NGSS Practices in Action

Breakout B: Elementary

Presented by: Christina Schwarz

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Introducing today’s presenter...

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Scientific Practices for Elementary School Classrooms

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The opinions expressed herein are those of the authors and not necessarily those of the NSF.
Who am I?

• Professor in science education and teacher education at Michigan State University
• Taught preservice methods and worked with elementary teachers for 15 years
• Background in science (planetary science/astronomy)
• Focus of teaching and research: supporting teachers and students at elementary and middle school in scientific practices. Current projects:
  • Scientific Practices project – fostering scientific modeling, explanation and argumentation in 5th and 6th grade classrooms
  • MoHSES 3rd grade project modeling water cycle
  • Head Start on Science preschool project
Why I love scientific practices

• Why I am passionate about practices
  – Practices are what learning science is all about!!!
  – Teaching using practices is fun and engaging
  – Practices are mentally stimulating and help us (yes teachers too!) better understand the world
  – It’s socially oriented, and we can learn how to work together to figure out the world
  – Practices help our students be prepared for lifelong learning

• Teachers with whom I work have said things like:
  – “This is the way students should learn. This is what science is all about!”
  – “This has helped me be a better teacher”
Caveats to this presentation

• I am not an author of the framework, but I have worked closely with others who are.
  – I have worked with teachers and students using science practices and how to engage students in practices.
  – I have conducted and know about science research and how practices work in science.

• I value all science practices. I foreground scientific modeling (or model-based explanations) and how modeling works with the others. You’ll see!
What grade do you typically teach?

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Overview

• Assumptions and focus on sense-making
• Recap of a few practices
• What does engaging in practices look like?
  – 5th grade PS vignette
  – 3rd grade ES vignette
  – K LS exemplar
• Ideas for how to start
• Resources
Assumptions

• Children are born investigators and come to our classrooms with many experiences and capacities for engaging in science
  – *Taking Science to School* (NRC, 2007) “young children have a repertoire of cognitive capacities directly related to many aspects of scientific practice” (pg. 44).

• They are **not** simple thinkers that can only reason around concrete objects (think about their use of language and storytelling!) – even if they don’t know the language of science or are unfamiliar with doing school science.

• Use their diverse ideas, experiences and ways of knowing as resources to build scientific sense-making
Focus of Practices: Sense-making

NGSS is a change from focusing on facts/vocab and hands on (but not minds on) activities to

Making sense of the world!! Investigating and trying to understand how and why the word works the way it does!!!
SENSE-MAKING
What are we trying to figure out? How will we go about figuring it out? How will we keep track of what we’re figuring out? What does it all mean?

- Asking Questions/Defining Problems
- Using Mathematics & Computational Reasoning
- Engaging in Argument from Evidence
- Constructing Explanations & Designing Solutions
- Obtaining, Evaluating & Communicating Information
- Analyzing and Interpreting Data
- Developing & Using Models
- Planning & Carrying out Investigations
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Asking Questions

• Questions should be about phenomena in the natural and designed world.

• Those questions lead to descriptions, models, and explanations of how and why the world works and can be tested empirically.
Developing and Using Models

Developing, using, evaluating, and revising scientific models for inquiry

- **Models as representations of ideas about how and why the world works the way it does** (e.g., Particle model of matter, light ray model, water cycle model, food web models)

- Involves ideas too hard to ‘see’ (too small, too big, too fast, too slow). - NOT art projects like Jell-O models
Constructing Explanations

- Constructing and revising accounts that describe, explain, or predict a particular phenomenon in the world (what, how, why).

- Strong explanations are supported by evidence, may describe patterns (how) or account for why.
Engaging in Argument from Evidence

• Social efforts (sharing, evaluating, responding/revising) to make sense of phenomena and persuade others of underlying ideas.
  – (K-2) listen to ideas and ask for clarification
  – (3-5) construct arguments supported by models and data; compare arguments, and respectively construct and receive critiques
Benefits of Practices?

Help students make sense of world by helping students put together experiences and ideas about how/why the world works!

– Develops confidence, curiosity, etc.
– Develops social capacities (working with others to collect data, make sense of ideas, and produce outcomes from this) that are important
Questions?
Poll: How do you use practices?

