Early Childhood Science Inquiry is a Journey (Not a Series of Unrelated Activities): Learning from the research

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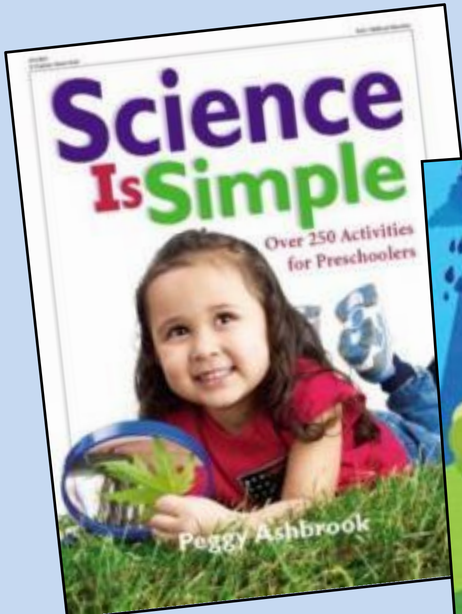
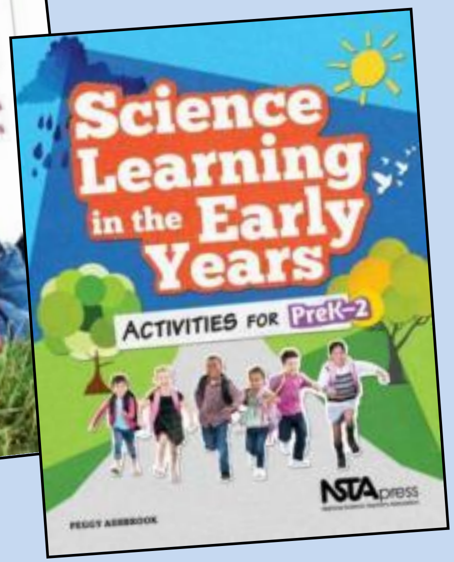




The Early Years blog

www.nsta.org/earlyyears

naeyc

National Association for the Education of Young Children

The NAEYC Early Childhood Science Interest Forum

Purpose and scope of presentation

- We will see how a science inquiry is more than a single activity.

An activity can extend into inquiry when teachers provide open exploration for students and deepen it through children's reflection on their exploration. Adding materials to prompt focused exploration and providing ways to share their understanding supports children's science learning.

Purpose and scope of presentation

- We will identify science and engineering practices in an early childhood exploration.

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

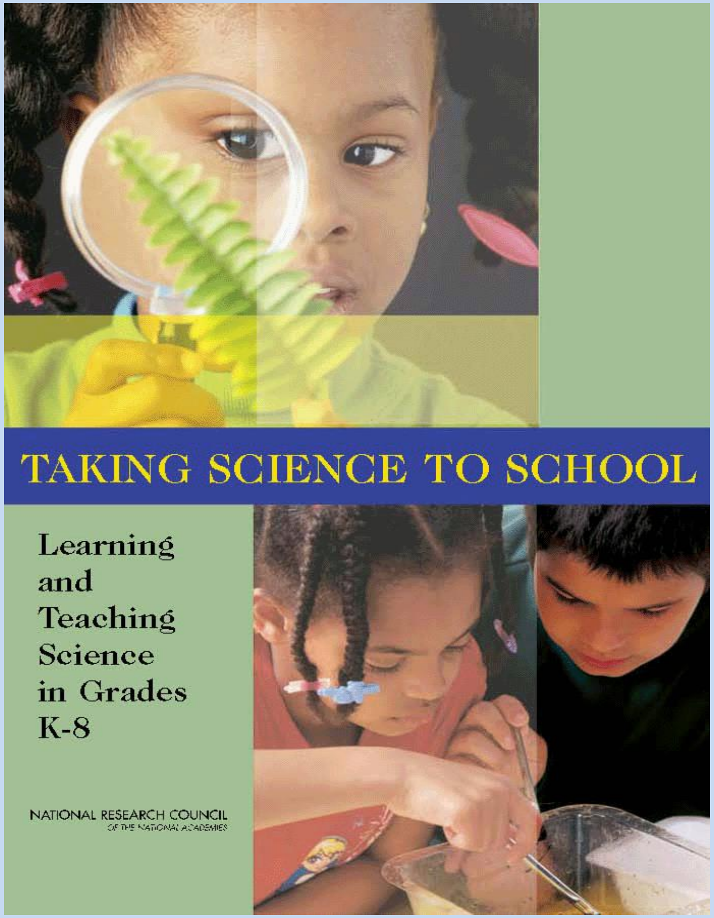
Purpose and scope of presentation

- We will decide next steps for implementing the principles and declarations of the NSTA Position Statement on Early Childhood Science Education in our program, whether we are administrators, child care providers, teachers, educators in an informal setting or have another role in early childhood education.
- Take home a list of resources for further learning.

"The National Science Teachers Association affirms that learning science and engineering practices in the early years can foster children's curiosity and enjoyment in exploring the world around them and lay the foundation for a progression of science learning in K–12 settings and throughout their entire lives…"

NSTA Early Childhood Science Education Position Statement

Taking Science to School: Learning and Teaching Science in Grades K-8



"… research shows that children's thinking is surprisingly sophisticated…. Children can use a wide range of reasoning processes that form the underpinnings of scientific thinking, even though their experience is variable and they have much more to learn."

Executive Summary
National Research Council. 2007.
Duschl, R.A., & Shouse, A.W., eds.
Washington, DC: National Academy Press

Ready, Set, SCIENCE!: Putting Research to Work in K-8 Science Classrooms

"The Importance of Teaching Science Well

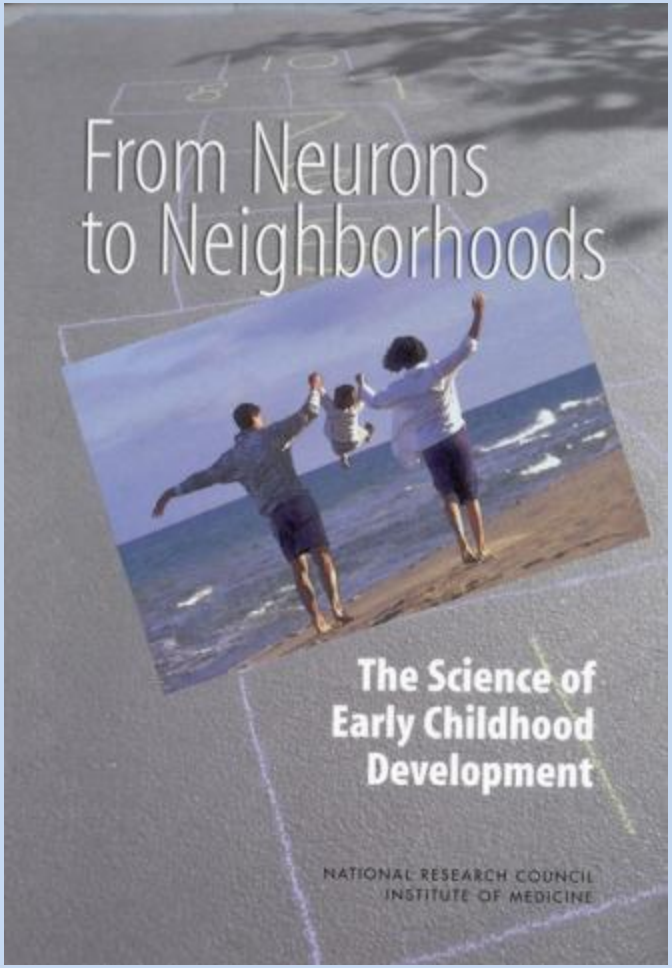
Knowledge of science can enable us to think critically and frame productive questions. With out scientific knowledge, we are wholly dependent on others as "experts." With scientific knowledge, we are empowered to become participants rather than merely observers."

Michaels S., Shouse A. W. and Schweingruber H. A. 2008. Washington, DC: National Academy Press

From Neurons to Neighborhoods: The Science of Early Childhood Development

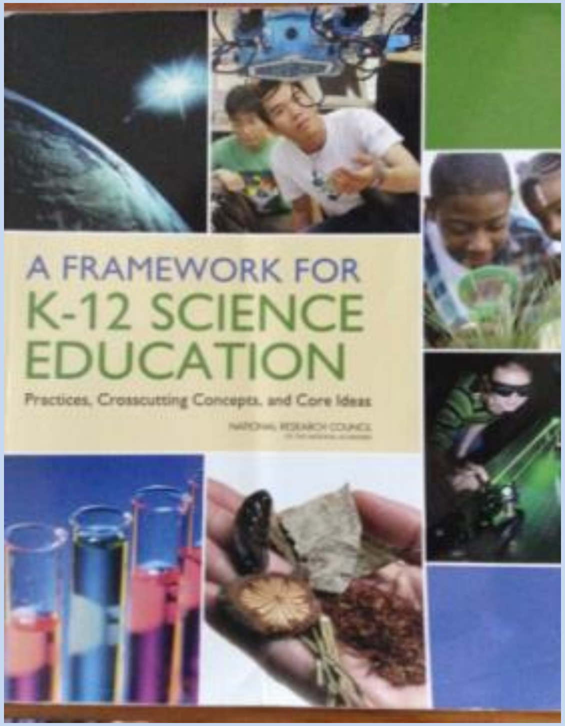
"How can society use knowledge about early childhood development to maximize the nation's human capital and ensure the ongoing vitality of its democratic institutions…?

