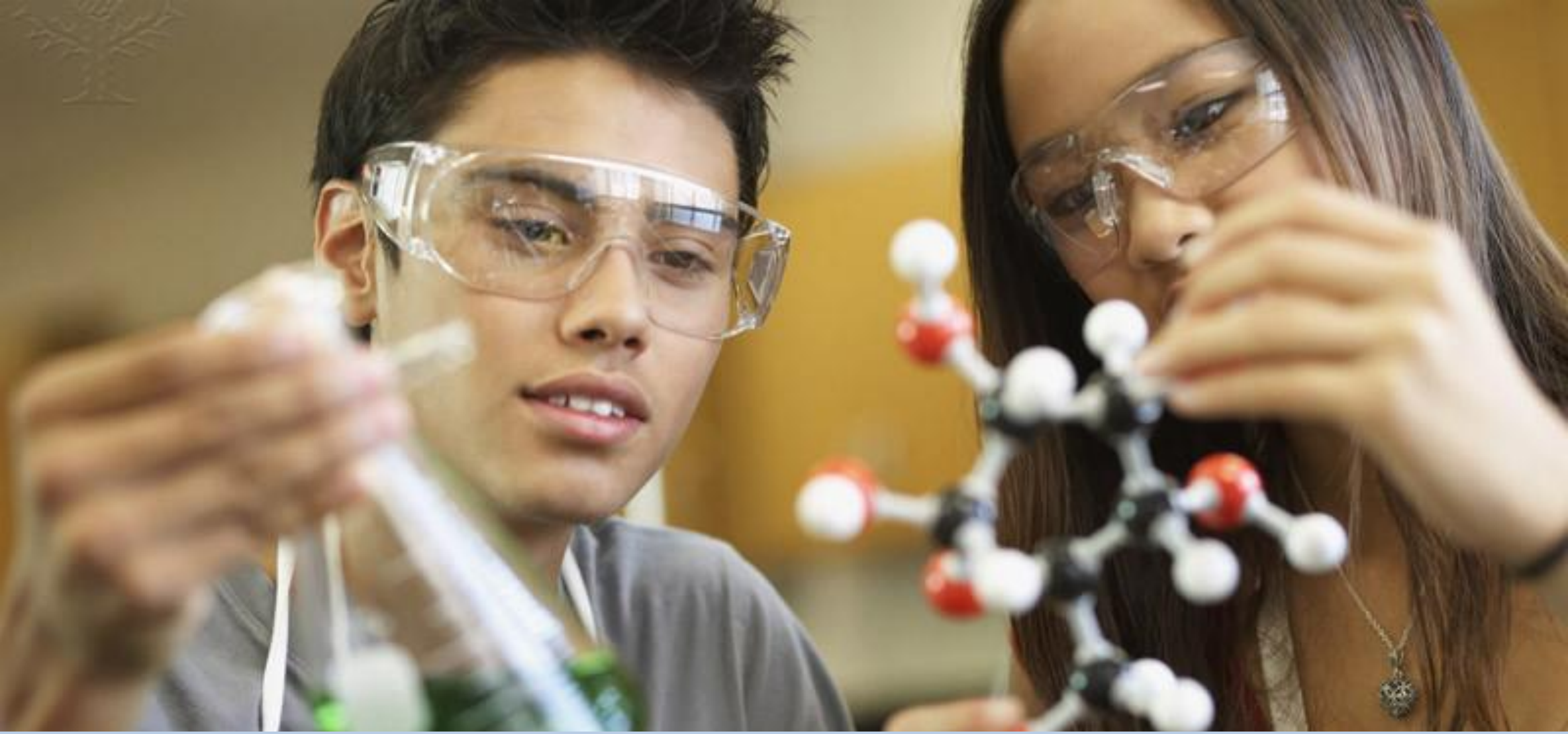

The Framework for K-12 Science Education:
What does it mean for afterschool?

Afterschool Alliance

April 26, 2016

Today's Speakers

Bronwyn Bevan

Senior Research Scientist, University of Washington

RESEARCH + PRACTICE COLLABORATORY

Katherine L. McNeill

Associate Professor of Science Education, Boston College

Emily McLeod

Director of Curriculum, Techbridge

Tracy Truzansky

Project Manager for Training, Vermont Afterschool

Afterschool Alliance

Webinar Overview

1. Introduction to the Framework (Bronwyn)
2. Making sense of the "Practices" (Katherine)
3. Perspectives on using the "Practices" in afterschool
   - Techbridge (Emily)
   - Vermont Afterschool (Tracy)
4. Panel Questions

Afterschool Alliance

Introduction to the "Framework for K-12 Science Education"