What is the most common way that you use scientific practices in your classrooms?

A. To engage students
B. To get them curious and excited
C. To help them develop their science skills
D. To help them understand ideas
What do Practices Look Like?

Curriculum sequences and vignettes from:
• 5th grade unit on evaporation/condensation
• 3rd grade water/hydrology cycle
• Kindergarten seed/plant growth
5th Grade Evap/Condensation

 Covered Cup

 Open Cup

 Rubber band

 Water level

 Water

 Condensation

 Water level after

 Water vapor is escaping

 Line: water level before
Example Model-Based Inquiry Unit and Sequence

Eight-week model-based inquiry unit on evaporation and condensation for 5th grade

Curriculum sequence

1. Central question
2. Develop initial model of evaporation
3. Empirical investigations and model revision
4. Computer simulations and theoretical ideas with model revision and evaluation
5. Consensus model construction
6. Model application
7. Repeat the sequence with condensation
Anchoring phenomena and central question:
Would you drink the liquid in the bottle cap from a solar still?
(2) Initial Model

Develop an initial model of evaporation – what happens to the water? (second half of unit on condensation)
(3) Empirical Investigations

Using humidity detectors to measure water vapor levels from evaporation and condensation
(4) Evaluate and Revise Model
(5) Introduce scientific ideas and simulations

**Changing Phase I: Create a Solid, Liquid, and Gas**

- **Dry Ice**
- **-80°C**

In the window above, you will see the model zoom down to see a SAMPLE of water molecules inside the bottom of the test tube. Click on the Bunsen burner several times and watch what happens to the thermometer, the water in the test tube, and the water molecules above. Describe what happens to water in the test tube and the behavior of the water molecules above when you reach a high temperature.
(6) Evaluate and Revise Models

Evaporation model before simulation

Evaporation model after simulation
(7) Peer comparison and evaluation
Mrs. M: So here is one model of evaporation. How many of you had a model exactly like this? Right, no one did. So let’s take a look at it right now. We have a label that says “uncovered”, and here I see there’s one says “covered”. So what’s specifically did Ben do? …

I really like the way he actually used arrows to show where the molecules are going so that you know the molecules are not staying at their spots.

Mrs. M: OK. You like that he actually used arrows, right? Do you wish anything else?

I wish that he would have, I really wish that he would’ve put the water level on the covered cup, like the original line, the where the water started at.
Whole Class Model Evaluation

Mrs. M: Interesting. Ben, what do you think about that?
I think it would be a good idea to show how far the water dropped from where it started.

Mrs. M: Could that be a piece that you would add maybe into…evidence, especially for an uncovered cup that you don’t have like humidity detectors, something like that.
Yeah.

Mrs. M: OK. So that would be an evidence piece. Do you get that? That’s a great suggestion. Excellent! So do you see now how the compliment and wish can be? So John, do another.
OK. I wish he could, oh, compliment first, I like how he showed the water droplets and in the uncovered cup it moved around a bit, I wish that the uncovered one could show which one are water molecules and which ones are air.
Mrs. M: Oh, my gosh, say that again.
In the uncovered cup, I wish he could show which molecules are water and which are air.

Mrs. M: So you like how he showed that there were water molecules, right? But you wish that he were to show which one is air and which one is water. Interesting! Why do you wish that?
Well, especially the uncovered one, it showed that it evaporated into the air, but it didn’t show which one in the cup have already evaporated and which one haven’t.

Mrs. M: What do you think Ben?
Yeah, it doesn't really show which one has already evaporated… (inaudible)

Mrs. M: Yeah, cuz in your brain, you Ben are like, I know what that molecule is doing and that molecule is doing, I know which one that one is and I know which one that one is, but whoever is looking at might not know that.
(8) Construct a consensus model

Small group evaporation consensus model

Example of whole class condensation consensus model
Ben: Should we label right here and write “no direct heat source”?
Sue: Sure. Ben. Your air molecules are too close together, because remember in the simulation, they spread out?
Ben: Yeah, but we don’t have that much room. We have to…
Sue: OK, we can make a note there that they eventually spread out.
Jack: Why don’t we just put an explanation on it?
Ben: Well, this is all the explanation.
Jack: All right. You need to explain that a little bit more.
Small Group’s Consensus Model of Evaporation

Sue: We have to explain it didn’t seep through the cup, if someone asked that. Our model cannot explain that.
Jack: Well, does this explain how paint dries?
Sue: Yes, the water molecules are leaving. This explains how nail polish dries. It also explains how you can smell stuff because molecules go away carrying scent.
(9) Use model to predict and explain

Pre-test

Post-test
What Did Students Learn?