From Neurons to Neighborhoods: The Science of Early Childhood Development (2000) Shonkoff J. P., and D.A. Phillips, eds. Executive Summary



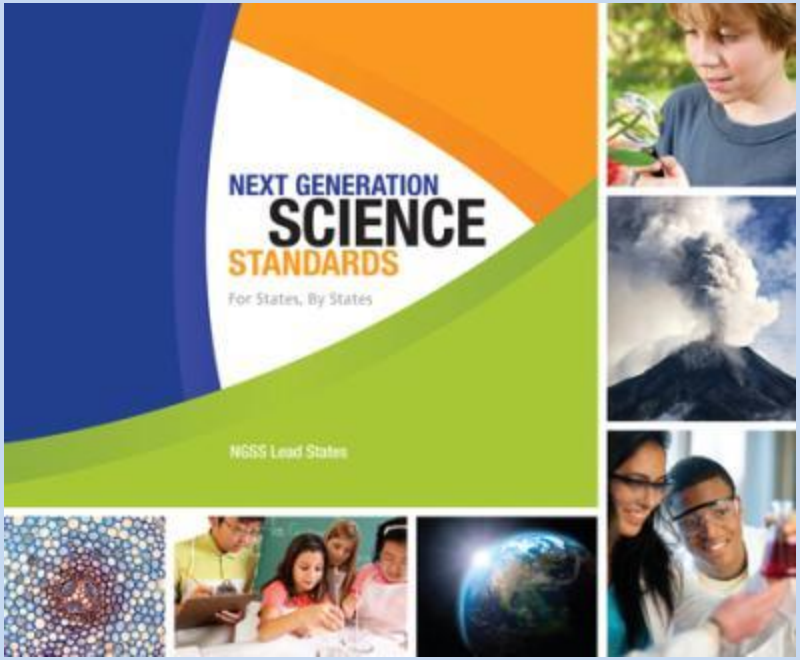
A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas

- Focus on core ideas, cross-cutting concepts, and practices
- Incorporates a *learning progressions* approach
- Emphasizes relationships across STEM disciplines
- **Uses the idea of "Science and Engineering Practices" rather than "process skills"**

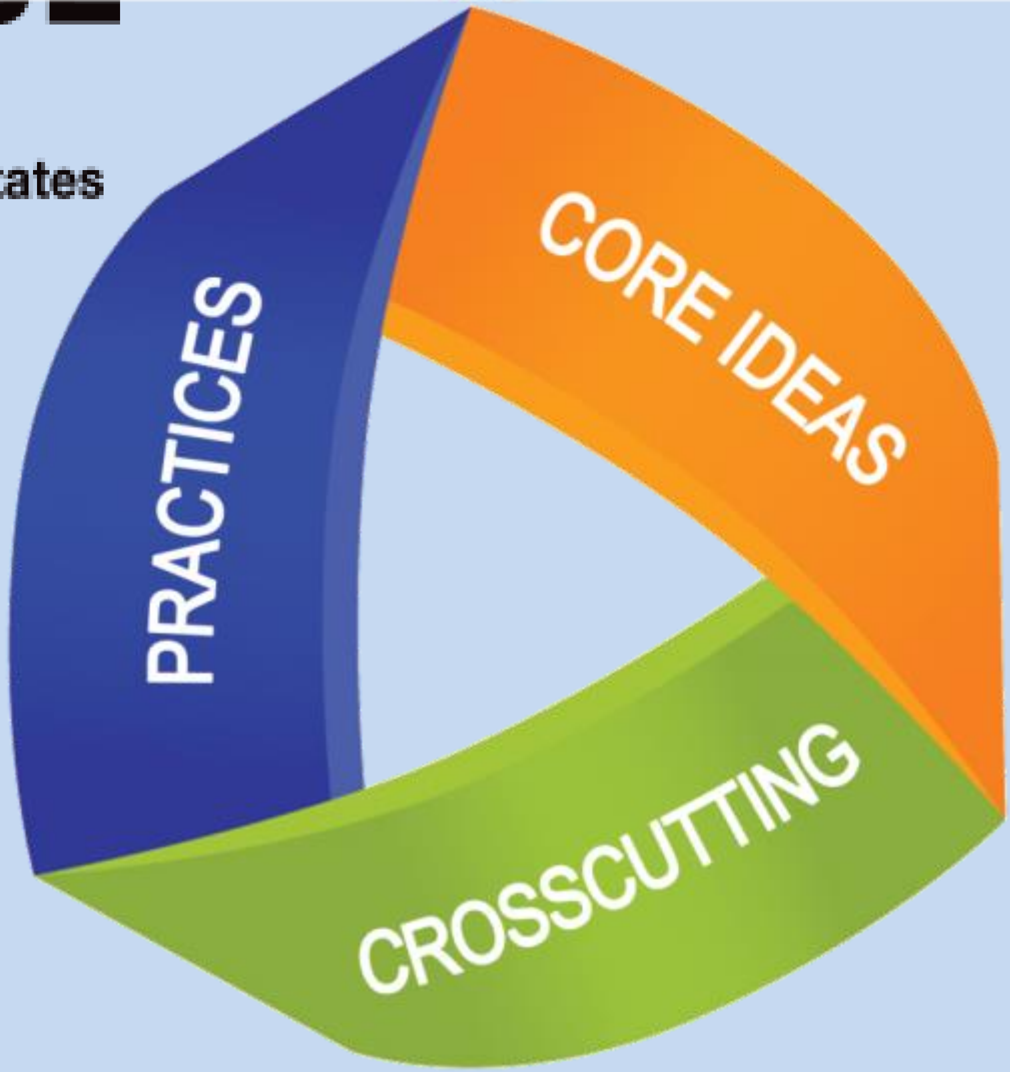


3-Dimensional Learning: *Next Generation Science Standards,* for students in grades K-12

- Based on *A Framework* and other earlier research
- Focus on core ideas, cross-cutting concepts, and practices
- Incorporates a *learning progressions* approach
- Emphasizes relationships across STEM disciplines

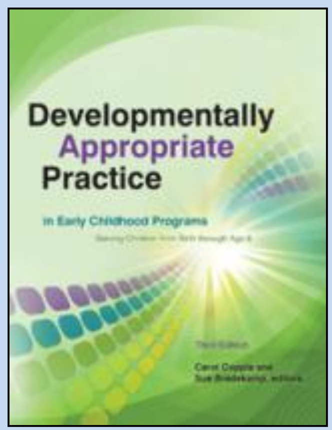


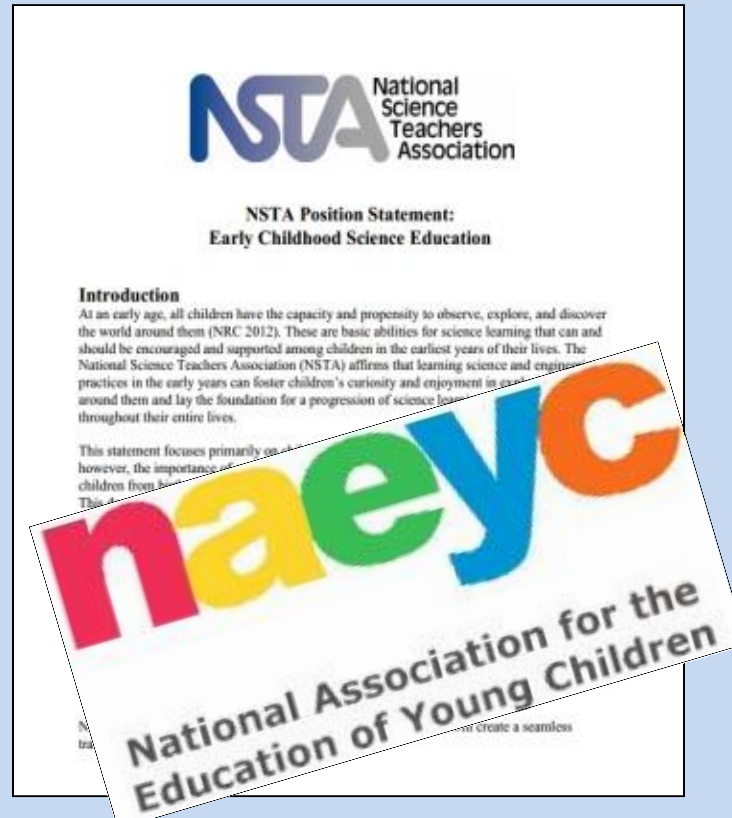
NEXT GENERATION
SCIENCE
STANDARDS
For States, By States



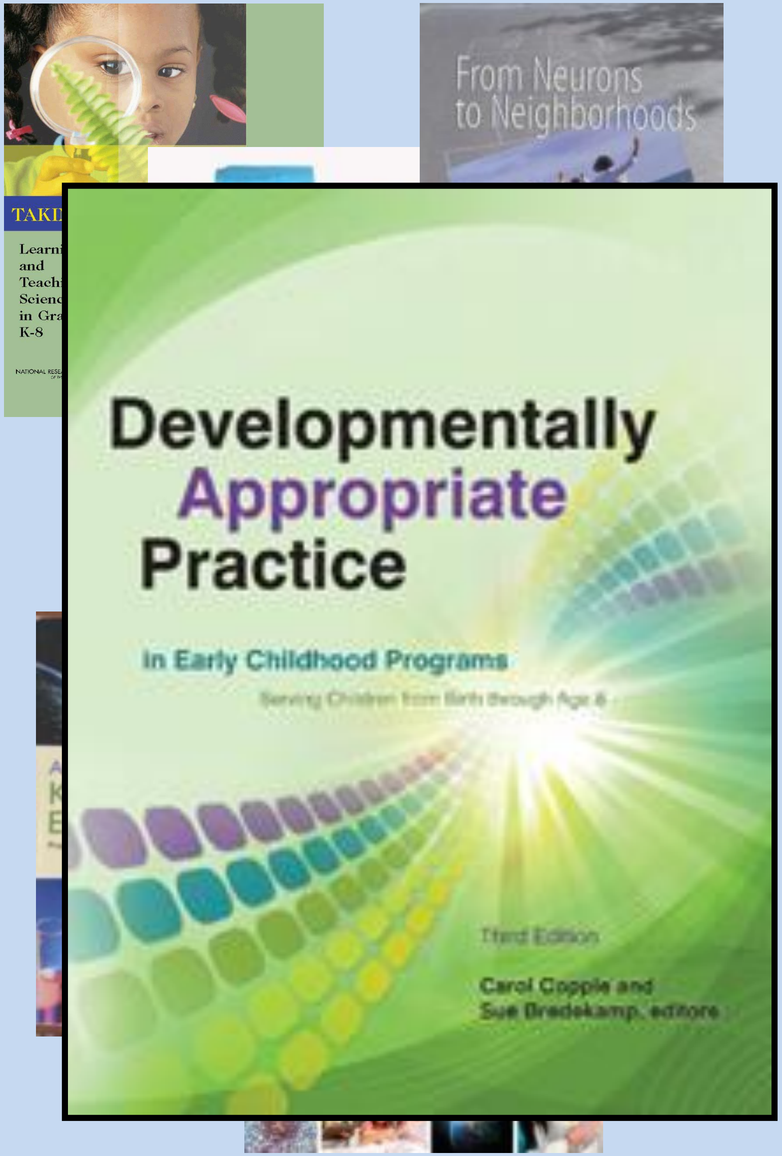
Poll

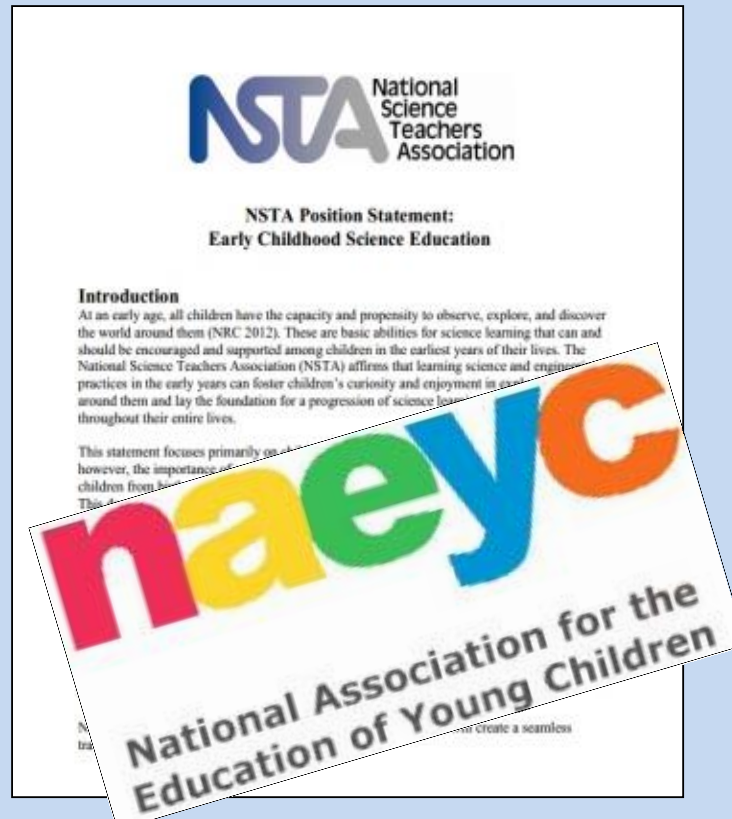
NSTA Position Statement on Early Childhood Science Education





Developmentally Appropriate Practice





NSTA Position Statement on Early Childhood Science Education

The National Science Teachers Association identifies the following key principles to guide the learning of science among young children:

- Children have the capacity to engage in scientific practices and develop understanding at a conceptual level.
- Adults play a central and important role in helping young children learn science.
- Young children develop science skills and knowledge over time.
- Young children develop science skills and learning by engaging in experiential learning.

