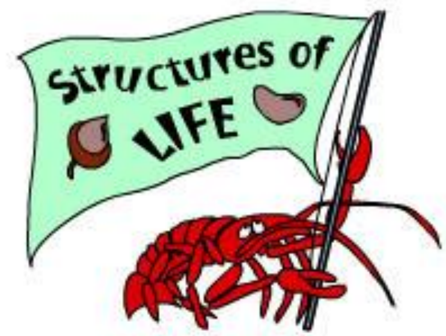
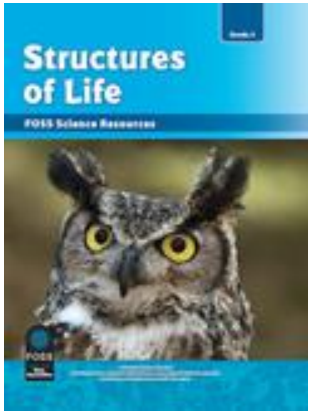
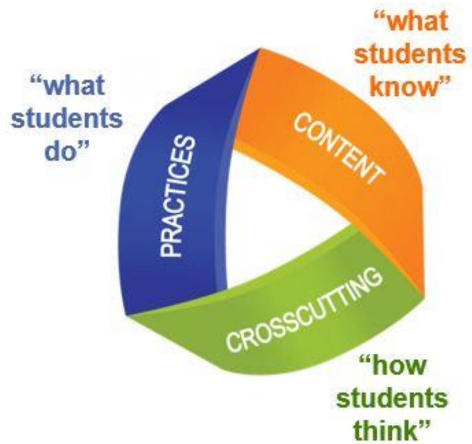
FOSS Structures of Life and NGSS: Focused Kit Training



How can I use my existing FOSS kit to engage in three-dimensional NGSS science learning?





Quoted text from Peter A'Hearn

Facilitator

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  - ESD 112 Science Materials Committee Member
  - Washington State Science Fellow

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Learning Objectives for Today

- Experience the three-dimensional learning found in the Next Generation Science Standards (NGSS).
- Understand alignment to WA state and NGSS.
- Understand the overall structure of the unit and the investigations.
- Gain content knowledge needed to teach the kit.
- Develop understanding of the physical structures of the living organisms (systems and subsystems).
- Learn how to prepare and care for the living organisms.
- Experience kit investigations and NGSS adaptations.
- Gain management and assessment ideas.

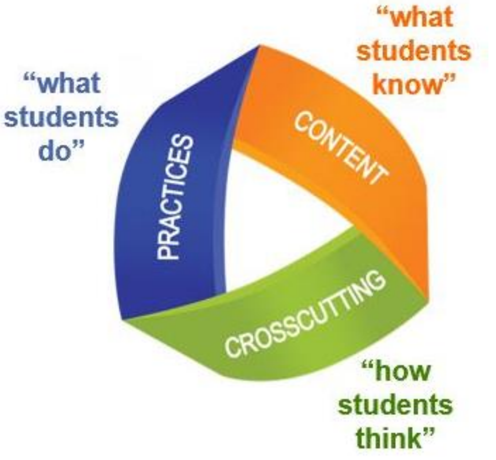
What is NGSS?

- The Next Generation Science Standards
- Officially adopted by Washington State
- Transition of science thinking and practices is happening now.
- New state testing in 2017-2018 (5th grade)

What is 3-Dimensional Learning?

Three dimensional learning shifts the focus of the science instruction to learning environments where students use:

- ***Disciplinary Core Ideas (science content)***
- ***Science and Engineering Practices (scientific behaviors)***
- ***Crosscutting Concepts (ideas used to make sense of science)***



to

- **EXPLORE**
- **EXAMINE**
- and **EXPLAIN**

- **how** and **why** phenomena occur (science)
- and to **design solutions** to problems (engineering)

DCIs- Disciplinary Core Ideas- What do we need to know and understand?

- The DCIs describe the science content to be addressed by each grade level.
- There are no grade-bands for science content as in the previous WA state science standards.

Disciplinary Core Ideas

Life Science	Physical Science
LS1: From Molecules to Organisms: Structures and Processes	PS1: Matter and Its Interactions
LS2: Ecosystems: Interactions, Energy, and Dynamics	PS2: Motion and Stability: Forces and Interactions
LS3: Heredity: Inheritance and Variation of Traits	PS3: Energy
LS4: Biological Evolution: Unity and Diversity	PS4: Waves and Their Applications in Technologies for Information Transfer
Earth & Space Science	**Engineering & Technology**
ESS1: Earth's Place in the Universe	ETS1: Engineering Design
ESS2: Earth's Systems	ETS2: Links Among Engineering, Technology, Science, and Society
ESS3: Earth and Human Activity	

SEPs- Science and Engineering Practices - What does doing science look like?