• Students learned about:
  – evaporation and condensation – the particle nature of matter, that particles move, and that they are conserved
  – how to explain their ideas – in particular, how and why things happen (e.g., mechanism) by reasoning through ideas carefully
  – that there is an audience to which one must pay attention other than the teacher
  – that their models need to explain phenomena in their lives
  – that evidence matters in justifying their explanations

• What were they still learning?
  – social norms like how to negotiate disagreements with one another, details about the evap/cond and particle nature of matter, and how these ideas apply to more complex situations
Thoughts?

- How is this type of sequence similar or different from your curriculum?
- Less content coverage, more depth; asking students to make sense of data and theory and to put it a model or explanation; peer revisions and whole class conversations
Questions?
3rd Grade Practices

Water flows downhill, sometimes faster, sometimes slower. As a hill becomes steeper, water flows faster. Gravity is the force that causes water to move downhill.

Key:

1. Rainfall
2. Water Infiltration
3. Runoff
4. Water in Streams
5. Water in Rivers

Diagram:

- Rainfall
- Water Infiltration
- Runoff
- Water in Streams
- Water in Rivers

Example:

- Rainfall
- Water Infiltration
- Runoff
- Water in Streams
- Water in Rivers
Where does water go and how does it move?

Imagine that you are on the school playground after a huge rainstorm. There are lots of places where there is water. Some places have large puddles. There is also water in ditches and moving to the drains. You go out the next day and you see that some of that water is not there anymore. You also see some areas where the water is still in larger puddles. What happened to the water that is gone? Where did it go and how did it do that? Why is some of the water still on the ground? How did it move?
MoHSES Question & Initial Model

Where does water go and how does it move?

Draw a diagram (model) of what you think happened to the water on the playground both above and below the ground in your model. Include what you think happened to water above and below the ground. Use words to explain what happened and why you think it happened.
MoHSES Water Investigations

Engage in investigations to answer question*

What do we need to find out?
How might we do this?

• Collect information about water location and placement (measure where it goes, how much, how fast; take pictures!). Where does it go? Why?

• Collect samples of dirt in different locations and test how water goes through soils

*The MoHSES project modified the FOSS Water unit
MoHSES Water Investigations

What did we find? What is this telling us?

What patterns do we see in where we find water and where the water goes?
MoHSES Water Explanations

What happened and why?

– We found that water collected in low puddles and where dirt was very compact.
– We found that water goes downhill into puddles
– We think that water drains through holes in the rocks and dirt because gravity pulls it down
– We think that some water evaporated into the air
“I think [water is] underground because it could soak through the rocky stuff...there’s like little tiny spaces that it can go through ...all over the place.”
Question: What happens when water hits the ground?
Susan: The soil soaks it up.
Teacher: Are you saying all of this rain will soak in right where it’s at?
John: We all had plants that could soak up the water in the dirt.
Teacher: So you had plants….
John: and roots
Teacher: Why?
Mark: It’s nourishment for the plants.
Teacher: Does everyone agree with the water going through the ground to the roots?
Emily: I had the water going down but the roots didn’t get it.
It was groundwater.
MoHSES Consensus Model Discussion

Question: What happens when water hits the ground?
Teacher: How did it get there?
Elizabeth: The plants don’t need all the water. Some of it goes through the dirt and gravel underground.
Teacher: OK, does everyone agree that plants take some of it or it can collect underground?
Jordan: It can go to a lake.
Teacher: Underground?
Jordan: Yeah. It moves here (in the gravel layer) and goes to the lake.
Teacher: Why?
Jordan: Because gravel has big spaces and lets the water flow through.
Possible Wrap-up

Communicate Findings

– Write a persuasive memo to the school/district with observations and recommendations for how to fix flooding problems
Question – How can I keep my plant alive?