NSTA Position Statement on Early Childhood Science Education

What does this look like in early childhood programs?

All children are participating in science inquiry:
…exploring and discovering,
…able to make changes and see what happens,
…able to repeat the experiences over time,
…develop science skills and learning by having experiences,
…talking with adults about what they observe and what they think.

"Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work."

**“Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas,
as well as an understanding of how scientists study
the natural world.”**

How are activities different from science inquiry?

- Inquiry connects activities about a single concept (i.e. what are the properties of matter), and builds conversations around the collected data (drawings, photographs, and writing) while asking for evidence. ("How do you know?" or, "What makes you think that?")

How are activities different from science inquiry?

➢Activities are good for introducing children to a wide range of materials. Not every activity develops into an on-going inquiry about a science concept.

Activities introduce children to a wide range of materials and phenomena.

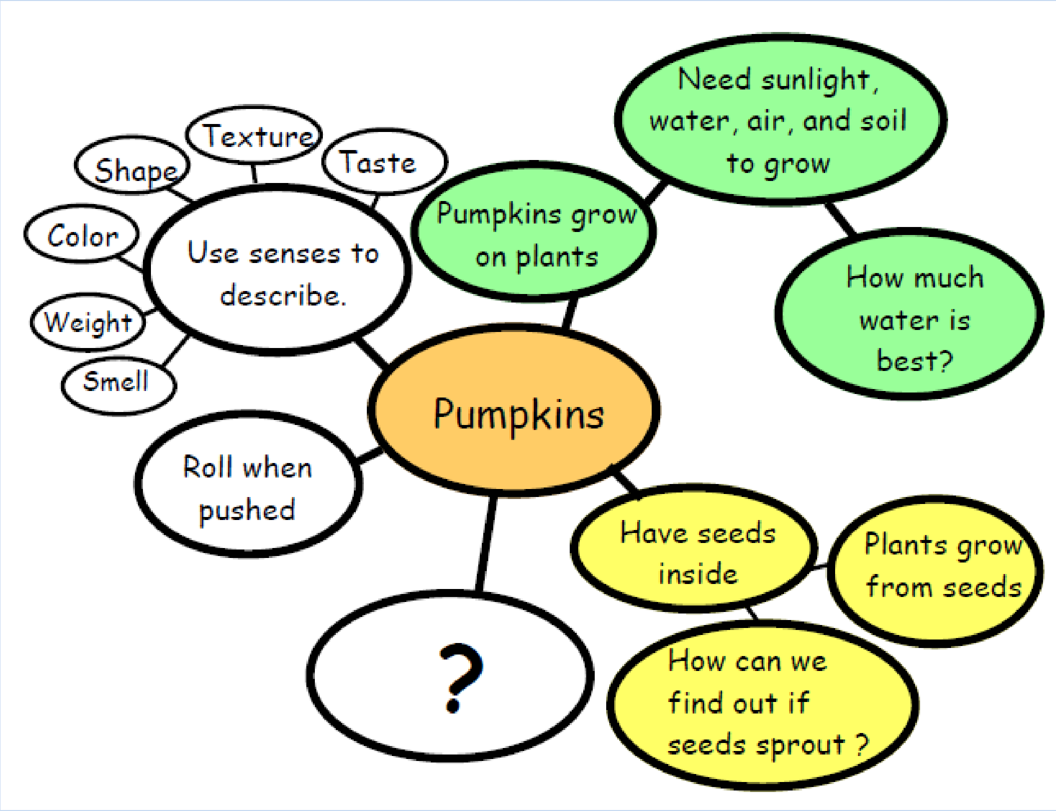
Activities can inspire questions that may develop into a science inquiry in search of answers.

Inquiry connects activities about a single concept and conversations around the collected data to reflect on evidence.

Inquiry connects activities about a single concept and conversations around the collected data to reflect on evidence.

Science inquiry often leads to additional questions that children are interested in pursuing.

Science activities are most productive when they are part of an exploration into a phenomena or an investigation into a question rather than around a theme.



As you plan, ask yourself if the activity will support the children's investigation.

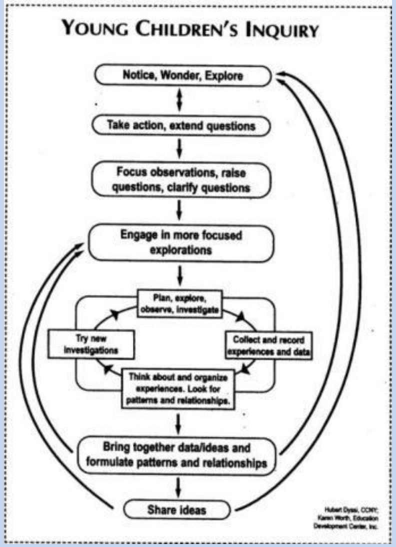
There are many fun activities but not all lead to deeper understanding.

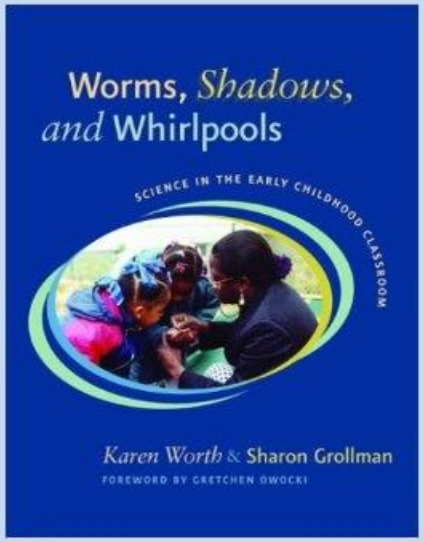
Eight indicators of effective PreK–3 curriculum:

- Children are active and engaged
- Goals are clear and shared by all
- Curriculum is evidence-based
- Valued content is learned through investigation, play, and focused, intentional teaching
- Curriculum builds on prior learning and experiences
- Curriculum is comprehensive
- Professional standards validate the curriculum’s subject-matter content
- Research and other evidence indicates that the curriculum, if implemented as intended, will likely have beneficial effects

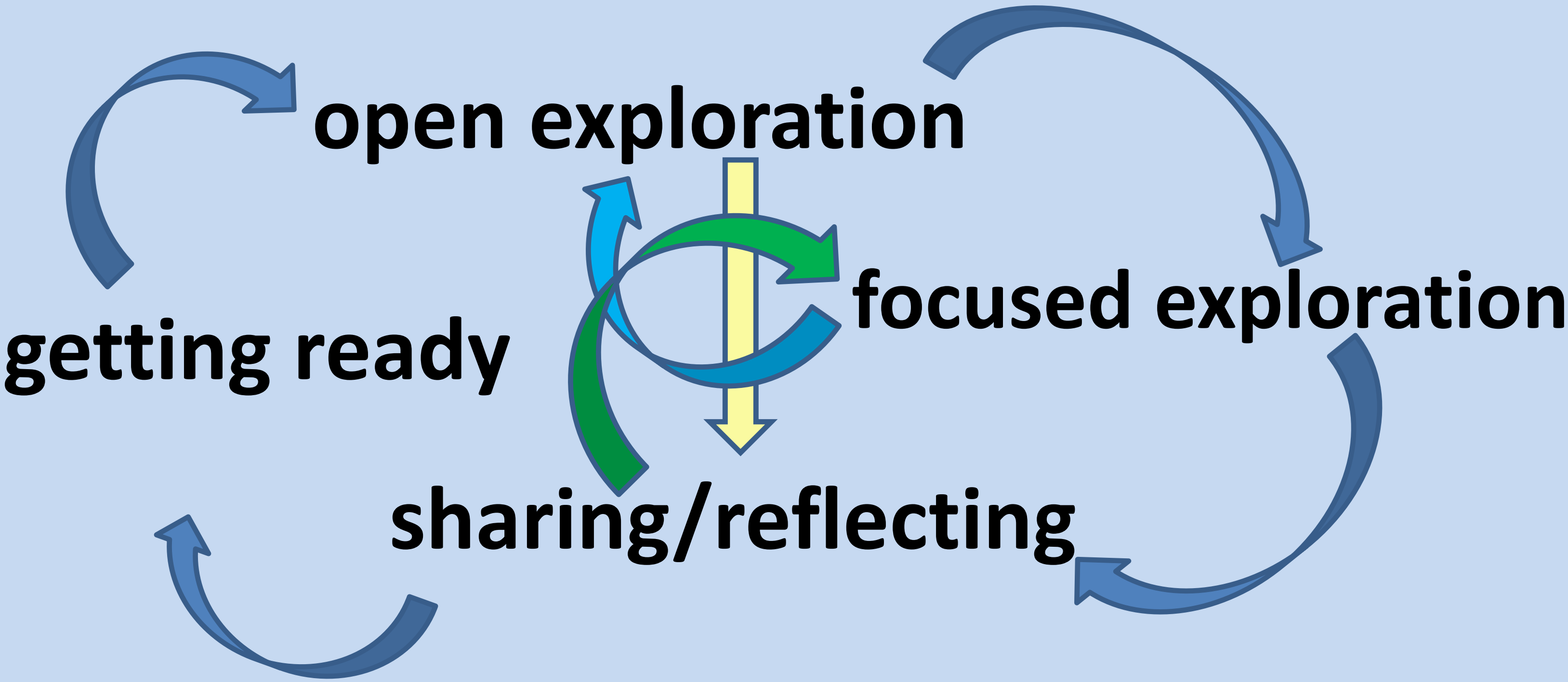
The National Association for the Education of Young Children (NAEYC) and the National Association of Early Childhood Specialists in State Departments of Education (NAECS/SDE)