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

CCCs- Crosscutting Concepts - How can we think about and make sense of science by looking at it through the lens of:

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

FOSS Kit Tour

- FOSS Science Kits:
  - Managed by ESD 112 and Evergreen-yellow tape kit goes to Evergreen
- In Your kit:
  - Materials
  - Teacher Manual
  - Science Stories and other supporting books
  - Bag for broken items
  - Inventory sheet
- FOSS Elements
  - Background for the Teacher
  - Investigations
  - Blackline Masters (also in Spanish)
  - Home-School Connection, Math Extensions
  - Assessment
  - Science Stories
- Your Teacher's Manual
- ESD 112 NGSS transition website http://web3.esd112.org/stem-initiatives/stem-materials-center/lifekits
- FOSS Website http://www.fossweb.com/ search for archived elements (http://lhsfoss.org/fossweb/schools/teachervideos/3_4/Structures_flash.html)


FOSSweb Login Page
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Apps
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The Full Option Science System™ website
FOSSweb is the official website of the active-learning science program, FOSS. Explore resources for educators and engaging activities for students and families.
To get started, log in or visit as a guest. Students may visit as a guest, or use the class login if you have one.
Teacher Login
Class Login
Or, Visit as a Guest
Username or email
Password
Remember Me
Teachers only: I've forgotten my password.
Log In
What is FOSS?
FOSS is a research-based science curriculum for grades K-8 developed at the Lawrence Hall of Science, University of California, Berkeley.
Find out more...

FOSSweb Login Page

www.fossweb.com

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FOSS

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Welcome to FOSSweb

The Full Option Science System™ website

FOSSweb is the official website of the active-learning science program, FOSS. Explore resources for educators and engaging activities for students and families.

To get started, log in or visit as a guest. Students may visit as a guest, or use the class login if you have one.

Teacher Login | Class Login | Or, Visit as a Guest

1 What's your role? Teacher

2 Where are you? Washington

3 Grade level: Grade 3

Visit

New to FOSSweb?

FOSSweb has a new design and added features! To get started, you'll need to register on the new FOSSweb and activate your modules using an access code.

Find out more

FOSSweb Module Detail

www.fossweb.com/moduledetail?dDocName=D1423634

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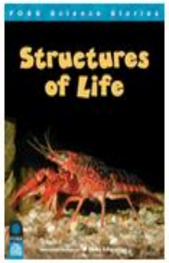
Structures of Life



Teaching the Module

- Important Module Updates
- Module Teaching Notes
- FOSSmap
- eTeacher Guide
- Resources by Investigation
- Teacher Preparation Video
- Module Summary
- Home/School Connection

Materials and Kit Information

- Materials Safety Data Sheets
- Materials Chapter
- Kit Inventory Checklist
- Equipment Photo Cards
- Plant and Animal Care
- Materials Folio for Meet the Bess Beetles
- Bess Beetle Alternative Investigation

Teacher Resources

- Investigation Masters
- Benchmark Assessments
- Taking FOSS Outdoors
- Embedded Assessments for FOSSmap