RESEARCH + PRACTICE COLLABORATORY

researchandpractice.org

Bronwyn Bevan
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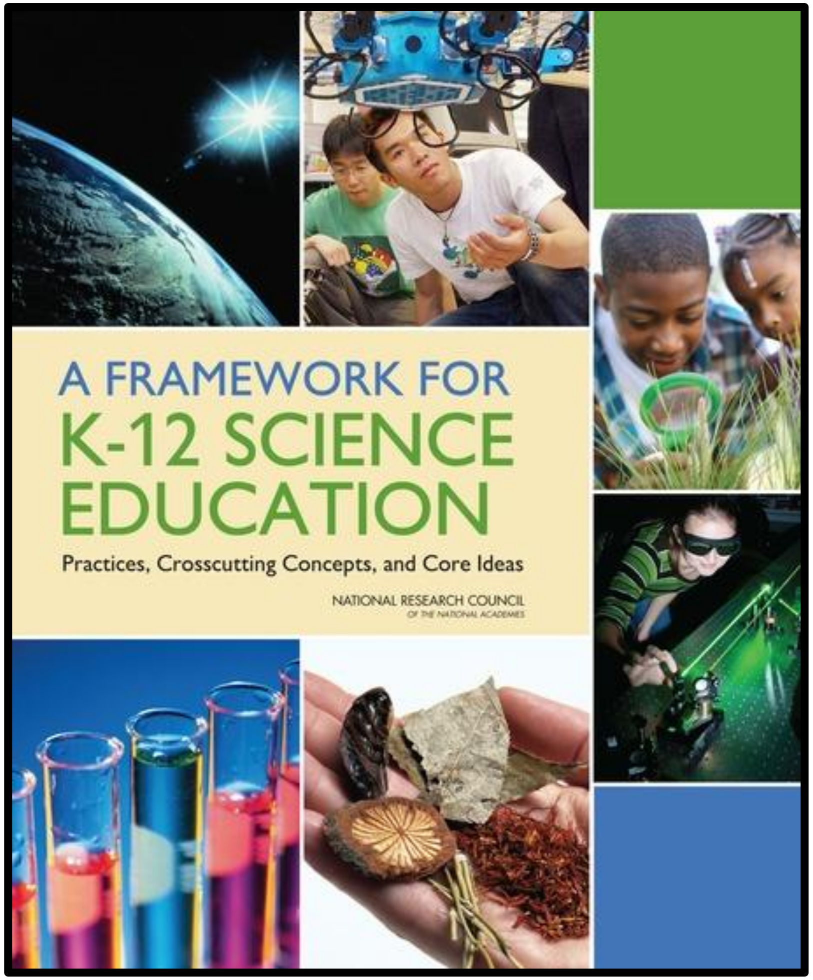
What is the Framework?



"The conceptual framework presented in this report … articulates [a] vision of the scope and nature of the education in science, engineering, and technology ***needed for the 21st century*** (p. 1)."

RESEARCH + PRACTICE COLLABORATORY

Download a free copy of the report, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012).

What's New and Different

- Emphasis on **phenomena** or real-world, first-hand learning experiences.
- Emphasis on three-dimensions of science:

1. **Concepts** (also called Disciplinary Core Ideas, DCIs)
    - **There are fewer** that are deemed necessary for K-12 students to learn upon high school graduation, allowing educators to **go deeper**
2. **Cross-Cutting Themes** (Energy, Patterns …)
    - **Big ideas within science** that connect the various fields (e.g. Biology, Physics, Chemistry...)
3. **STEM Practices**
    - Behaviors that scientists engage in as they **investigate** the natural world and what engineers do as they **design and build** models and systems.

Snapshot: The Concepts

3 Disciplinary Core Ideas

Physical Sciences

PS1: Matter and its interactions

PS2: Motion and stability: Forces and interactions

PS3: Energy

PS4: Waves and their applications in technologies for information transfer

Life Sciences

LS1: From molecules to organisms: Structures and processes

LS2: Ecosystems: Interactions, energy, and dynamics

LS3: Heredity: Inheritance and variation of traits

LS4: Biological evolution: Unity and diversity

Earth and Space Sciences

ESS1: Earth's place in the universe

ESS2: Earth's systems

ESS3: Earth and human activity

Engineering, Technology, and Applications of Science

ETS1: Engineering design

ETS2: Links among engineering, technology, science, and society

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Snapshot: The Crosscutting Themes

2 Crosscutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

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Download a free copy of the report, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012).

Snapshot: The Practices

BOX S-1

THE THREE DIMENSIONS OF THE FRAMEWORK

1 Scientific and Engineering Practices

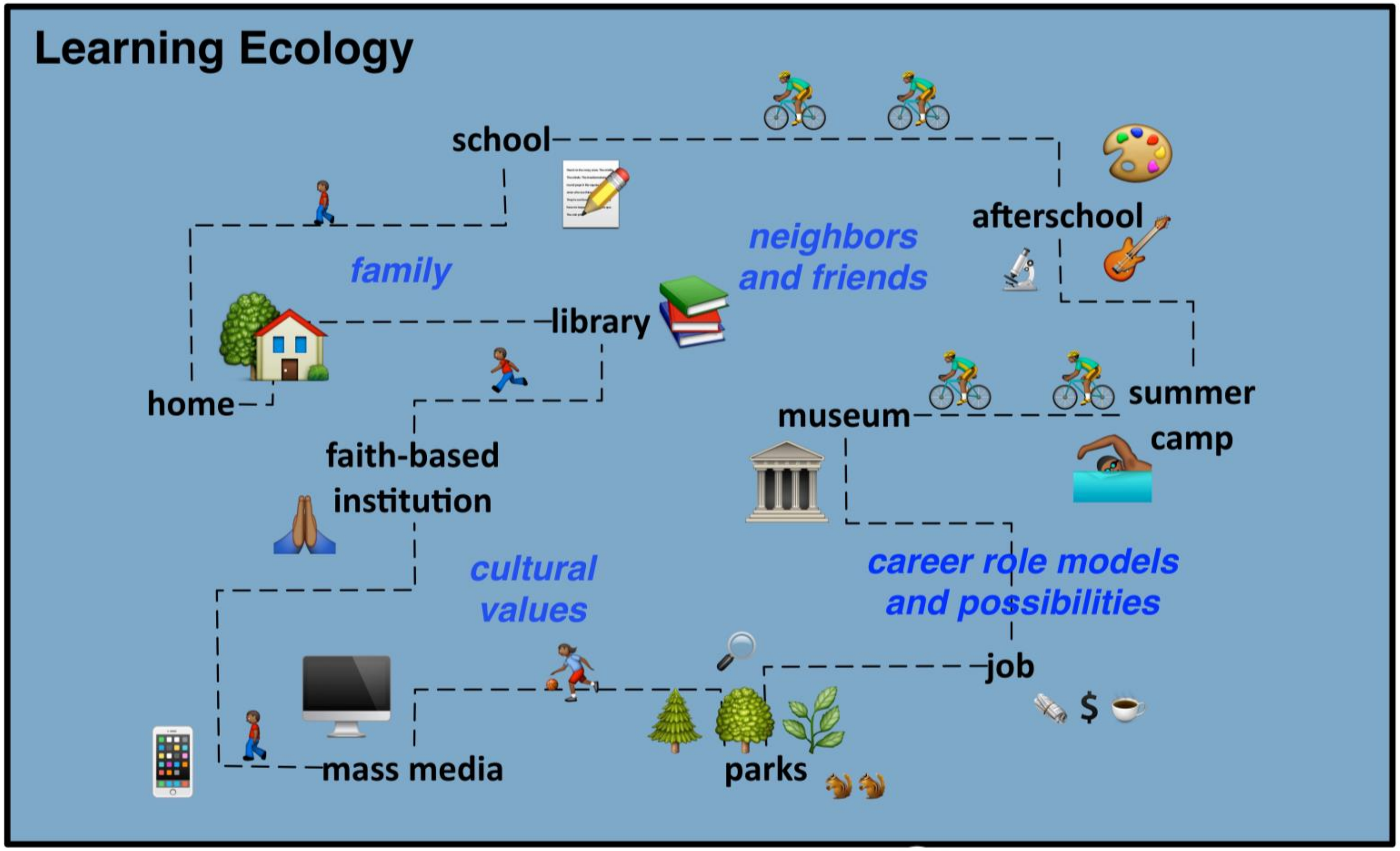
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Download a free copy of the report, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012).

