Stare at one of the birds for 30 seconds and then stare at the empty cage.
Teacher Professional Development in the Age of NGSS

Sara Heredia, Exploratorium; Bethany Sjoberg, Highline Public Schools; Jessica Thompson, University of Washington

STEM Smart workshops are funded by the National Science Foundation grant #1449550. Any opinions, findings, and conclusions or recommendations at this event or in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Agenda

- Bird in Cage Activity
- Design principles for science teacher learning
- Two models of professional learning
  - Exploratorium Teacher Institute
  - University of Washington
- Reflections/discussion
What is going on?

1. Pick a set of observations about the bird in the cage and explain why there is variation.

2. What evidence do you need to support your explanation?

3. What would you like to try next to gather some of that evidence for your explanation?
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Disciplinary Core Idea(s)
LS1: From cells to organisms: Structures and processes

Science Practices
Constructing explanations
Planning investigations

Crosscutting Concept(s)
System and system models
Structure and function
How is this different?

How this activity is different from how you learned about the structure and function of the eye and how humans see?
Design principles to support teacher learning

- Time for teacher sensemaking
  - as a science learner
  - as a science teacher
- Time for planning collaboratively for implementation
- Follow-up to support implementation
- Teachers involved in creating resources, common tools, practices
Exploratorium Teacher Institute
Teacher development of Next Generation Science Snacks

- Teachers as learners in 3D activity
- Sensemaking as science learner
- Reflect on enactment
- Sensemaking as science teacher
- Modify activity for classroom
- Collaborative development
- Classroom Enactment

This material is based upon work supported by the National Science Foundation (NSF) under grant DRL-1503153.
Write a well-developed explanation, argument or model that describes the phenomena represented with snack.

What ideas/concepts will students come up with in this activity? Challenging ideas or common intuitive ideas

What will students know and understand after they’ve completed the activity? Where will we go next?

What materials and resources might students use to resolve confusion or uncertainty about what’s going on? [focus on engaging in science practices]

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Science Snacks

Hungry for fresh, exciting science content based in mind-blowing natural phenomena? Try our Science Snacks: hands-on, teacher-tested activities you can do at home or in your classroom using cheap, readily available materials. Satisfy your curiosity without ever getting full.

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Building NGSS Networked Improvement Communities

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Today

Key Ideas
1) Professional development can aim to adapt and improve teaching practice (not just adopt and disseminate)
2) Networks can support the improvement of practice over time
3) Such networks need a common vision, and set of practices and tools of ambitious science teaching practice
4) Need to design for job-embedded professional development
Our Local School Context

Student Cultural and Linguistic Diversity
Improving teaching as well as teachers

Networked Improvement Communities:

Across institutions, a commonly shared set of core practices, along with its tools, could evolve over time to improve and innovate within the work of teaching.

Bryk, Gomez, & Grunow, 2011; Hiebert & Morris, 2012
Starting with a common set of evidence-based teaching practices

NETWORK GOALS:
- All students have improved written and spoken scientific models, explanations & arguments.
- Improve tools that support ambitious and equitable teaching—for all students and EL students in particular.

http://ambitiousscienceteaching.org/
**GOAL:**

Improve all students’ written and spoken science explanations, arguments & models

**PRIMARY DRIVERS:**

- Making the language of science explicit
- Equitable talk for how/why explanations
- Using evidence to construct and revise explanations
- Revising models with evidence

**SECONDARY (ACTIONABLE) DRIVERS:**

- Using language functions as lens for reading, writing, and modeling (ACE)
- Structured talk for how/why reasoning
  - 5th/6th STEM Academy
  - Cascade MS
  - College Place MS
  - Pacific MS
  - Renton HS?
- Revising lists of student generated hypotheses with evidence
- Peer feedback to deepen written explanations
  - Chinook MS
  - Evergreen Campus
  - Highline HS
- Sequenced share-out of models
  - ACE/Global Mt. Ranier