Digital-Only Resources

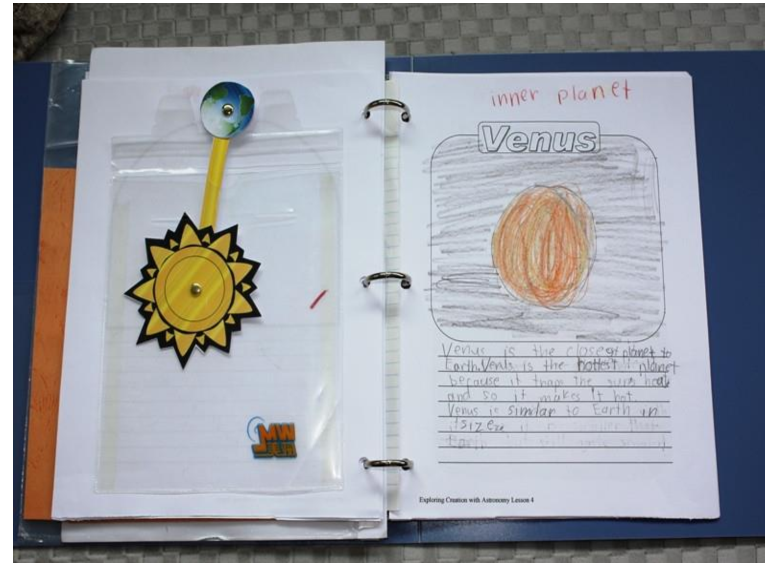
Global Resources

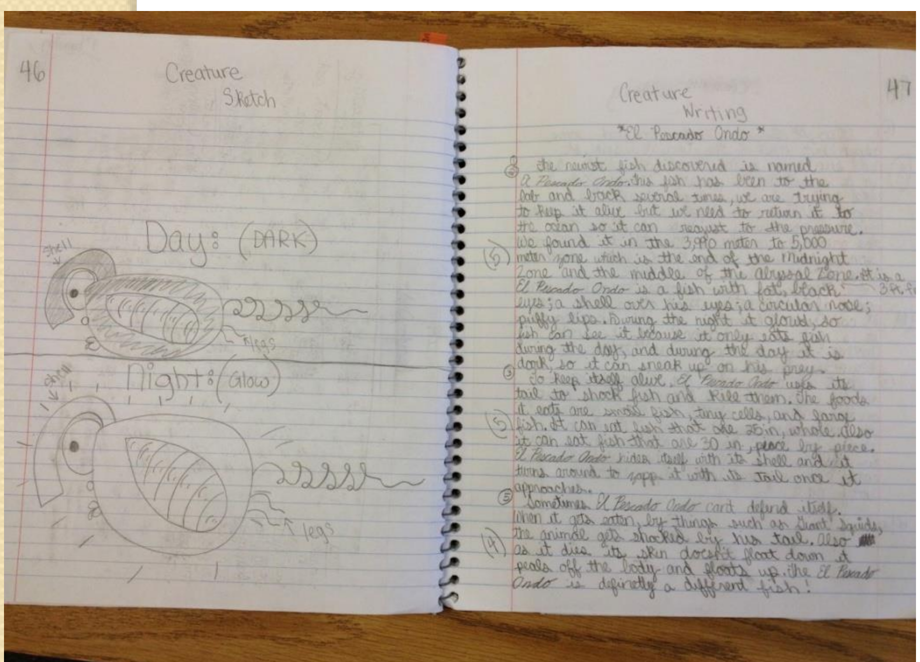
- Newsletter
- Professional Development and Training
- FOSSmap
- PlanetFOSS
- Standards Connections
- Scope & Sequence
- Order Replacement Parts
- Program FAQs
- Technical Help

* Premium Content (learn more)

Investigation	Activity	Science/ Engineering Practices focus	Crosscutting Concepts focus
1-Origin of Seeds (seeds and seed structure)	Part 1- Seed Search Part 2- The Sprouting Seed Part 3- Seed Soak	**Analyzing and Interpreting Data** Students make observations and/or measurements to produce data to serve as the basis for an explanation of a phenomenon.	**Structure and Function** Different materials have different substructures, which can sometimes be observed.
2- Growing Further (plant structures over time and life cycle)	Part 1- Germination Part 2- Hydroponics Part 3- Life Cycle of the Bean	" "	**Stability and Change** Change is measured in terms of differences over time and may occur at different rates.
3-Meet the Crayfish (exoskeleton structure and function)	Part 1- Meet the Crayfish Part 2- Crayfish Habitat Part 3- Crayfish at Home Part 4- Crayfish Territory	**Constructing Explanations** Construction and explanation of observed relationships.	**Cause and Effect** Cause and effect relationships are routinely identified, tested and used to explain change.
4- **Meet the Land Snail** (exoskeleton structure and function)	Part 1- Land Snails at Home Part 2- Compare Crayfish and Snails Part 3- The Snail Pull Part 4- Choose Your Own	**Planning and Carrying Out Investigations** Plan and conduct an investigation collaboratively to produce data as the basis for evidence.	**Structure and Function** Subsystems have shapes and parts that serve functions.
5- **Bones** (new) (internal skeletal structure)	Part 1- Counting Bones Part 2- Mr. Bones Puzzle Part 3- Owl Pellets	**Developing and Using Models** Develop and/or use models to describe and/or predict phenomena.	**Systems / System Models** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