***Worms, Shadows and Whirlpools* is my favorite resource for early childhood science investigations and inquiry.**



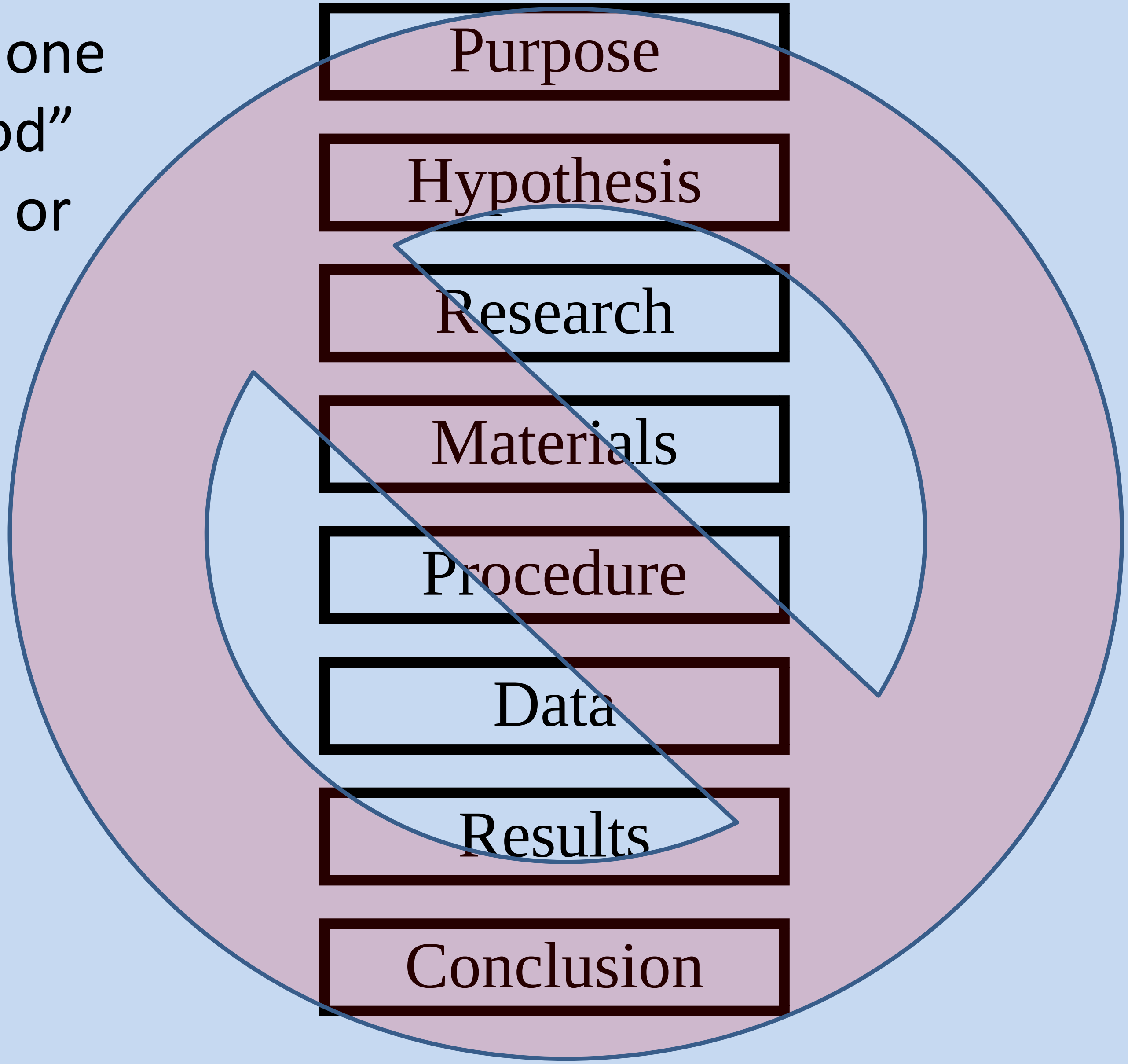


What does science inquiry look like in a classroom as children follow an inquiry cycle* ?



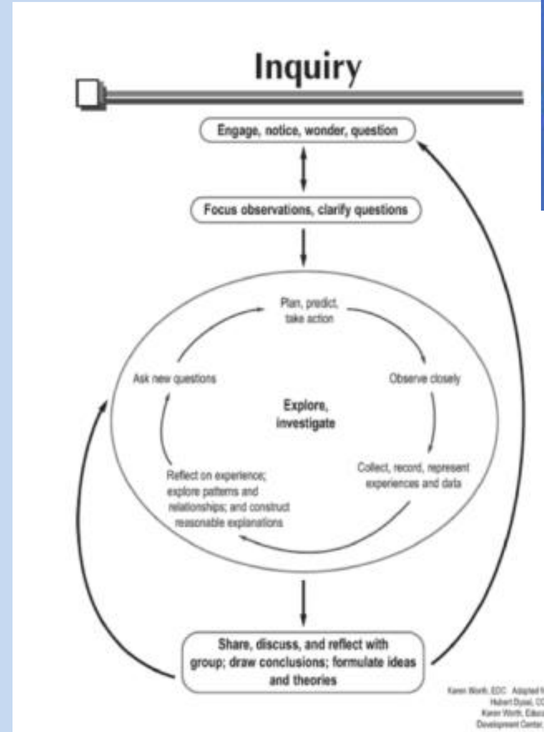
*Inspired by *The Young Scientist Series* by Ingrid Chalufour and Karen Worth

There is not just one "scientific method" used by children or by scientists.

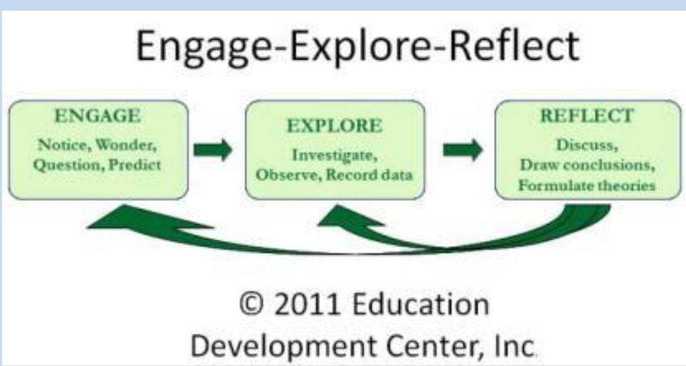


Steps:	Suggestions:
QUESTION Help children form their own questions related to their world.	• Wow! This is very interesting. • You look curious about ... • I saw you watching ... • You seem to be fascinated with ...
OBSERVE Ask children to use their senses and closely observe the world around them.	• What do you notice? • How does that feel/taste/sound? • Look at these different parts of ... • Let's take a picture so we can look at it again.
PREDICT Encourage children to make an educated guess about what will happen in the future.	• What's your guess? • What do you imagine ... ? • I wonder what might happen if ... ? • How do you think this will turn out?
EXPERIMENT Provide opportunities for children to experiment and test their predictions.	• Let's try this out. • We can check out ... • What could we do to see if this is true? • How could we keep track of how things change?
DISCUSS Allow children to discuss the results of their experiment.	• What did we learn about ... ? • How is this different/same from when we started? • Which grew the fastest/longest/heaviest? Why? • Was your prediction correct? How do you know?

The Office of Head Start (OHS)



Worms, Shadows and Whirlpools by Sharon Grollmann and Karen Worth



Engaging children in inquiry helps children develop:

- Understanding of scientific and engineering concepts.
- Appreciation of "how we know" what we know in science.
- Understanding of the nature of science—how science “works”.
- Skills necessary to become independent inquirers about the natural world.

Poll

More Than Standards

Children learn best when they feel safe.

How can we create a classroom culture in which it is safe to ask questions?

2.Structure and Properties of Matter

Students who demonstrate understanding can:

2-PS1-1. **Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.**[Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

2-PS1-2. **Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*** [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

2-PS1-3. **Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.** [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]

2-PS1-4. **Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.** [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

Exploring the properties of matter, wet and dry, and how small pieces come together to form a larger object.


DRY SAND

How does it feel?

-bumpy

-bumpy because it has little rocks

-dry sand is bumpy because it has a har

-dry sand is a little bit hard

-it's a little bit soft and smooth

-it has tons of rocks in it

-it is kind of slippery

-it's too hard

-it feels like chalk

-it feels bumpy

-it doesn't feel like wet sand because nothing rained on it

Can you make a castle with it?

-No. You can make a castle with wet sand. I did at the beach. *(Did you use buckets or castle molds?)* We made it by piling sand.

-No. If it was wet you could.

What can you do with dry sand?

-You can make lots of things. You can draw in it.

WET SAND

gooey.

ter *[on the]* surface.

nd in it

w things in it

ts of things, like sand castles.

t because something rained on it. Oh yeah, we

ucet.

from outside when it rained.

sand in the world? (asked by one of the kids)

made it.

sky.

Can you make a castle with it?

-too gooey for me

Adding some dry sand:

-it melts in

-it's soaking into the wet sand

-when the dry sand touches the wet sand it turns into wet sand

-now it's kind of crunchy

-You can draw with wet sand and dry sand. You can draw with any kind of sand.

Putting wet hands back in the dry sand- it sticks (to hands)

DRY SAND

How does it feel?

-bumpy

-bumpy because it has little rocks

-dry sand is bumpy because it has a hard surface

-dry sand is a little bit hard

-it's a little bit soft and smooth

-it has tons of rocks in it

-it is kind of slippery

-it's too hard

-it feels like chalk

-it feels bumpy

-it doesn't feel like wet sand because nothing rained on it

Can you make a castle with it?

-No. You can make a castle with wet sand. I did at the beach. *(Did you use buckets or castle molds?)* We made it by piling sand.

-No. If it was wet you could.

What can you do with dry sand?

-You can make lots of things. You can draw in it.

WET SAND

-Wet sand is very gooey.

-Wet sand has water *[on the]* surface.

-has water and sand in it

-it's easier to draw things in it

- You can make lots of things, like sand castles.

How does it feel?

-It feels wet.

-It feels different because something rained on it. Oh yeah, we got it from the faucet.

-We brought it in from outside when it rained.

Why is there sand in the world? (asked by one of the kids)

It's how God made it.

God is in the sky.

Can you make a castle with it?

-too gooey for me

Adding some dry sand:

-it melts in

-it's soaking into the wet sand

-when the dry sand touches the wet sand it turns into wet sand

-now it's kind of crunchy

-You can draw with wet sand and dry sand. You can draw with any kind of sand.

Putting wet hands back in the dry sand- it sticks (to hands)

Next Generation Science Standards: Grade 2 Endpoint Performance Expectation

Students who demonstrate understanding can: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.[Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

NEXT GENERATION SCIENCE STANDARDS For States, By States

Disciplinary Core Ideas:

PS1.A: Structure and Properties of Matter

Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.

Crosscutting Concepts:

***Cause and effect: Mechanism and explanation*. ** Events have causes, sometimes simple, sometimes multifaceted.

Science and Engineering Practices: Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in K–2 **builds on prior experiences and progresses to simple investigations, based on fair tests,** which provide data to support explanations or design solutions.

Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.

NEXT GENERATION SCIENCE STANDARDS For States, By States

Using the science and engineering practices in early childhood.

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

PRACTICES
CORE IDEAS
CROSSCUTTING

The eight practices of science and engineering that the Framework identifies as essential for all students to learn:

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.