* Change package developed
Science teaching practice: Peer feedback to deepen written explanations
# Markers of Ambitious Teaching

<table>
<thead>
<tr>
<th>Ambitious Teaching</th>
<th>Status Quo Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TASK</strong></td>
<td></td>
</tr>
<tr>
<td>Begins with a complex and content-rich scenario and high expectations for student learning</td>
<td>“Basics first” approach or Activity-Mania</td>
</tr>
<tr>
<td>Activities are designed in service of learning about big ideas and supporting students in revising their ideas over time</td>
<td>Inquiry with focus on individual activities</td>
</tr>
<tr>
<td><strong>TALK</strong></td>
<td></td>
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<tr>
<td>Purposeful talk with elaborating, questioning, and reorganizing of ideas as the goal; students’ ideas are uncompromisingly treated as intellectual resources</td>
<td>Talk aimed at a “right answer”, dominated by teacher-talk</td>
</tr>
<tr>
<td><strong>TOOLS</strong></td>
<td></td>
</tr>
<tr>
<td>Tools that scaffold student reasoning</td>
<td>Materials that describe “how to proceed”</td>
</tr>
</tbody>
</table>
Systems thinking: Developing Networks that Improve Practice

Year 1
Job-embedded PD Model & developing coaches

Year 2
Naming and testing “bite size” teaching practices

Year 3
Networking practices across schools

Year 4
Systematizing data & principal support
Social Networking Analysis
## Markers of Networked Professional Development

<table>
<thead>
<tr>
<th>Status Quo PD Adopt &amp; Disseminate</th>
<th>Networked Improvement Communities Adapt &amp; Improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull out of classrooms</td>
<td>Job-embedded- in classrooms</td>
</tr>
<tr>
<td>Traditional roles with an “ivory tower”</td>
<td>Blurring roles</td>
</tr>
<tr>
<td>Focus on what to teach (walk-throughs of lessons)</td>
<td>Focus on student thinking as basis of revision to teaching</td>
</tr>
<tr>
<td>Stand-alone “teacher proof” tools</td>
<td>Tools that stabilize ambitious practices</td>
</tr>
<tr>
<td>Potpourri learning: 3 days/year</td>
<td>Accelerated learning: 90-day inquiry cycles into specific practice &amp; principled adaptations</td>
</tr>
<tr>
<td>Individual’s tinkering</td>
<td>Teams engaged in small tests of small changes &amp; shared with the network</td>
</tr>
</tbody>
</table>
Social structures supporting the improvement of practice

Peer feedback to deepen written explanations

Sample Timeline

Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul

△ studio day embedded workshop
○ district-wide convening workshops
□ school-based data/planning workshops
★ Instructional walks with principals

Note: Filled shapes represent release days/time from instruction.
“Studio Day”
Learning in and from practice

All-day job-embedded professional development where teachers collaborate to give real-time feedback in an authentic teaching & learning space.

(Ball & Cohen, 1999; Borko, 2004; Grossman et al., 2009; Lampart 2009)
Learning Loops: What gets tested and shared in and across schools?

Working theory of student learning

Teaching Practice

Practical measurements

Bryk, Gomez, Gunrow, LeMahieu, 2015
NIC measurements

• Outcome: classroom observation of science and ELL practices, student explanations & use of evidence
• Process data: studio day data, SNA data, teacher self reports
• Process step measure: features of the science teaching practice is being used
• Learning cycle measures: Temporary data for small tests of small changes for science teams
How can we better support EL students in science and learn from one another’s attempts? How can we leverage planning?