Science Notebooks Support Science and Engineering Practices





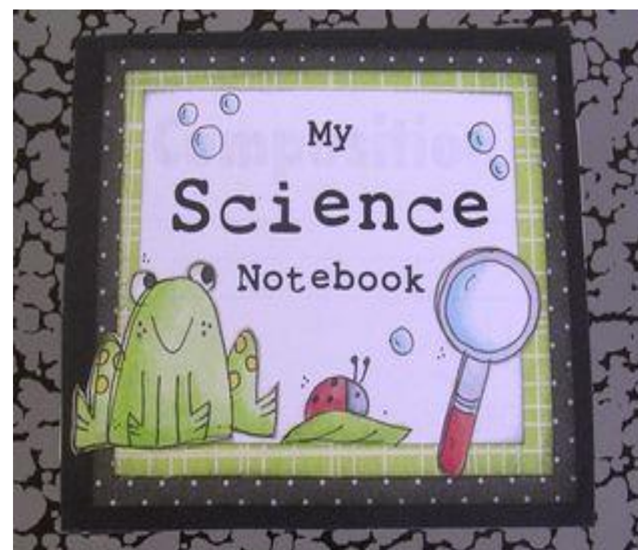
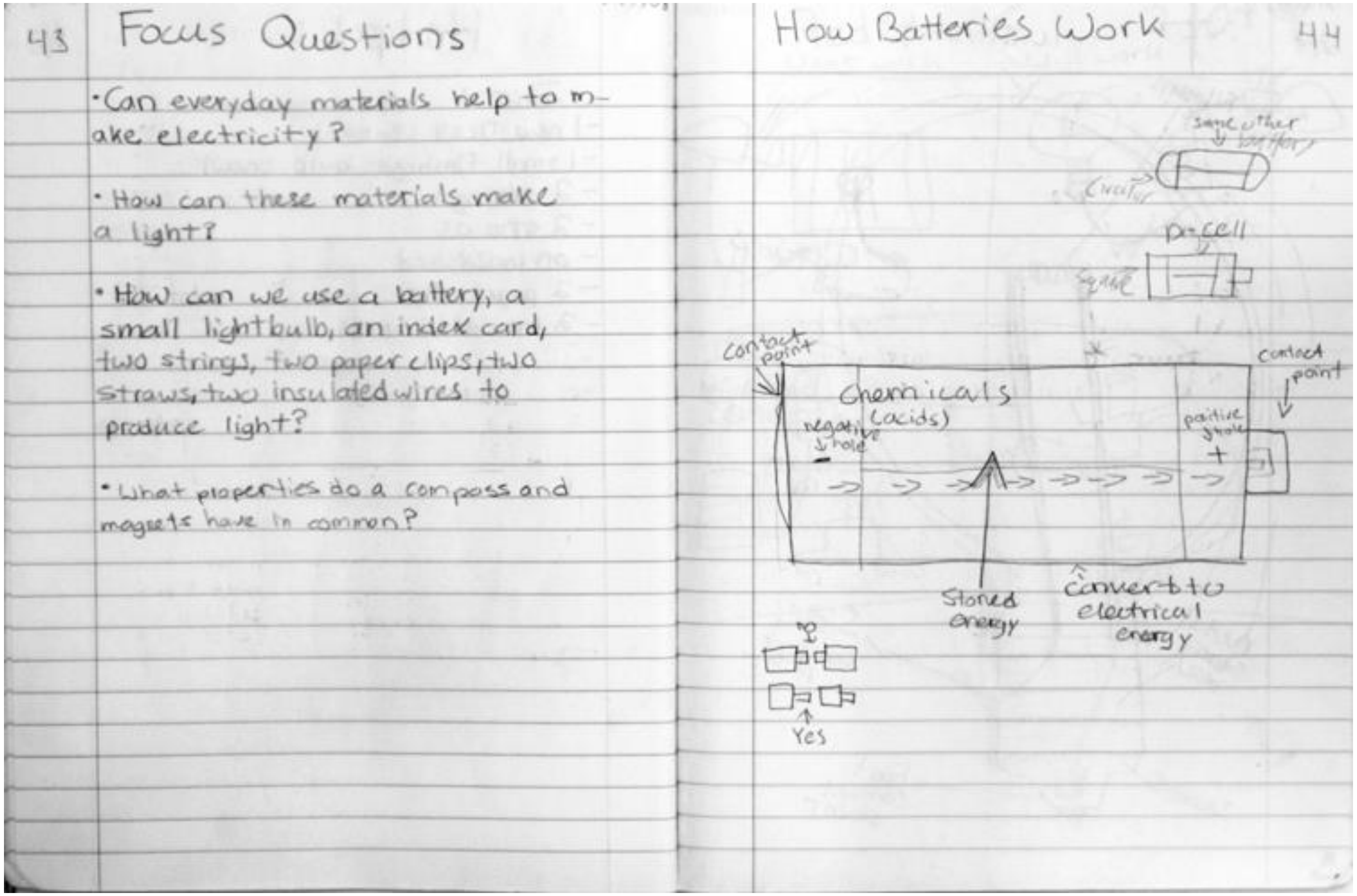


