Design Team:
Lori Farkash, 2nd Grade Teacher, Moses Y. Beach School, CT
Nancy Michael, 2nd Grade Teacher, Pembroke Elementary School, CT
Ruth Purdie Dyer, 2nd Grade Teacher, WCAIS Magnet School, CT

Second grade: plant growth, structure/function
Phenomenon to questions to ideas for investigations

Let’s take it apart!

Let’s leave some in water and observe it every day!
...after 10 days...
Productive arguments lead to new questions

Some think the sprouts are coming from the kernels...some think the sprouts are coming from the cob & some aren't sure! This is so exciting 😎
Where are the green parts growing from?

It’s coming from the cob because it comes from underneath the kernels.

I disagree with you because when I looked closely at this I saw a sprout coming out of a kernel.

I agree with both of you because I see some are coming from the kernels AND the cob.
Productive arguments lead to new questions, which lead to new investigations.

A plan to resolve the argument:

**Harvest Corn**

**Day 4**

*I Noticed...*

- There are green things coming out of the corn!
- It looks like the sprouts are coming from in between the kernels and from under the kernels.
- The white things are getting longer.

*I Wondered...*

- Is the water making the corn grow?
- Is it sprouting from the kernels? Or is it sprouting from the cob?
- Why are they getting longer?

**Notice**

- We noticed: little white and green things coming out of the corn

**Wonder**

- We wondered: Are the coming out of the kernels or the cob?

**Investigate**

- We decided to investigate this by:
  1. Fill pots (containers) with soil
  2. Put the cob into 1 container
  3. Put the kernel into a different container
  4. Add water to each container

**Predict**

- We predicted that: The kernels will grow! OR The cobs will grow!

**What do we do next?**

- Draw a scrawled list of changes!
- Set up an investigation to see if sprouts are coming from the cob or the kernels.
Experiment Set Up: “Cob into container, kernel into a different container”

Results!

Look! The cob didn't sprout but the kernels did! Are the kernels seeds? 😐 & now we're wondering, what's inside the kernel to make it sprout? 😬
New things we notice and gaps in our explanations lead to new questions.

Now we have a reason to test the effects of light!
Other examples

- Evolution – We have seen physical traits change in a population over time. But can behavior be inherited?
- Ecosystems – We figured out that all animals get energy and building materials by consuming other living things. But what about plants?
- Can you come up with another example
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3. How do we help students *use practices to figure out* pieces of the science ideas?
4. How do we *push students to go deeper* and revise the science ideas we have built together so far?
5. How do we help students *put together pieces* of the disciplinary core ideas and crosscutting concepts?
Questions?

Download these units and other open-source storylines:
http://www.nextgenstorylines.org

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