How People Learn [STEM]

- Learning develops **across settings** and over time.
- STEM learning is best accomplished in the context of **STEM practices/doing STEM**.
- **Integrating 21st century skills** (creativity, team-work, problem-solving, communication) supports deeper learning.

Kids Learn in Many Settings



Research+Practice Collaboratory. 2015.

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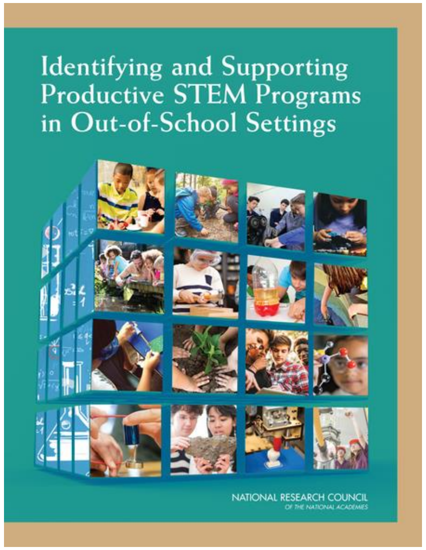
Want to know more about learning ecologies?
Check out this paper: [Ecological Perspectives and Cross-Setting Learning in Connected Science Learning](#) (2016).

High Quality STEM Learning in Afterschool

- Provides **first-hand experiences** with phenomena, concepts, and practices that are both intellectually and socio-emotionally engaging.
- **Recognizes and leverages/builds on** young people's interests, prior experiences, and cultural resources (which vary across communities).
- **Actively makes connections** to STEM ideas and experiences in school, at home, and in future learning and work opportunities.



Download a free copy of the report, Identifying and Supporting Productive STEM Programs in Out-of-School Settings (2015)

RESEARCH + PRACTICE COLLABORATORY

Shifting afterschool to a focus on science practices

Katherine L. McNeill
Boston College
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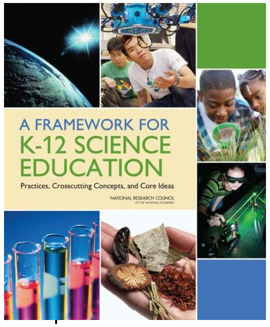
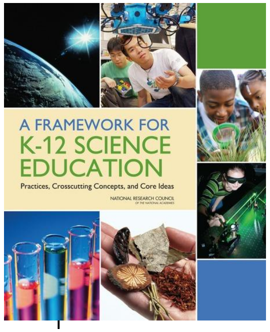
Read more about Katherine’s research and science teaching resources: www.katherinelmcneill.com

Science Practices:
A shift in science education



- Historically, science education has overemphasized students learning a myriad of facts rather than understanding how ideas are developed and transform over time (Roth & Garnier, 2006).
- “Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements – knowledge and practice – are essential” (NRC, 2012, p. 26).

Science Practices:
What are they?



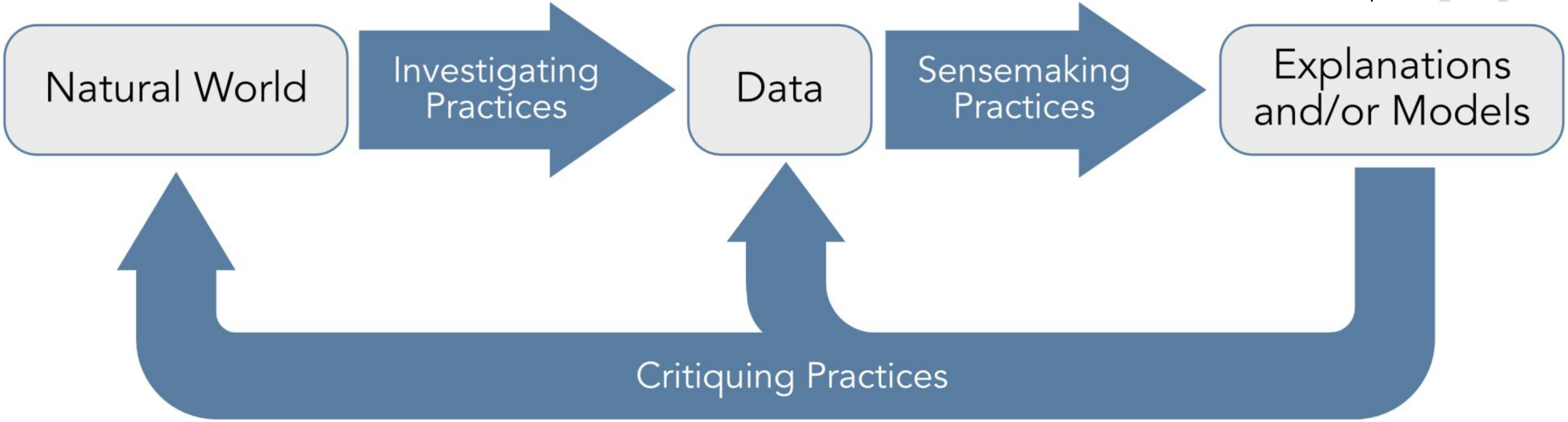
"Engaging in the practices of science helps students understand how scientific knowledge develops…The actual doing of science or engineering can also pique students' curiosity, capture their interest, and motivate their continued study" (NRC, 2012, p. 42)