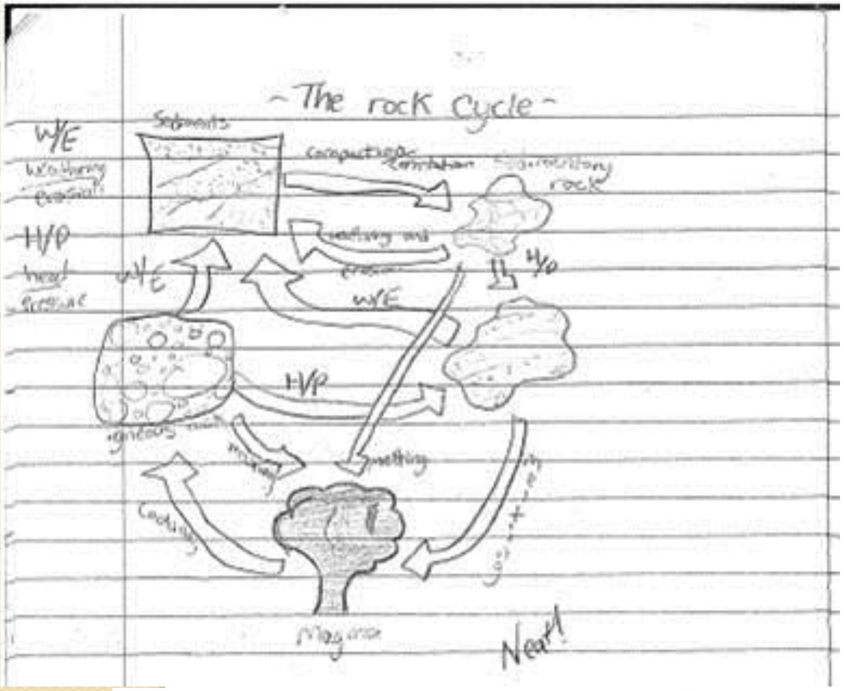
Table of Contents

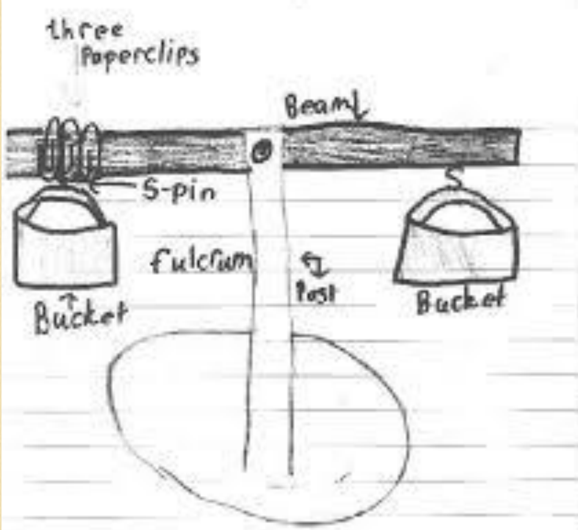
#	Page Title	#	Page Title
		1	
2		3	
4		5	
6		7	
8		9	
10		11	
12		13	
14		15	
16		17	
18		19	
20		21	
22		23	
24		25	
26		27	
28		29	
30		31	
32		33	
34		35	
36		37	
38		39	
40		41	
42		43	
44		45	
46		47	
48		49	
50		51	

Science Notebook - Table of Contents

Page #	Left Side Classroom Activities, Notes, & Labs	Page #	Right Side Practice, Review, Analysis, or Reflection
x	Lab Safety Challenge	1	Lab Safety Analysis +
2	D&T activity +	3	D and I conclusion +
4	Control/Variables	5	Terms & Questions +
6	1¢ Boat Challenge +	7	Observations/ Conclusion +
8	Controls & Variables II	9	?'s +
10	Terms & Footprints +	11	Reflection +
12	Marble Ramp Lab +	13	Reflection +
14	Observations/Data +	15	Quiz
16	Biosphere +	17	Atmospheric Layers +
18	Atmosphere Study Guide +	19	Thoughts about Atmosphere Scale +
20	Atmosphere Property: Temperature +	21	Temperature Graph +
22	Pressure Demos +	23	Pressure Notes +
24	Our Air +	25	Properties of Air +
26	Density +	27	Demo Sketch +
28	Dew Point Lab +	29	Humidity Notes +
30	H_2O Cycle +	31	Properties & H_2O Cycle
32	Water Cycle Game +	33	Game con't. Reflection +


43
Focus Questions
•Can everyday materials help to make electricity?
• How can these materials make a light?
• How can we use a battery, a small lightbulb, an index card, two strings, two paper clips, two straws, two insulated wires to produce light?
• What properties do a compass and magnets have in common?
How Batteries Work
44
same other battery
Circular
D-cell
Square
contact point
Chemicals (acids)
negative hole
−
positive hole
+
Stored energy
convert to electrical energy
Yes





Life Cycles of Plants

A Plant Life Cycles
1 Four Stages
a. germination
b. growth
c. reproduction
d. death

2 Different Life Cycles
a. annuals - in one growing season
b. biennial - two growing seasons
c. perennial - more than two growing seasons
1. have underground parts
2 trees/shrubs best known

B Life Cycle of a Tree
1 Trees have longest life cycle
a. Redswood are about 3,000 years old
b. annual rings
1 tell growing seasons (age)
2 show growing conditions
a) dark rings (spring)
light rings (summer)
b) thick rings (much rain)
thin rings (little rain)