NSTA Position Statement: Early Childhood Science Education

Declarations, NSTA recommends that teachers and other education providers who support children's learning in any early childhood setting should :

- **emphasize the learning of science and engineering practices**, including asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information (NRC 2012, NGSS Lead States 2013);

The National Science Teachers Association matrix of NGSS science and engineering practices: a way to see where our children are headed

http://nstahosted.org/pdfs/ngss/MatrixOfScienceAndEngineeringPractices.pdf

Science & Engineering Practices

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.

NGSS@NSTA

K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.	Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
• Ask questions based on observations to find more information about the natural and/or designed world(s).	• Ask questions about what would happen if a variable is changed.	• Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. • Ask questions to determine relationships between independent and dependent variables and relationships in models.. • Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.	• Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. • Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. • Ask questions to clarify and refine a model, an explanation, or an engineering problem.
• Ask and/or identify questions that can be answered by an investigation.	• Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	• Ask questions that require sufficient and appropriate empirical evidence to answer. • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	• Evaluate a question to determine if it is testable and relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
		• Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.	• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
• Define a simple problem that can be solved through the development of a new or improved object or tool.	• Use prior knowledge to describe problems that can be solved. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	• Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.

The National Science Teachers Association matrix of NGSS science and engineering practices: a way to see where our children are headed

http://nstahosted.org/pdfs/ngss/MatrixOfScienceAndEngineeringPractices.pdf

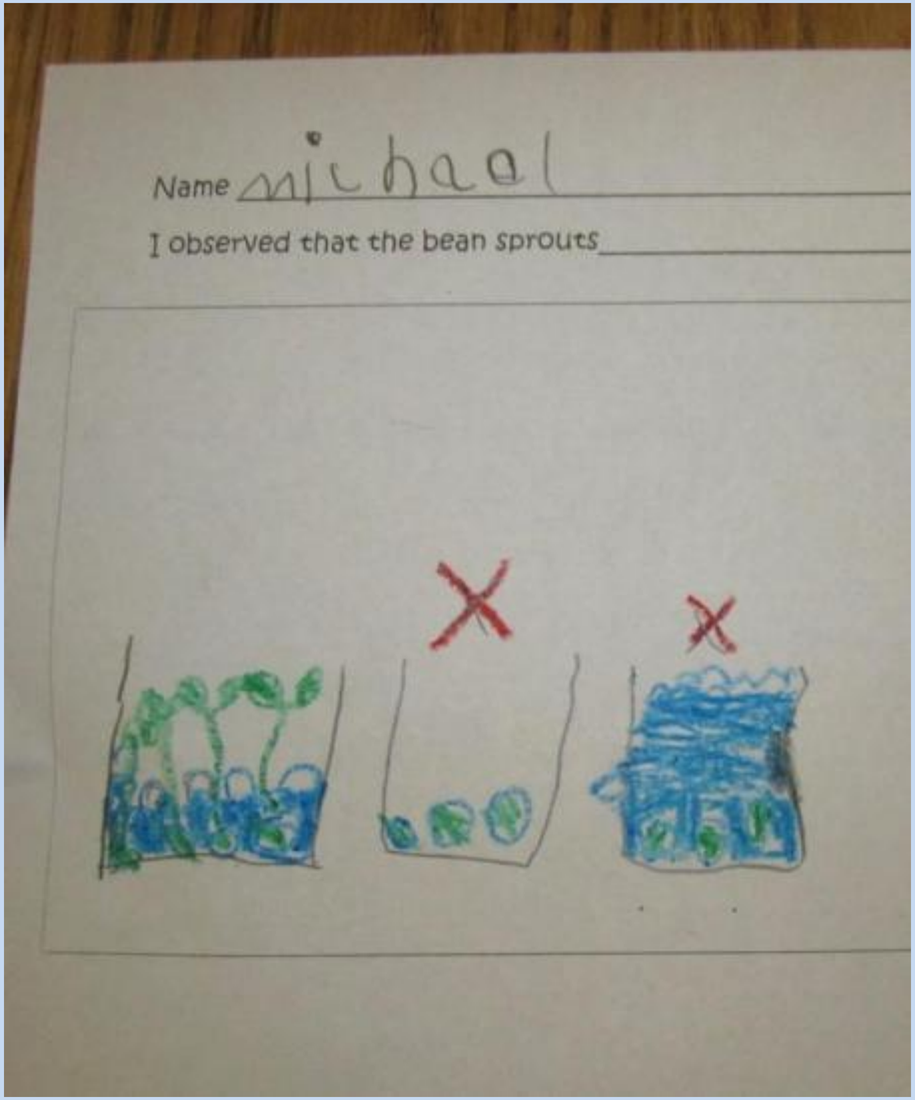
K–2 Condensed Practices	3–5 Condensed Practices
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.	Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.
• Ask questions based on observations to find more information about the natural and/or designed world(s).	• Ask questions about what would happen if a variable is changed.
• Ask and/or identify questions that can be answered by an investigation.	• Identify scientific (testable) and non-scientific (non-testable) questions. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
• Define a simple problem that can be solved through the development of a new or improved object or tool.	• Use prior knowledge to describe problems that can be solved. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Science process or inquiry skills	**Practices of science and engineering (NGSS identified)**
Engages, notices, wonders, questions.	1. Asking questions (for science) and defining problems (for engineering).
Records and represents experience.	2. Developing and using models.
Begins to explore, investigates.	3. Planning and carrying out investigations.
Collects data.	
Records and represents experience.	4. Using mathematics and computational thinking.
Reflects on experience, synthesizes, and analyzes data from experiences.	5. Analyzing and interpreting data 6. Constructing explanations (for science) and designing solutions (for engineering).
Uses language to communicate findings.	7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.

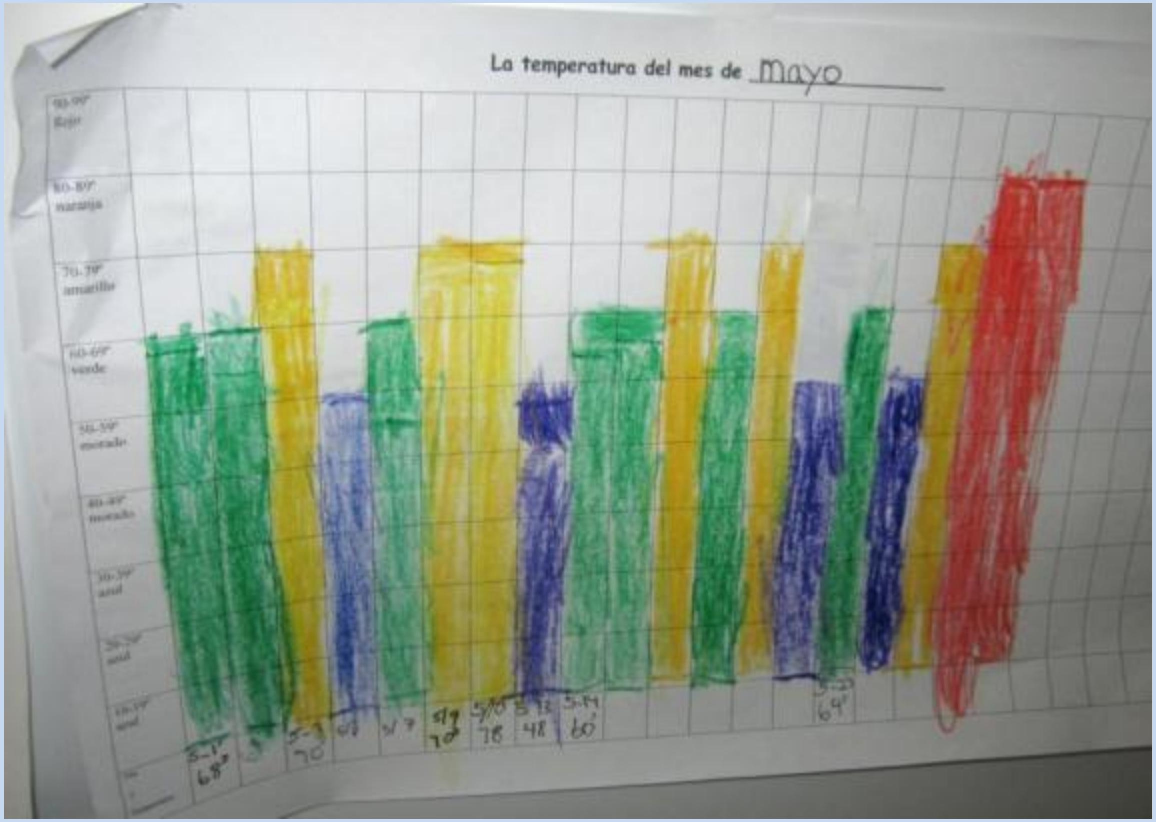
Asking questions and defining problems

Developing and using models.

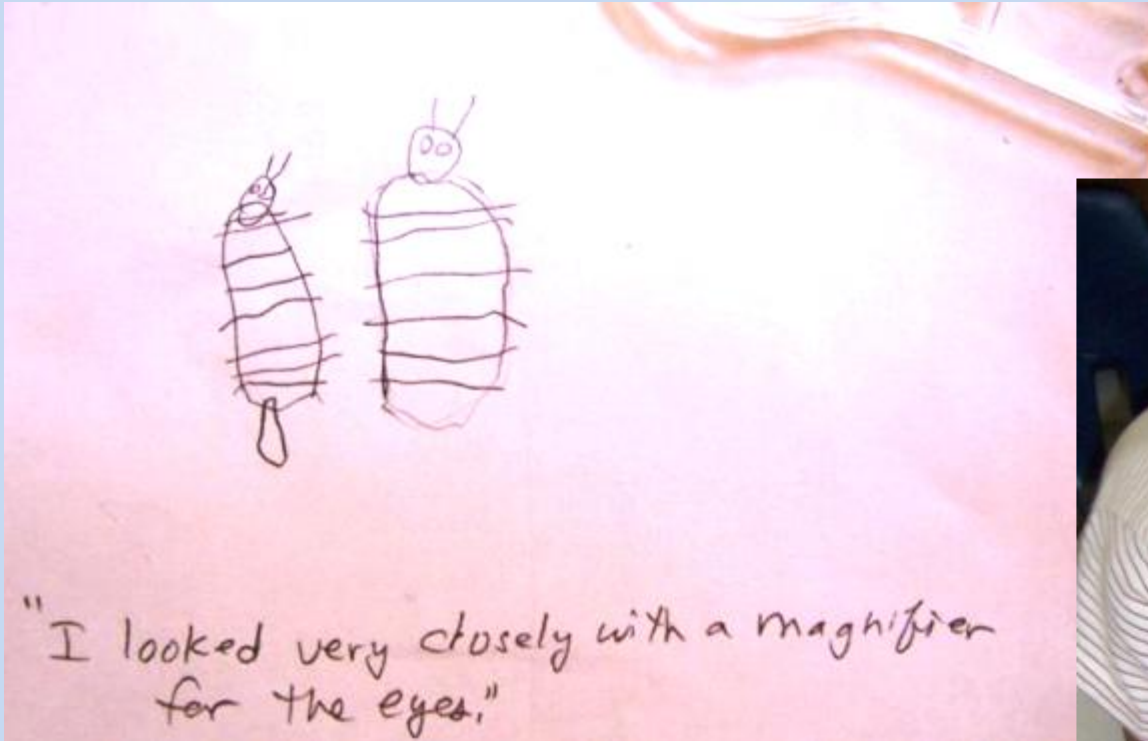
Planning and carrying out investigations.