Eight NGSS Science Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Grouping the Practices

Read more about how Katherine makes sense of the practices:
www.sciencepracticesleadership.com/science-practices



Investigating Practices	Sensemaking Practices	Critiquing Practices
1. Asking questions 3. Planning & carrying out investigations 5. Using mathematical & computational thinking	4. Analyzing & interpreting data 6. Constructing explanations 2. Developing & using models	7. Engaging in argument from evidence 8. Obtaining, evaluating & communicating information

Investigating Practices

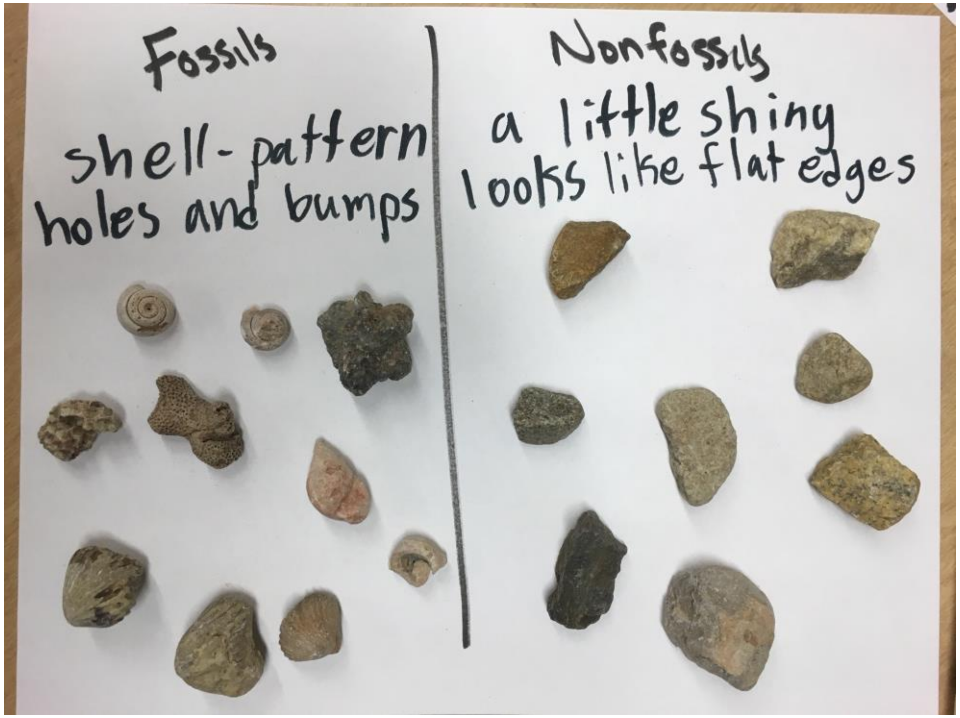
- Investigating practices focus on asking questions and investigating the natural world.
- The products of these investigations are <u>data.</u>

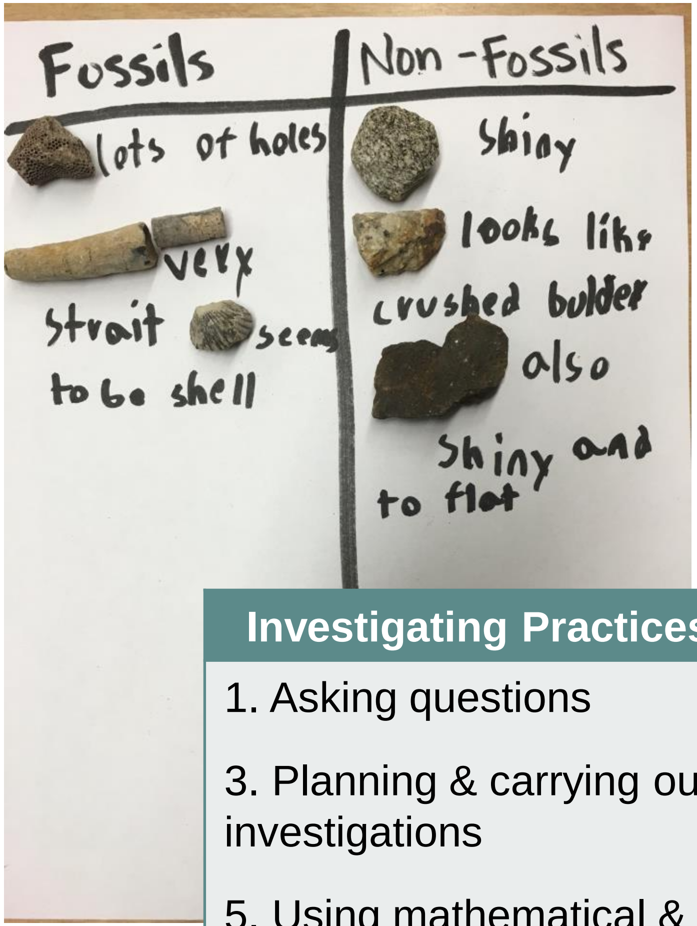
Investigating Practices
1. Asking questions
3. Planning & carrying out investigations
5. Using mathematical & computational thinking