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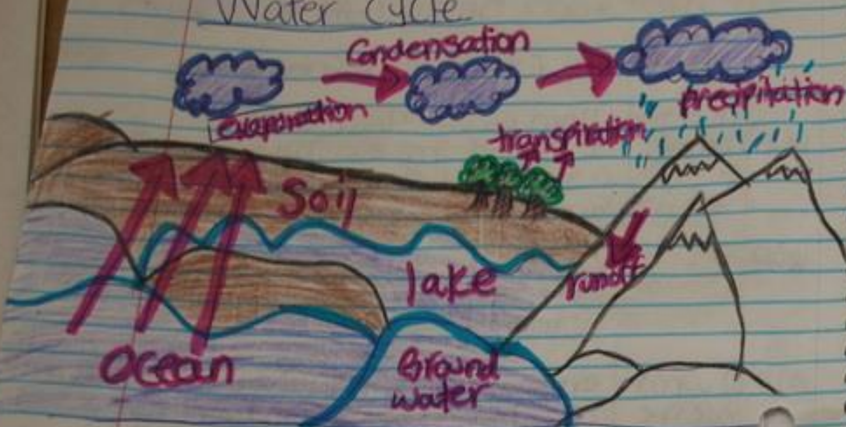
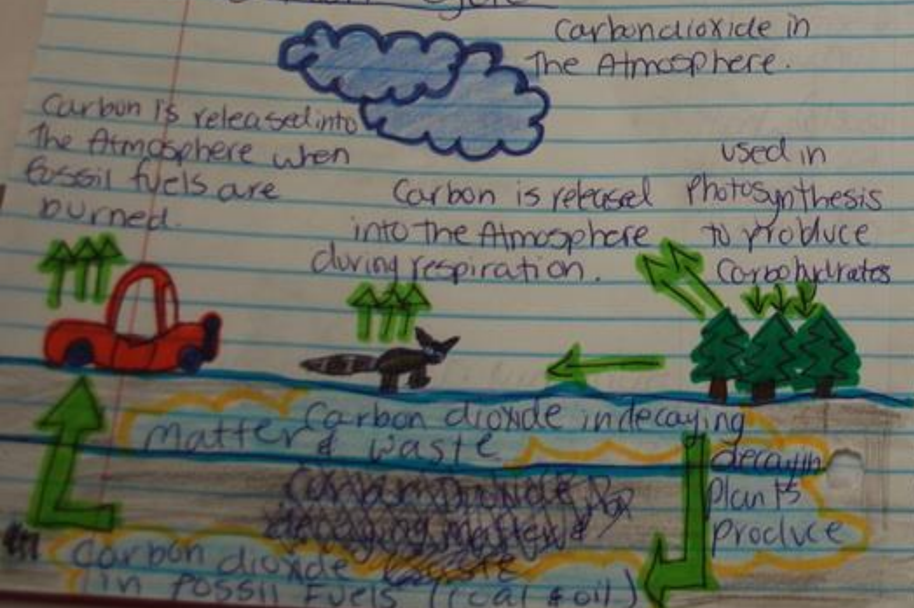
Water Cycle



Carbon Cycle



Precipitation

<u>Precipitation is when water falls to the Earth as rain, snow, sleet or hail.</u>

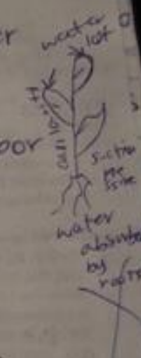
Jacksonville - the average amount of rainfall per year is 48.96 in

Runoff/Seepage (percolation)

- percipitation runs along the surface of the ground until it enters a river or stream that carries the runoff back to an ocean or a lake.
- rain also can seep into the soil and can become groundwater which plants use in their roots, beginning the water cycle anew.

Transpiration

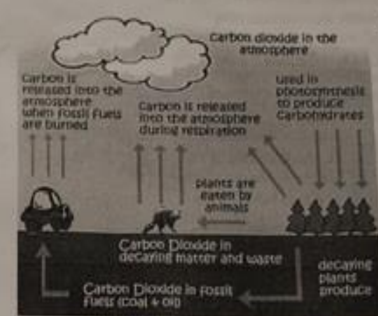
- <u>Transpiration is when plants lose water through their leaves.</u>
- plants pull water from the ground and lose water through their roots in a process called transpiration This puts water vapor in the air.



Other ways to recycle water

Animals breathe out water vapor in every breath.

Animals return water to the environment by breathing and by urinating



2. Carbon Cycle:

A. carbon is one of the most important elements in life.

B. Molecules that have carbon are called organic molecules molecules.

1. There is a lot of carbon dioxide (CO_2) in the air.
2. CO_2 is taken out of the air by plants through photosynthesis
3. Animals can't go through photosynthesis so they get their carbon atoms from food they eat.
4. BOTH plants and animals release CO_2 into the air through Respiration.
5. Decaying plants, animals, and waste (decomposition) after millions of years will be changed into fossil fuels. This is often done by decomposers such as shrooms and fungus
6. Fossil fuels can be burned by automobiles and factories, releasing carbon back into the atmosphere.