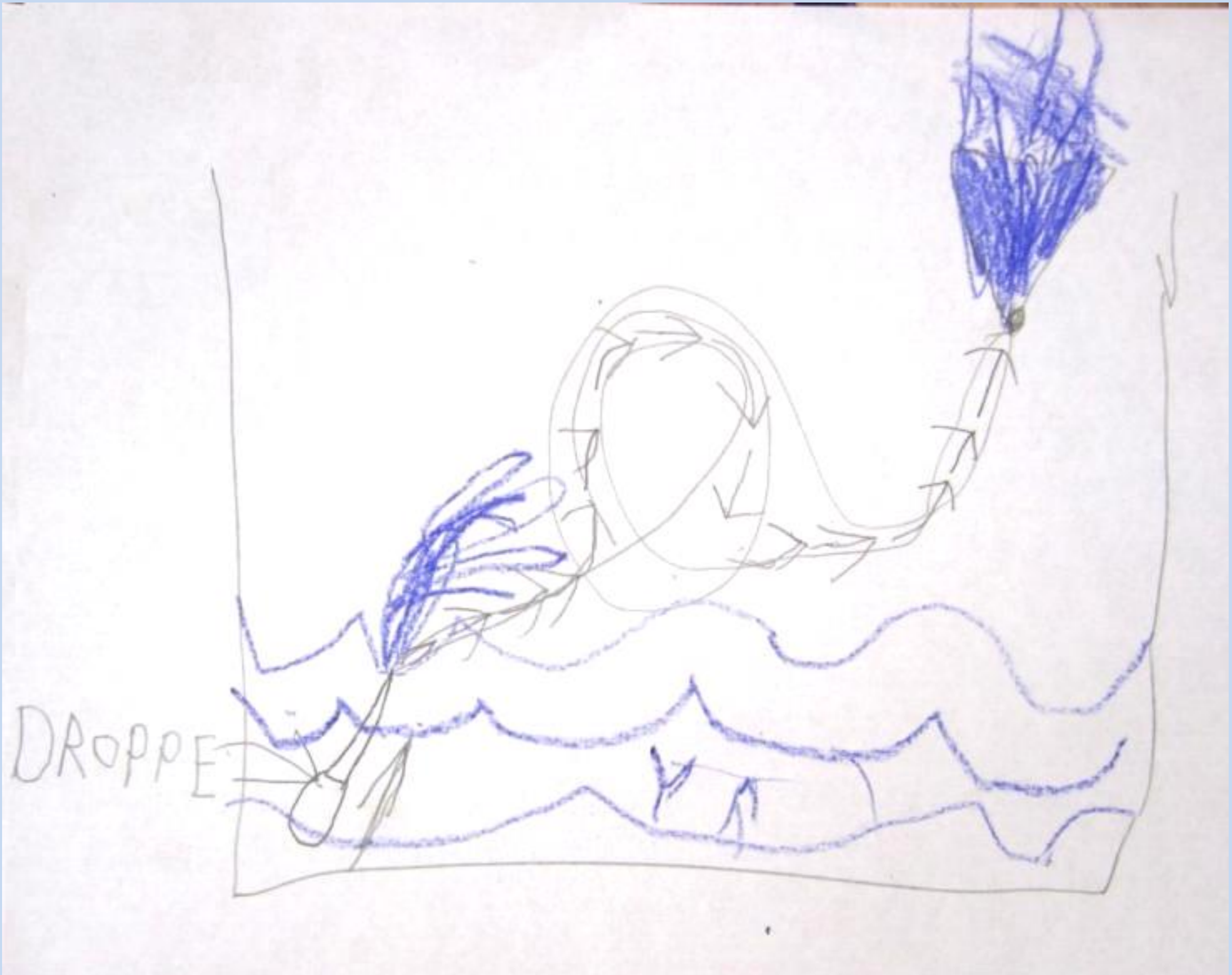
Analyzing and interpreting data.



Using mathematics and computational thinking.



Constructing explanations and designing solutions.



Engaging in argument from evidence.

Obtaining, evaluating, and communicating information.

Challenge yourself!

Use the list of science and engineering practices from the *Framework* and *NGSS* and identify which of the 8 practices you see in the following photographs.

NEXT GENERATION SCIENCE STANDARDS For States, By States

APPENDIX F – Science and Engineering Practices in the NGSS

A Science Framework for K-12 Science Education provides the blueprint for developing the *Next Generation Science Standards* (NGSS). The *Framework* expresses a vision in science education that requires students to operate at the nexus of three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ideas that all students should learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for students to learn these disciplinary core ideas in the context of science and engineering practices. The importance of combining science and engineering practices and disciplinary core ideas is stated in the *Framework* as follows:

> *Standards and performance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content.* (NRC *Framework*, 2012, p. 218)

The *Framework* specifies that each performance expectation must combine a relevant practice of science or engineering, with a core disciplinary idea and crosscutting concept, appropriate for students of the designated grade level. That guideline is perhaps the most significant way in which the NGSS differs from prior standards documents. In the future, science assessments will not assess students' understanding of core ideas separately from their abilities to use the practices of science and engineering. They will be assessed together, showing students not only "know" science concepts; but also, students can use their understanding to investigate the natural world through the practices of science inquiry, or solve meaningful problems through the practices of engineering design. The *Framework* uses the term "practices," rather than "science processes" or "inquiry" skills for a specific reason:

> *We use the term "practices" instead of a term such as "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice.* (NRC *Framework*, 2012, p. 30)

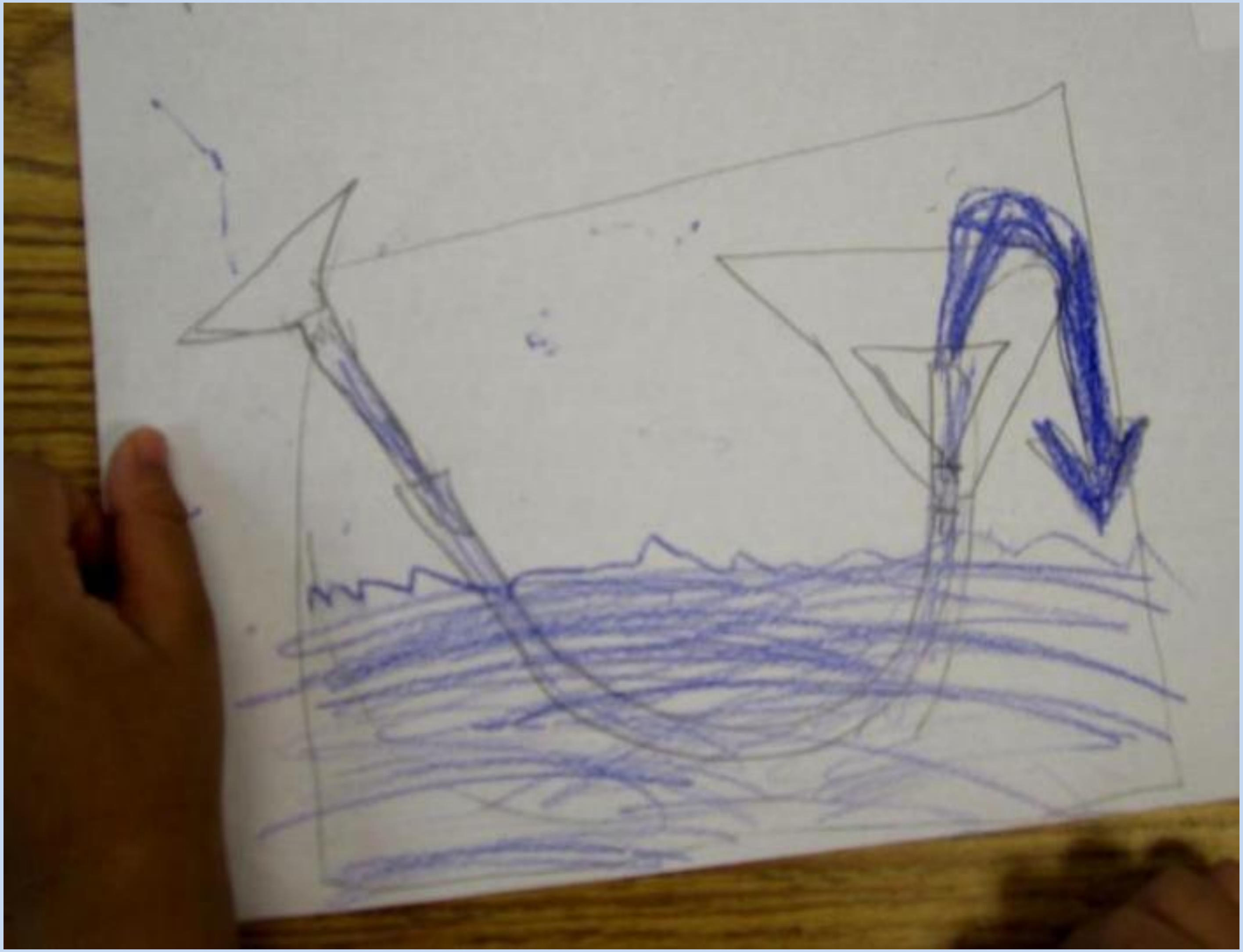
The eight practices of science and engineering that the *Framework* identifies as essential for all students to learn and describes in detail are listed below:

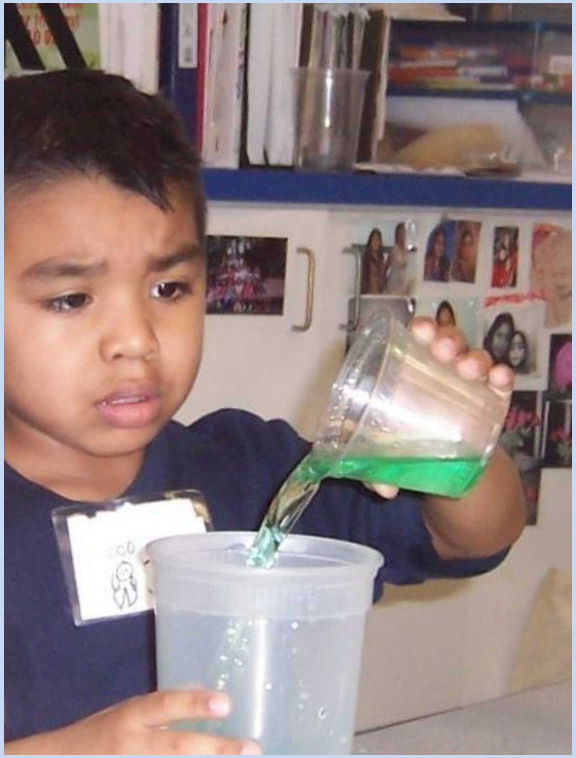
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for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