(SS&J question: What is a seed and how do we know? “It’s a seed because it’s soft or peeling”)

* See Schweingruber, Smith & Jeffries NSTA webinar from 1/29/2013
Planning and carrying out investigations

– How can we find out? (“We could plant it.” “We could water it and see if it grows.”)

– Make predictions with pictures/words

– Keeping track of information/data (science notebooks). From SSJ “What is happening today?”

* See Schweingruber, Smith, & Jeffries NSTA webinar from 1/29/2013
Kindergarten Practices*

Analyzing and interpreting data
– Using math to look at patterns
  • E.g., Bar charts

* See Schweingruber, Smith & Jeffries NSTA webinar from 1/29/2013
Kindergarten Practices*

Explaining patterns
– What happened and why?
  • Maybe some didn’t get enough soil
  • That one had too much water

New questions to investigate!
Engaging in argument from evidence
– Why did seeds grow and other didn’t?

* See Schweingruber, Smith & Jeffries NSTA webinar from 1/29/2013
Poll: What is your biggest challenge in implementing practices?

A. Not sure I understand the practices
B. Not enough curricular resources written for scientific practices
C. I have to use my districts’ materials that don’t use practices
D. Not sure how to effectively support students at engaging in practices
E. Takes too much time to do it and I’m pressured to cover more material
Some Ideas

• Consider learners as developers and evaluators of knowledge, not just consumers. All disciplines in science have at their core a central activity of *making sense* of our world and why things work the way they do. School should *engage* students in doing this sense-making NOT in hearing about how others have done it.
Some Ideas

• To do this, **Less is more!!** Focus on one or two important (powerful) science idea(s) per unit that can lead to great driving questions and ways to investigate. Remember, it’s not about learning a lot of (or even mostly) facts/vocab – it’s about helping learners put that information together with other ideas and make sense of the world! They need a lot of chances to talk, draw, write, and apply those ideas.
Some Ideas

• If possible, involve students in deciding questions and investigations - at least consider their ideas. Ask students what they think the observations and data mean and why.
  – What happens if students make off the wall comments or suggestions?
    • Ask them to talk more about their ideas and rationales (maybe they’re not as crazy as they seem). As other students about their ideas and feedback in response.
    • Ask students to decide together what they should do and ask them to offer good reasons for those decisions
Some Ideas

• Focus on a few practices at the start (e.g. questions, investigations, explanations).
  – If you’re comfortable with these practices, use modeling and argumentation as a way to help students develop and revise their ideas with each other. Help them use math to collect and interpret data. Use literacy skills to argue and communicate information and findings!
Some Ideas

– Use talk moves to help develop a learning community that talk about their thinking and sense-making in class (see Talk Science Primer – Michaels & O’Connor)

• Establish ground rules, help them elaborate and deepen their thinking (use pair talk, ask them to say more, tell us why you think that), ask to compare/contrast or build on other ideas (agree/disagree/build)
Some Ideas

• Engaging students in practices helps them learn and think more deeply. They are more likely to learn other 21st century skills involved in working and negotiating with others as they are working on making sense of the world.
Summary of Main Points

1. Engaging students in scientific practices is fun and helps their learning
2. Engaging in practices is about helping learners make sense of phenomena in the world (not about learning information for information sake or just hands-on messing about for exposure)
3. Use a driving question that addresses a core/important idea and provides coherence in the unit; monitor and respond to students ideas throughout
4. Focus on phenomena and data from those phenomena
5. Help students develop and revise models and explanations of the world answering how and why questions about the phenomena
6. Actively involve students in deciding how to engage in practices
7. Help learners engage in social practices of sharing ideas, evaluating and persuading one another of the best ideas and for making sense of the world. Use talk moves
8. Enjoy the outcomes!
A Few Practices Resources

• Books, references and articles:
  – *Ready, Set, Science!* NRC publication
  – TERC Talk Science Primer – Michaels & O’Connor
  – Science & Children articles on scientific practices

• Helpful websites
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