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<tr>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Overall</td>
<td>509.36</td>
<td>351.53</td>
<td>366.15</td>
</tr>
<tr>
<td>Sharing existing materials</td>
<td>86.24</td>
<td>83.77</td>
<td>54.95</td>
</tr>
<tr>
<td>Co-creating instructional materials</td>
<td>91.56</td>
<td>75.27</td>
<td>55.50</td>
</tr>
<tr>
<td>Understanding science content</td>
<td>65.29</td>
<td>84.81</td>
<td>49.65</td>
</tr>
<tr>
<td>Discussing student learning</td>
<td>84.75</td>
<td>59.10</td>
<td>60.85</td>
</tr>
<tr>
<td>Understanding learning and teaching</td>
<td>70.45</td>
<td>60.67</td>
<td>57.95</td>
</tr>
<tr>
<td>Analyzing examples of student work</td>
<td>41.55</td>
<td>41.02</td>
<td>29.10</td>
</tr>
<tr>
<td>Providing feedback</td>
<td>33.45</td>
<td>51.19</td>
<td>23.85</td>
</tr>
<tr>
<td>Improving instruction for ELL</td>
<td>24.69</td>
<td>33.96</td>
<td>24.95</td>
</tr>
</tbody>
</table>
EVERGREEN DATA SNAP TOOL

Name: Nicole Flynn
Date: 1/24/14
Class Period: 3rd Period

1) Science lesson topic: Phenomenon: Ocean Acidification Lesson: Rearrangement of Weak Acids

2) Who tried the practice?
   - Teacher
   - Teacher + Coach

3) How often have students used A/B talk in your class?
   - This is the first time.
   - They have tried it 1-2 times before.
   - They have tried it 3-5 times before.
   - This is done regularly in my class 2-3x/wk.
   - This is done regularly in my class 3-5x/wk.
   - We practice A/B talk daily.

4) PLAN your A/B question:
   Based on your hypothesis what is happening to these 2 molecules (H2O & CO2)?

5) Below are the drivers for supporting ambitious and equitable instruction in small group interactions that you generated from studies. Bubble all that applied to this lesson:

   What-how-why: Give them the “why”
   - as a part of the launch, build in what level of observation then as a why “get ready to talk” (2x)
   - have students compare and contrast data and talk about what happens.
   - as a part of tools/models start with what questions or provide visuals of the “what”
   - provide modeling keys
   - students have readings/videos that help them develop a “targeted why”
   - have targeted questions about the why
   - ask 3 rounds of structured “why” questions
   - remind students about resources (journal etc.)

   Equity: Structured Turn & Talk A/B partner talk
   - Directions on how to do A/B talk were shared with students
   - The directions were specific to this lesson
   - Students were given feedback on HOW they engaged in the talk
   - Have students engage with their partner’s ideas “listening for understanding”
   - Be explicit about how much students are talking – engage them in self-monitoring/give an exit card about how the A/B talk supported their science reasoning
   - Provide private talk

   Small Group Discourse: Accountability in Modeling
   - Have all students participate in written forms of models (using color pencils/pens)
   - Have students use role cards
   - Students were given a “model scaffold” to work on together
   - Students had an explanation checklist

   EL supports: Empowering ELs to share what they know & develop fluency with academic talk
   - EL students are identified
   - Use sentence stems for EL students
   - Differentiate questions for different levels of EL students
   - Intentionally pair students to support use of language and language development

Learning Target: I determine how particles might Δ in chemical reaction.

Know before class: Rearrangement of H2O & CO2 = H2 & CO2
Peer feedback to deepen written explanations

**Problem of Practice:** Students talk deeply about scientific phenomena, but that talk often does not translate into writing. How can we capitalize on talk or feedback to help them deepen their *writing*?

**Simplified Practice Flow:**

- **Think/Write:** Students construct all of part of initial (ideally written) explanation.
- **Talk/Feedback:** Students work together to improve explanations through questioning and feedback.
- **Process Feedback:** Students are supported in deciding how to use feedback.
- **Write:** Students write/revise explanations in light of feedback.

**Grade 8 video:** Why was one skateboarder successful at making it through a loop and the other not?
Before Talk

Question: Why did the nylon stopper stay in between the shampoo and the water in the density column?