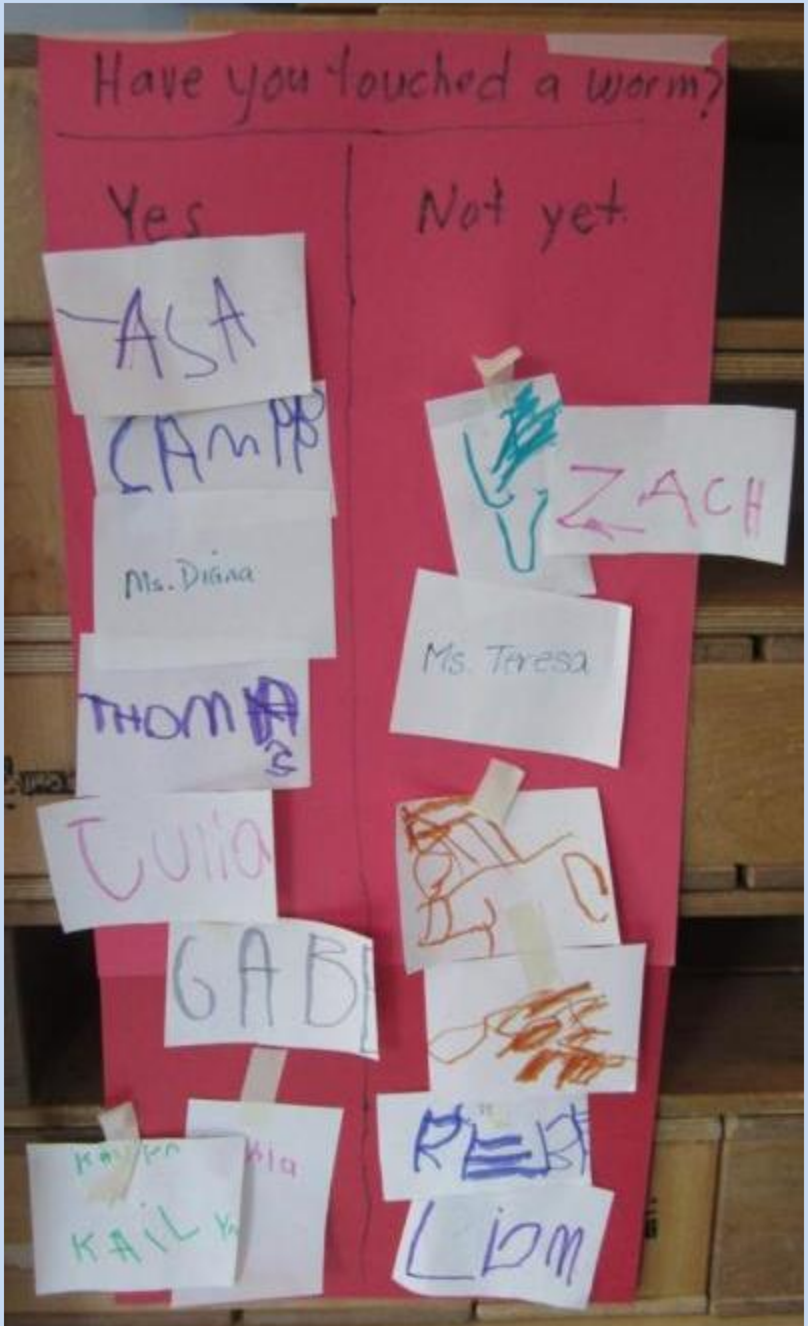
Rationale

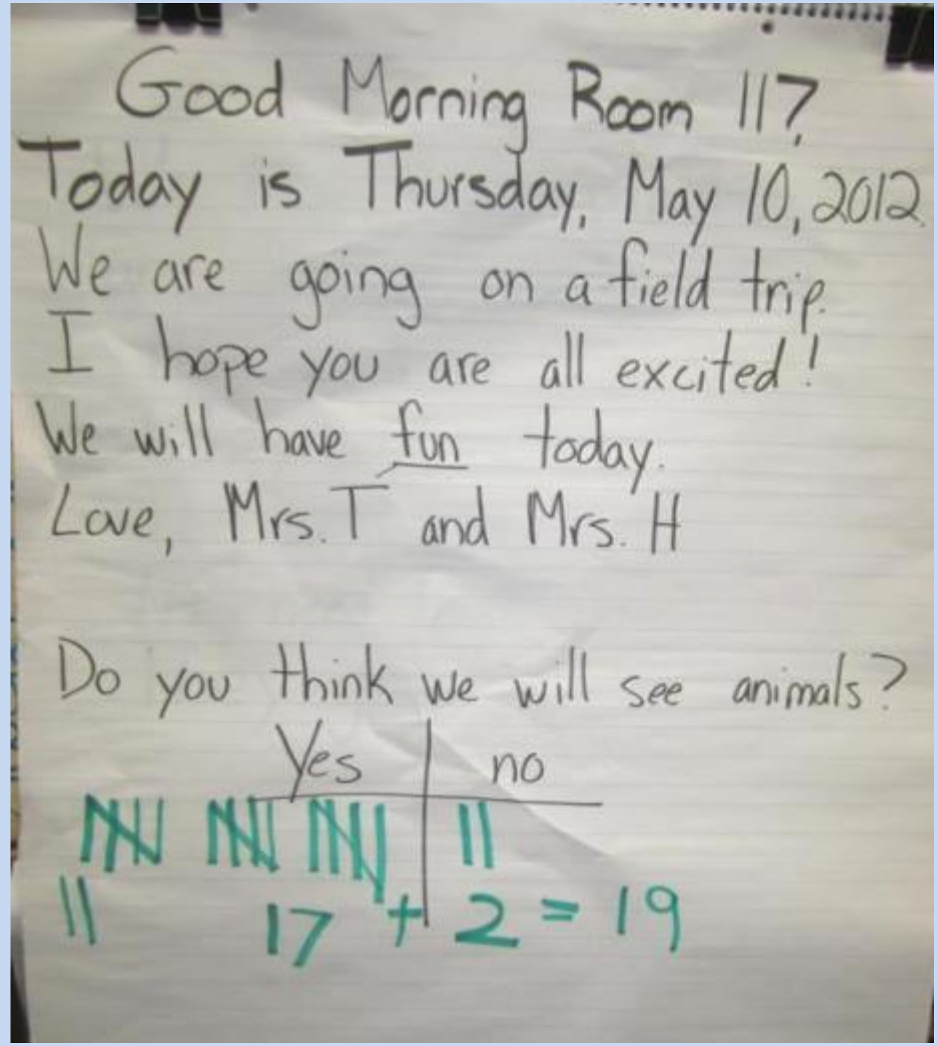
Chapter 3 of the *Framework* describes each of the eight practices of science and engineering and presents the following rationale for why they are essential.

> *Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science. Participation in these practices also*

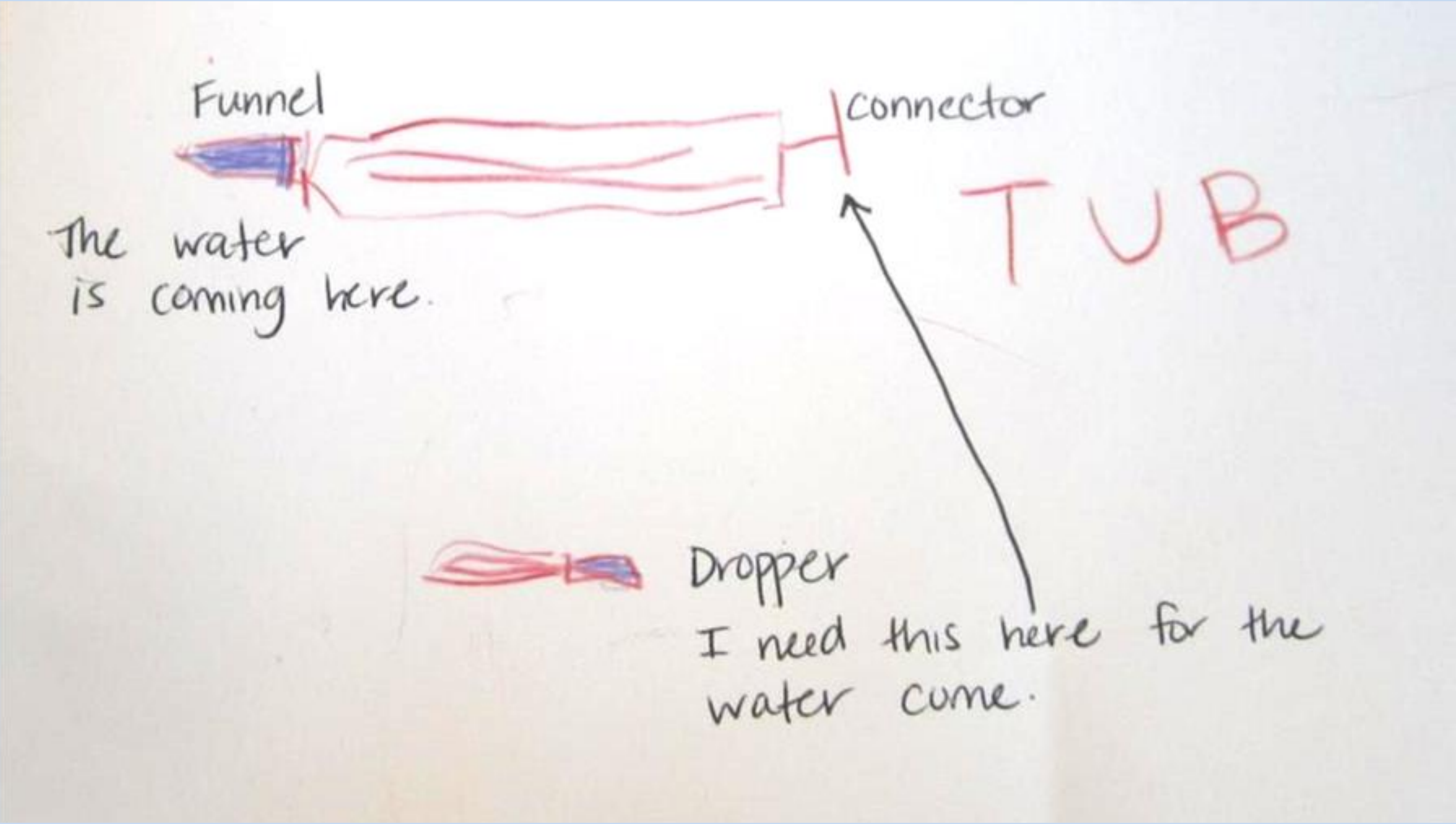


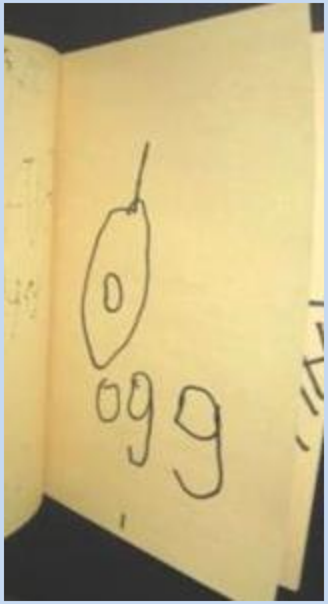

Have you touched a worm?
Yes
Not yet
ASA
ZACH
Ms. Diana
Ms. Teresa
GABI
Liam


Good Morning Room 117
Today is Thursday, May 10, 2012
We are going on a field trip
I hope you are all excited!
We will have fun today.
Love, Mrs. T and Mrs. H
Do you think we will see animals?
Yes
no
17 + 2 = 19


Ee Ff Gg


Funnel
connector
TUB
The water is coming here.
Dropper
I need this here for the water come.