Dig into Katherine's model here:
www.sciencepracticesleadership.com/science-practices

Ex 1 | Investigating Practices

3rd Grade: Questioning & Investigating



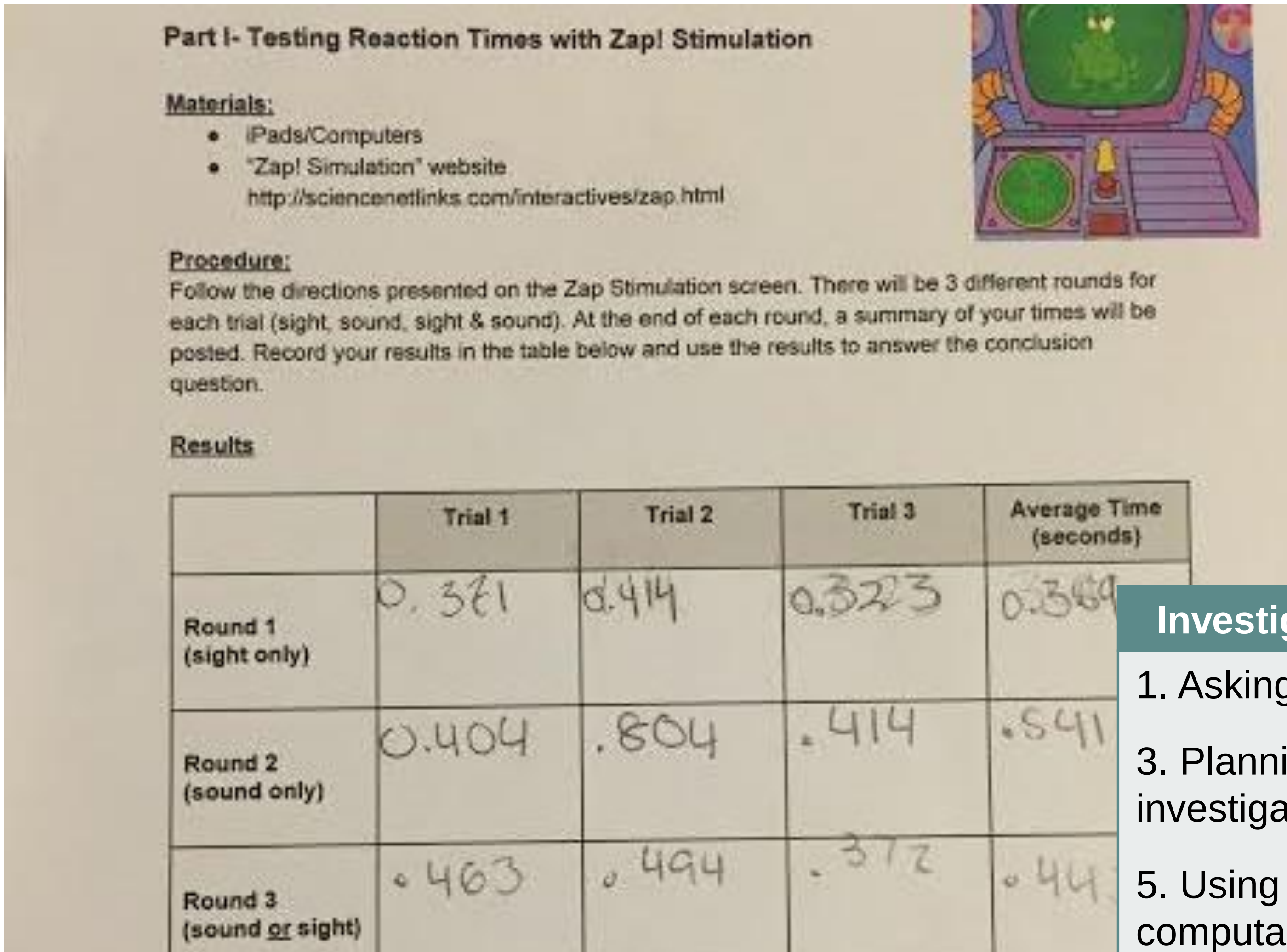


Investigating Practices

1. Asking questions
3. Planning & carrying out investigations
5. Using mathematical & computational thinking

Ex 2 | Investigating Practices

5th Grade: Investigating and Math



Part I- Testing Reaction Times with Zap! Stimulation

Materials:

- iPads/Computers
- "Zap! Simulation" website
  http://sciencenetlinks.com/interactives/zap.html

Procedure:

Follow the directions presented on the Zap Stimulation screen. There will be 3 different rounds for each trial (sight, sound, sight & sound). At the end of each round, a summary of your times will be posted. Record your results in the table below and use the results to answer the conclusion question.