Include a zoom-in of:

- the nylon stopper
- the shampoo
- the water

After Talk

AFTER DISCUSSION:

Question: Why did the nylon stopper stay in between the shampoo and the water in the density column?

Include a zoom-in of:

- the nylon stopper
- the shampoo
- the water

The nylon stopper stayed between the shampoo and water because their density is right between the shampoo and water.

The nylon stopper stayed between the water and shampoo because the masses were more packed into shampoo so the nylon didn't go totally in and pulled more up, so a cushion formed.
Depth of Writing Before and After Talk

*From 1 class of 20 students*
Model for Improvement

What are we trying to accomplish?

How will we know that a change is an improvement?

What change can we make that will result in improvement?

Changes That Result in Improvement

Implementation of Change

Hunches
Theories
Ideas

Very Small Scale Test

Challenges

Complexity

Opportunities

Time
Develop “change packages” that investigate how the practices work, under which conditions and for whom.
- Patterns in the data
- Hypothesis about a change in the practice process/context
- PDSA(Reflect)
### Network Drivers for Structured Talk

#### Working on scientific explanations
- **Press students toward “how” and “why”**
  - *Giving students “the what,” asking targeted why questions, asking students to use evidence in their models, adding questions and tasks that prompt how/why level writing...*
- **Engage students in connecting ideas**
  - *Providing them with opportunities to juxtapose data/hypotheses/ideas/models, asking them to apply ideas to a new scenario*, using a summary chart to connect activities to the phenomenon...
- **Focus students on key science ideas**
  - *Clarifying important ideas through targeted just-in-time instruction, using an explanation checklist*...
- **Have students track how their thinking has changed over time**
  - *Highlighting revised explanations on their models...*

#### Creating equitable opportunities to learn
- **Ensure students understand the protocol**
  - *Sharing directions on how to do structured talk, chunking the protocol so students can get used to each part...*
- **Provide adequate processing/sharing time**
  - *Giving students private think time prior to talking, using a timer to moderate turns...*
- **Provide access to supportive resources**
  - *Reminding students of resources they have available, providing a word bank or sentence stems...*
- **Create accessible entry points for students**
  - *Launching with multiple choice questions*, making students experts on particular parts of the model, *pairing students based on comfort...*
- **Seek out and integrate students’ experiences**
  - *Asking students to comment on their talk experience (e.g., exit ticket), allowing students to leverage debate-oriented discourse...*

#### Promoting robust classroom discourse
- **Help students think about their engagement in structured talk**
  - *Engaging students in self-monitoring or providing explicit feedback, analyzing good videotaped conversations together, explaining why you’re using structured talk...*
- **Create meaningful science contexts for students to work together**
  - *Having students work on a joint model, keeping the talk anchored in authentic science, having options for “fast finishers”...*
- **Plan for sharing out after structured talk**
  - *Creating a public record of shared ideas using students’ names*, requiring students to write their initial ideas and how their ideas changed in preparation for sharing...
- **Scaffold talk norms in the classroom**
  - *Modeling the kind of conversation you expect, providing sample questions students could use to press each other for explanation...*

#### Supporting language development
- **Identify and plan support for EL students**
  - *Differentiating questions for different levels, intentionally pairing students to support language use and development...*
- **Provide written scaffolds for EL students**
  - *Creating sentence frames, providing private write time prior to talking, acknowledging key vocabulary on the board...*
- **Give EL students extra support before they share with the whole class**
  - *Allowing students to confer with partners before sharing, having partners read written comments aloud to practice, pre-selecting students to share and letting them know so they can prepare...*
- **Encourage multiple language use**
  - *Using 1st and 2nd languages with partners*, providing a “gotta have” checklist in Spanish...*

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**Learnings from ACE**
Learnings from Cascade
Learnings from Chinook
Learnings from College Place
Learnings from Evergreen

**Learnings from Highline**
Learnings from New Start
Learnings from Rainier
Learnings from Renton
Website: http://ambitiousscienceteaching.org/

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