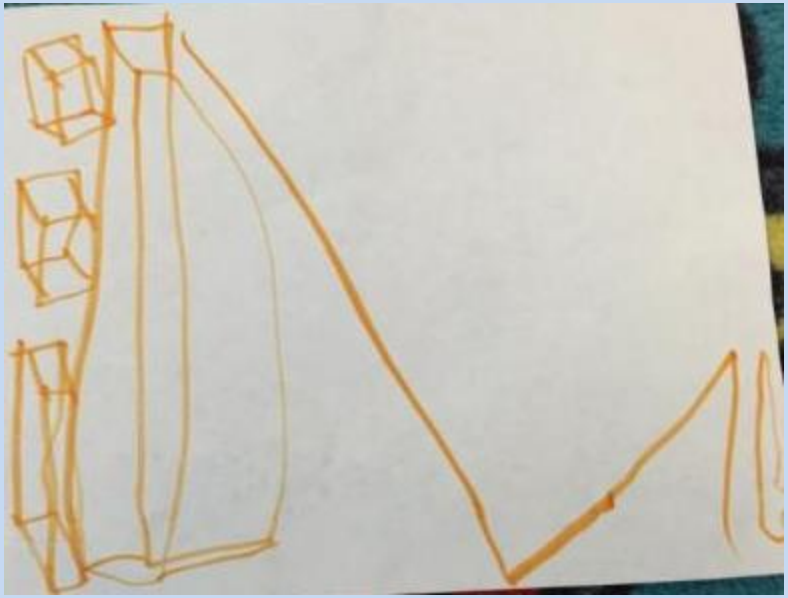

RAINBARREL
AVERY
DIRTBOX

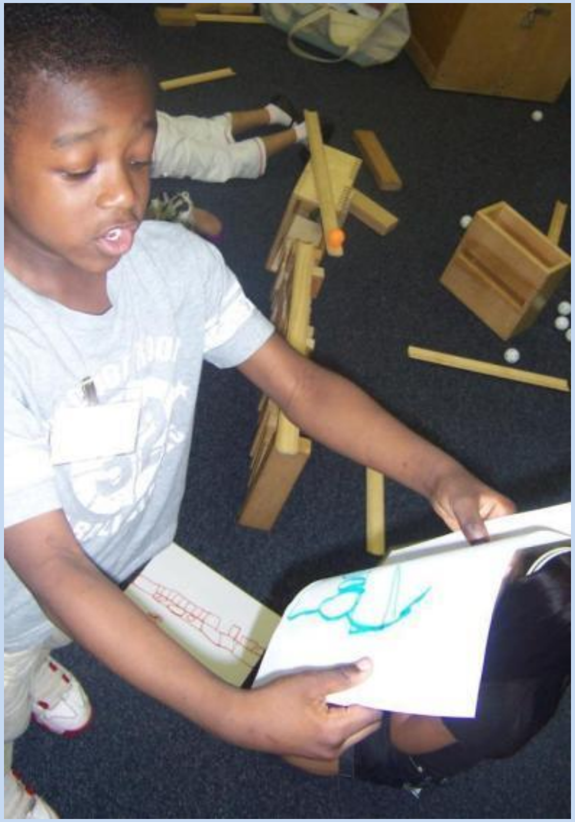

ogg
1

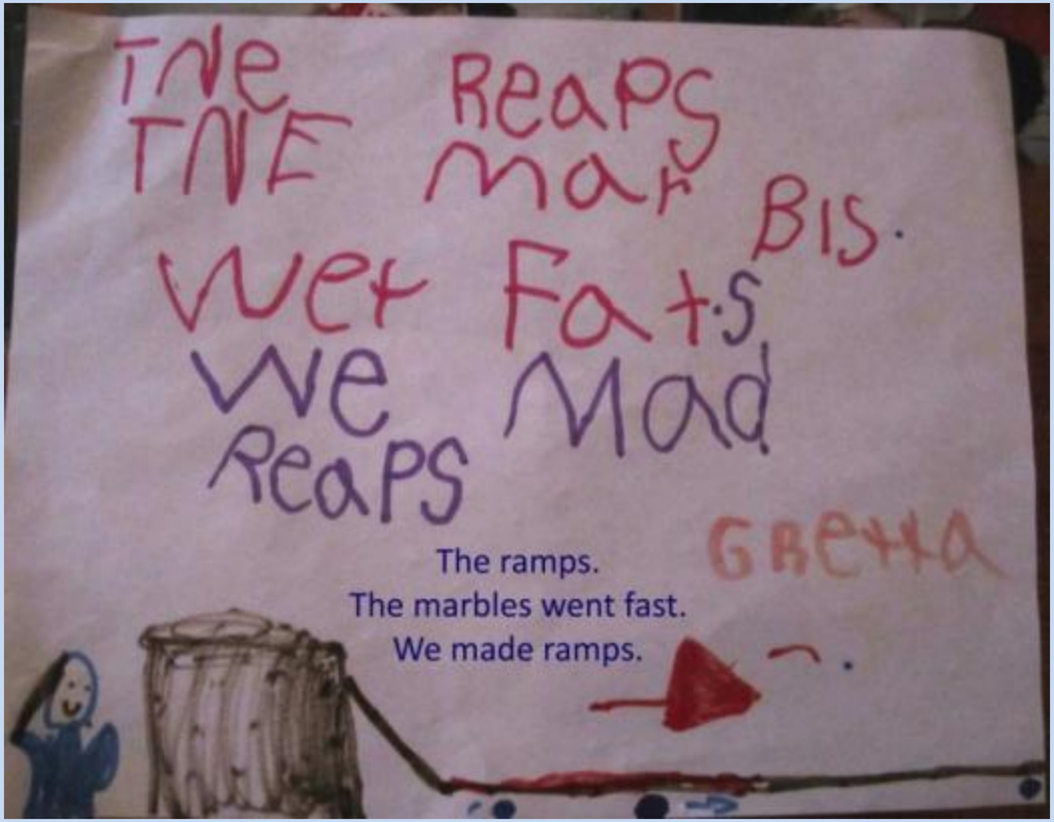

2


3


4




The Reaps
The mar Bis.
Wet Fats.
We Mad
Reaps
GReta
The ramps.
The marbles went fast.
We made ramps.

Your Next Steps: Implementing science inquiry through the principles and declarations of the NSTA Position Statement on Early Childhood Science Education

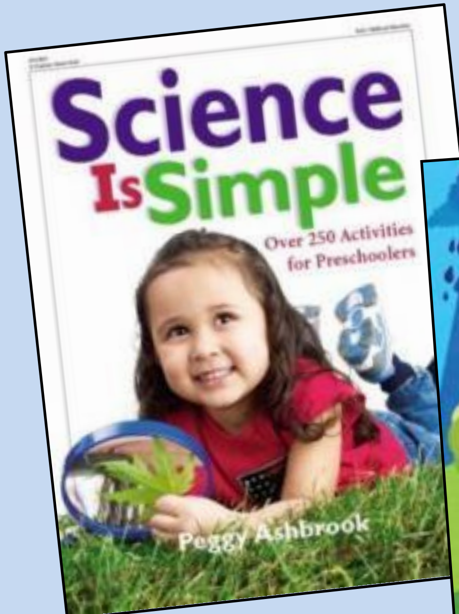
I will:

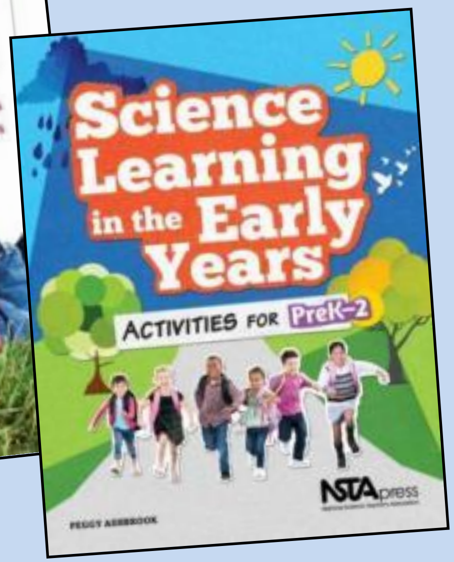
a) talk about the ideas in this webinar with my colleague.
b) see how my K-5 program's learning standards align with the NGSS.
c) plan a series of activities around a single science concept for children to begin exploring when school begins.
d) revise my weekly schedule to allow children to re-visit and re-engage with their ideas over time.
e) Search out additional resources such as visiting the National Science Teachers Association's Learning Center or becoming a member in NSTA or NAEYC.

Poll

Peggy Ashbrook

scienceissimple@yahoo.com





The Early Years blog
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naeyc
National Association for the Education of Young Children

The NAEYC Early Childhood Science Interest Forum

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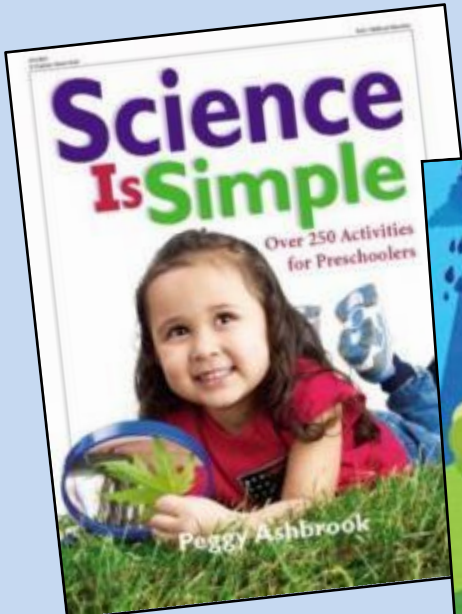

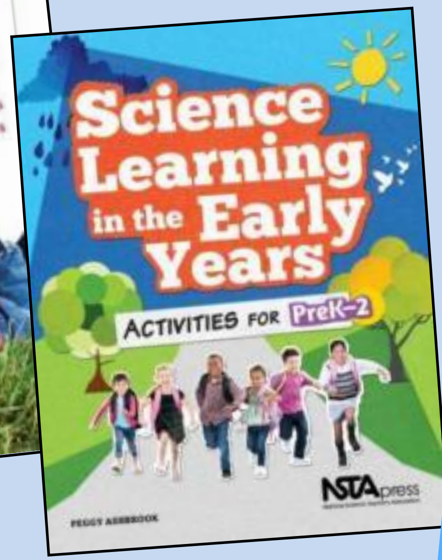

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Questions and discussion, some answers

naeyc

National Association for the Education of Young Children

The NA… Childho… Interest Forum