Results

	Trial 1	Trial 2	Trial 3	Average Time (seconds)
Round 1 (sight only)	0.381	0.414	0.3223	0.369
Round 2 (sound only)	0.404	.804	.414	.541
Round 3 (sound or sight)	.463	.494	.372	.44

Investigating Practices

1. Asking questions
3. Planning & carrying out investigations
5. Using mathematical & computational thinking

Sensemaking Practices

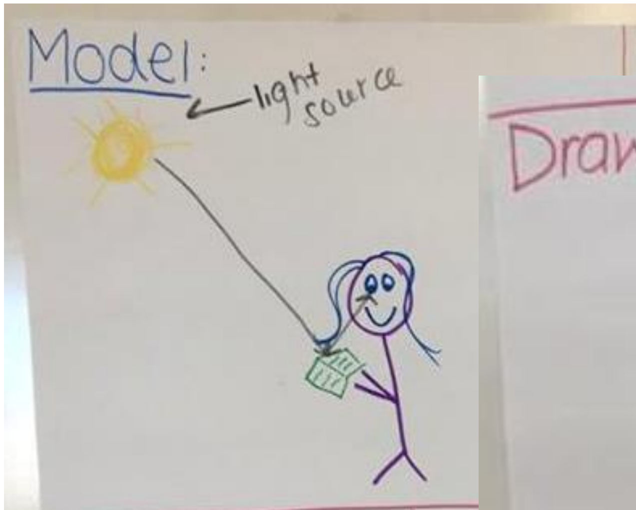
- The **Sensemaking Practices** focus on making sense of that data by looking for patterns and relations to develop explanations and models.

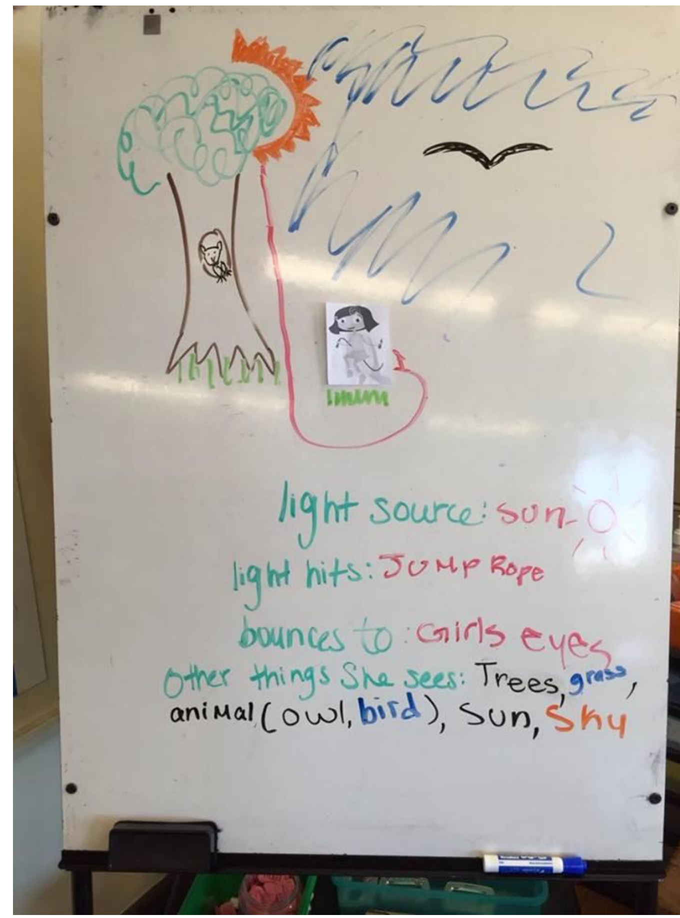
Sensemaking Practices
4. Analyzing & interpreting data
6. Constructing explanations
2. Developing & using models

Dig into Katherine's model here:
www.sciencepracticesleadership.com/science-practices

Sensemaking Practices

4th Grade: Models





Critiquing Practices

- The **Critiquing Practices** emphasize that students need to compare, contrast and evaluate competing explanations and models as they make sense of the world around them.
- Critique is a hallmark of the practices of scientists, but is frequently absent from K-12 science instruction (Osborne, 2012).

Critiquing Practices
7. Engaging in argument from evidence 8. Obtaining, evaluating and communicating information

Dig into Katherine's model here:

www.sciencepracticesleadership.com/science-practices

Critiquing Practice

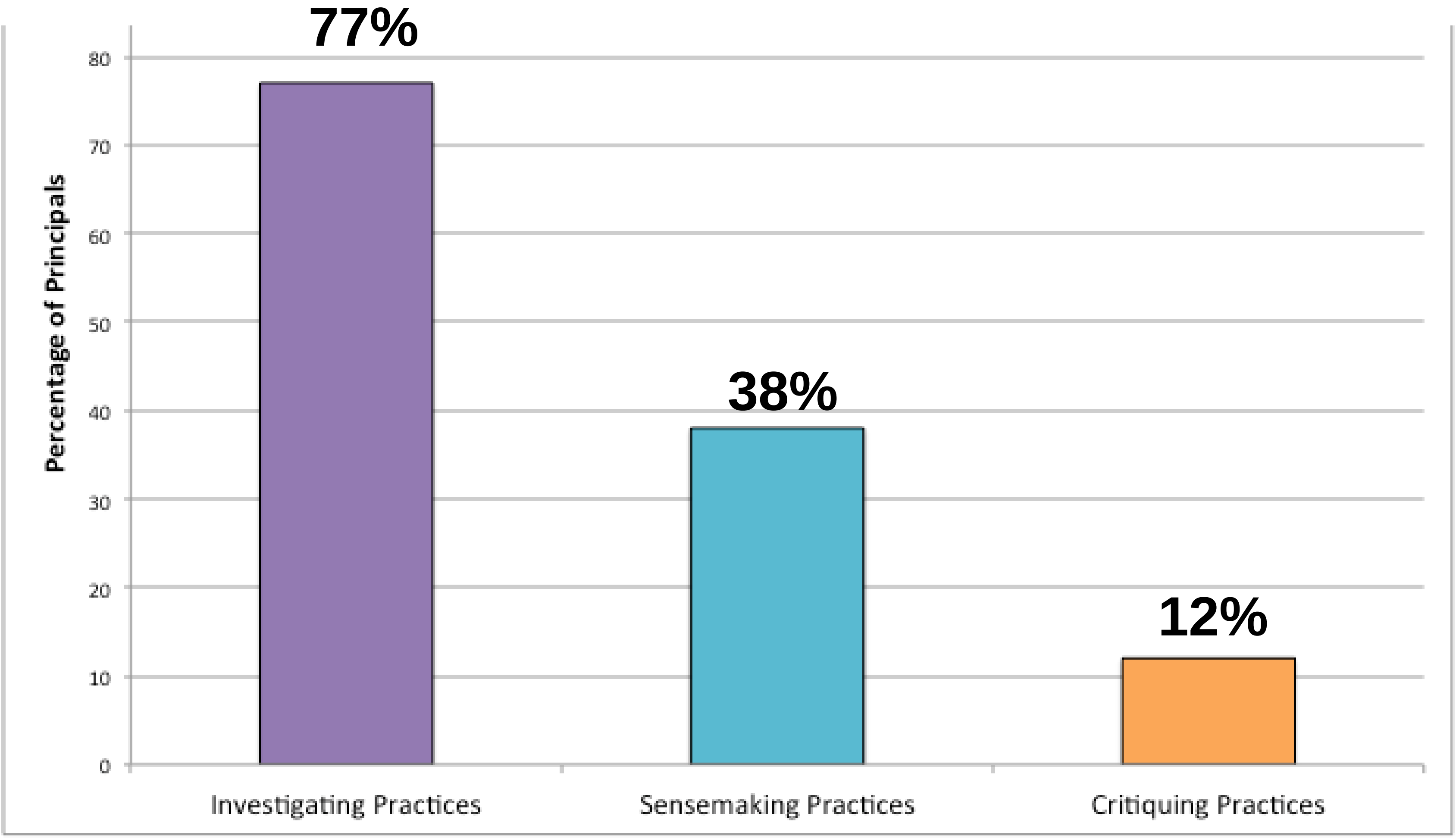
6th Grade: Arguing from Evidence

How do you get students to do this?
Check out the Argumentation Toolkit:
www.argumentationtoolkit.org

Why is the Atacama Desert the driest place on Earth?

Jose:	I think one of the reasons the Atacama Desert is the driest place on earth is because of the mountains surrounding it. So even if there is some precipitation the water will go on the mountain, because it is like the rain shadow effect.
Teacher:	Ahh. The rain shadow effect.
Danny:	I agree and disagree. I disagree because when I was looking at the map I saw by the Atacama desert the ocean currents were cold so that means um the cold water and cold water doesn't evaporate and it is dense. And it was warm air. It has to be warm water to evaporate.
Sheila:	I agree with Danny because if you can't have evaporation. If the water goes up and you have no evaporation, you can't - you don't have no water to support the clouds to make rain. So if the water, the cold water can't evaporate, you can't have rain. Because evaporation has to happen.
Danny:	I agree. I agree, because like you can't have rain. Its not rain before. Rain happens by evaporation.
Marcel:	I disagree. [inaudible]. The mountains are higher. How can it just go over it?
Danny:	I disagree because the waves, the currents going towards the Atacama desert are cold. And cold can't evaporate.
Jose:	I think that I disagree because you say there is no precipitation. But there [points to map]- If you see there are warm currents on the top of South America and there are lots of prevailing winds. So there are warm currents and evaporation happens. And then the cold gathers and the wind takes it across the Andes mountains.

Current Science Instruction in K-8 Schools (n = 26)



Conclusions

- The focus on science practices is an exciting but challenging time.
- Students need support to actively engage in these practices while they are simultaneously applying and developing stronger understandings of disciplinary core ideas.
- Grouping the 8 science practices into Investigating, Sensemaking and Critiquing can be an entry point for analyzing current science activities and instruction.
- In the past, some of the science practices (Investigating) have received more attention than others (Sensemaking and Critiquing).

Thanks to the National Science Foundation!

- *Constructing and Critiquing Arguments in Middle School Science Classrooms,* DRL-1119584.
- *Instructional Leadership for Scientific Practices*, DRL-1415541.

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Inspire a girl to change the world.

Engaging Youth in Science and Engineering Practices Through Sustained Investigations

Emily McLeod, Director of Curriculum, Techbridge
emcleod@techbridgegirls.org

Who We Are

- Techbridge empowers girls through STEM-based afterschool & summer programming
- San Francisco Bay Area, Washington, D.C., & Seattle
- Focus on reaching girls in underserved communities
- Girls make a school-year-long commitment to the program
- Also deliver STEM-focused PD for afterschool providers nationally

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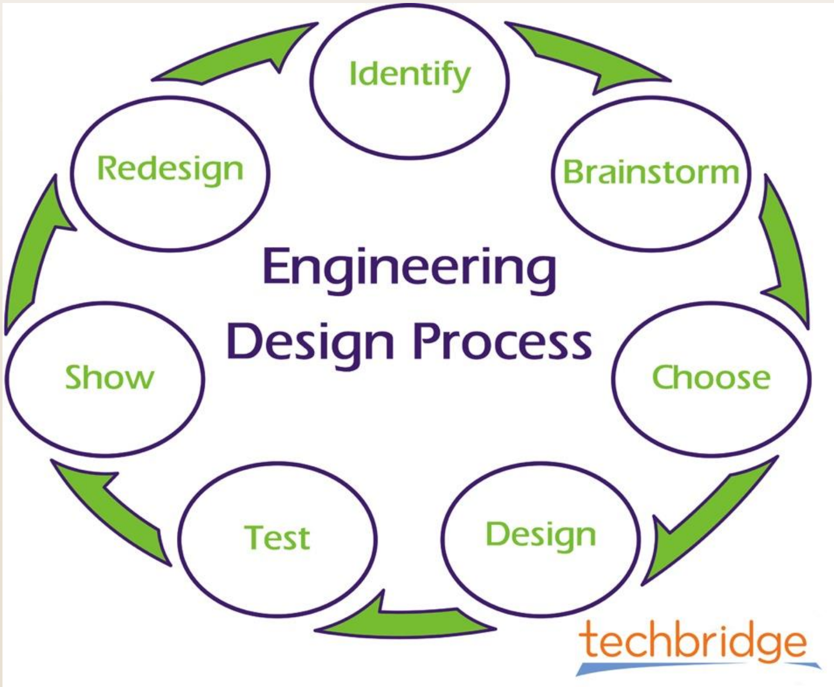
Techbridge's Approach to the NGSS