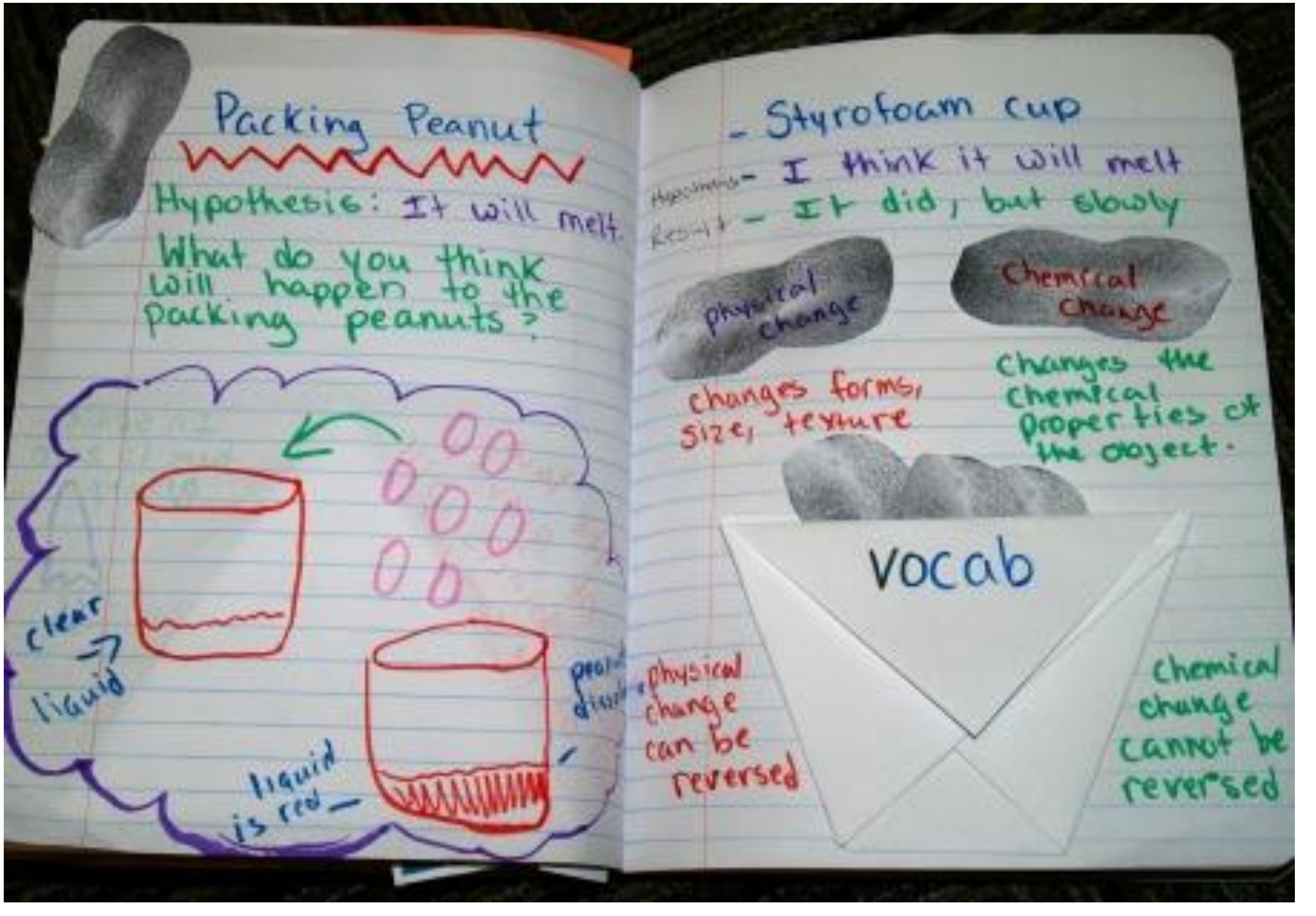
More Details:

Photosynthesis

- Photosynthesis is when autotrophs use the sun's energy to change CO_2 (carbon dioxide) and H_2O into sugars.
- Photosynthesis takes CO_2 out of the air.

  Photosynthesis:

  $CO_2 + H_2O + \text{Sunlight} \rightarrow C_6H_{12}O_6 \text{ (a sugar)} + O_2$
- The sugar that the autotrophs make in photosynthesis is made up of <u>carbon</u>.