- Girls engage in the science and engineering practices through hands-on, open-ended design projects
- Projects often span multiple weeks or months
- Content most frequently aligns with Engineering Design Disciplinary Core Ideas
- We explicitly connect projects and practices to the work of scientists and engineers, through educator language, role models, and field trips



Why This Approach?

- Supports school-day learning by giving youth a chance to deep dive with authentic investigations
- Supplements school-day content with focus on engineering (new in the NGSS)
- Engaging in real-world practices makes the work meaningful and helps youth develop identities as scientists and engineers

- Increases equity by foregrounding youth voice and choice
- Practices and design process help to develop characteristics such as persistence

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High School: The Maker Project

- Focus on girl-driven tinkering and making
- After exposure to a variety of engineering + tech tools and practices, girls form teams, identify a design project, conduct research and investigations, build and test multiple prototypes
- Teams coached by mentors working in STEM fields
- Work is shared with a wide audience at the Bay Area Maker Faire
- Depth and length of project affords multiple opportunities to engage in practices

New research report! STEM-Rich Making in Afterschool Programs (2016)

Sample Project: Soundbox

- Interactive space with sound & light
- Girls engaged in a variety of science and engineering practices as they worked on the project:
  - Formulating questions
  - Carrying out investigations
  - Making observations
  - Constructing explanations
  - Designing solutions
  - Communicating information

Sample Project: Self-Zipping Jacket

- Jacket zips up and down depending on ambient temperature
- Project provides a meaningful context for learning; new concepts and skills develop as the need arises
- Team built multiple models and persisted through challenges

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Elementary and Middle School

- Projects are shorter (1 to 6 weeks) and linked to STEM careers
- Girls are given a context and a design challenge, then conduct investigations and develop solutions
- Frequent opportunities for sharing information
- **Sample project:** Biomass Stove Design Challenge

Tips for Engaging Youth in Practices

- Encourage youth choice, youth-driven investigation and design
- Make space and time for more sustained investigations
- Develop projects that authentically connect to real-world practices of scientists and engineers
- Use STEM professionals as role models and mentors
- Identify opportunities for youth to share information and present work

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Vermont Afterschool

Partnerships, Advocacy, Training, and Resources for Excellence in Afterschool

Tracy's title for her section…

Tracy Truzansky

Project Manager for Training Vermont Afterschool

tracytruzansky@vermontafterschool.org

Vermont Afterschool

1. Advocacy
2. Quality Initiatives
3. Professional Development
   - 450 afterschool programs sites
   - 109 school-based, rural, high poverty 21st CCLC afterschool program sites
   - Noyce Systems-Building Grant → scale up STEM Initiative

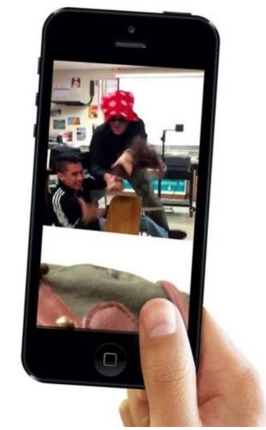
"Using program implementation and assessment data to inform our decisions on STEM professional development anchored in the Frameworks"

Why focus on the Framework in afterschool?

1. **Minimize fear** – emphasize the "doing" of science (and engineering) from the "knowing"
2. **Build continuity** – understand a school's efforts to "map" a science learning grade level progression
3. **Provide repetition** – repeat terms and processes learned in the school day – its reciprocal!
4. **Emphasize value** – reinforce afterschool's significance in the STEM learning ecosystem

Vermont Afterschool
Partnerships, Advocacy, Training, and Resources for Excellence in Afterschool

STEM PD Strategies and Formats



PD STRATEGIES

STEM Training "Branches"

1. Content/Curriculum
2. Skills

Diverse Training Formats

Identifying STEM "Levels"

Use STEM Training Experts

Leadership Development

- Site Directors
- Trainers
- Workshop Developers

PD FORMATS

Face-to-Face

2 HR Evenings

4 HR Regional

Conference

Curriculum Sampler

Full Day

Afterschool Professional Learning Community (APLS)

Facilitated Videos

Staff Meetings

Webinars

Vermont Afterschool

Partnerships, Advocacy, Training, and Resources for Excellence in Afterschool

Putting the Frameworks Into Practice

CONTENT

Cross-cutting Concepts in 8 weeks!

- One CCC/multiple content
- One content/2 or more CCC

Quality STEM Curriculum

- Aligned
- Open-Ended/Flexible
- Kits vs STEM “Closet”

STEM Experts

- Montshire Museum - Tinkering
- MOS, Engineering is Everywhere
- Vermont Energy Education Program
- Vermont Fish and Wildlife
- UVM College of Medicine

SKILLS

Use National Supports

- PEAR, Dimensions of Success
- Click2SciencePD
- ACRES
- Uncovering Misconceptions: Probes

***Simplify* the Practices**

Use Science Language

- Cycle of Science Inquiry
- Engineering Design Process
- Claims, Evidence, Reasoning
- Fair Test and Variables

Real Tools

Science Talk – Social/Emotional Learning

Panel Questions

Thank you for attending!

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Afterschool Snack Blog

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