Packing Peanut
Hypothesis: It will melt.
What do you think will happen to the packing peanuts?
clear
liquid
liquid is red
physical change can be reversed
Styrofoam cup
Hypothesis - I think it will melt
Result - It did, but slowly
physical change
chemical change
changes forms, size, texture
changes the chemical properties of the object.
vocab
chemical change cannot be reversed

INVESTIGATION 1: ORIGIN of SEEDS

Part 1: Seed Search

Is it a fruit or a vegetable?

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	**6. Structure and function**
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 1

As Is	Shift to NGSS 3-Dimensional
Students observe specimens and count seeds. The teacher tells students the definition of the term fruit. Teacher tells students which specimens are fruit.	Teacher asks students to develop their own definition for the term fruit using prior knowledge, observations, and reasoning. Students argue from evidence as to which specimens are fruit based on properties, explaining and defending their reasoning. Students come to a conclusion using all the class evidence, experiences, and thinking. Students consider the purpose of fruit in the life cycle of a living organism.

Describe the Properties of an Apple

- What words would you use to describe an apple?
- What words describe its:
  - Size
  - Shape
  - Color
  - Feel
  - Smell
  - Structures or Parts
- Is an apple a fruit? Do all types of fruit have the same properties?
- How are the properties of a fruit the same as the properties of a vegetable? How are they different? How can we tell them apart?

Is It a Fruit or a Vegetable?

- Make a T-Chart in your science notebook that looks like this:

My Thinking

Fruit	Vegetable

My Thinking

1. Think about the properties of a fruit. How can you tell something is a fruit?
2. Think about each of the items on the list.
3. Decide if each item is a fruit or a vegetable.
4. Write each item under the side that says Fruit or the side that says Vegetable.
5. Be ready to explain what rules you are using to sort.

- **bell pepper**
- **plum**
- **apple**
- **tomato**
- **corn on the cob**
- **kiwi**
- **carrot**
- **banana**
- **orange**
- **lettuce**
- **strawberry**
- **celery**
- **cucumber**
- **pomegranate**
- **snow pea**
- **squash**

Observe and Look For Evidence

- Scientists use observation to help them learn and think about science.
- Observe specimens of fruit and vegetables. Can you discover information that will help you decide if it is a fruit or a vegetable?
- Use the jeweler's loupes (or magnifying glasses) to closely examine the specimens.
- What parts does each specimen have?
- Can you see patterns in where the parts are placed?
- Are there seeds? Can you see a pattern in where they are placed?

Record Data

- In your notebooks, for each specimen you observe record:
  - The name of the item
  - Some properties of the specimen
  - The number of seeds found (actual or estimate)
  - A model of the specimen's seed (trace and draw details)
  - Anything else you find interesting or important

What is Data?

- Scientists gather data (information) to help them understand what they are studying.
- There are two types of data:
  1) **Numbers** (quantitative)-measured lengths, widths, temperatures, weight, volume etc…
  2) **Descriptive** (qualitative)- written descriptions, sketches, diagrams, colors, feel
- Scientists use both types of data together to understand and record different things about what they are studying.
- What types of data did you just gather?

Post Observation Partner Thinking:

Compare and discuss your sort with a partner.

Class Thinking

1. How can you tell if something is a fruit or a vegetable?
2. What rules or properties are part of our definition for the word “fruit”?
3. What rules or properties are part of our definition for the word “vegetable”?
4. How is a fruit different from a vegetable?
5. How will we sort these items as a class?
6. Be ready to explain your thinking.

- **bell pepper**
- **plum**
- **apple**
- **tomato**
- **corn on the cob**
- **kiwi**
- **carrot**
- **banana**
- **orange**
- **lettuce**
- **strawberry**
- **celery**
- **cucumber**
- **pomegranate**
- **snow pea**
- **squash**

More Information

- Here is the actual sort. Does it match your definition for fruit? What is the definition of a vegetable?

Fruit	Vegetables
Bell pepper	Carrot
Plum	Celery
Apple	Lettuce
Tomato	
Corn on the cob	
Kiwi	
Banana	
Orange	
Strawberry	
Cucumber	
Pomegranate	
Snow Peas	
Squash	

What do all the fruits have in common? What do the vegetables have in common? What's the rule for something to be a fruit? A vegetable? What does fruit have that vegetables don't? What thinking will help you decide? **What is the purpose of fruit? What is the purpose of vegetables?**

Read for More Information

- Read pages 3-4 in the Structures of Life text.
- Record what you learned about what makes something a fruit.

C-E-R Claim-Evidence-Reasoning (application and formative assessment)

Thinking Question: Is a green bean a fruit or a vegetable? Examine your specimen to find evidence that will help you answer this question.

My Claim	My Evidence	How my evidence helps prove my claim.

Claims – Evidence – Reasoning – Rebuttal (CER)

- **CLAIM – A statement/conclusion that responds to the *question under investigation***
- **EVIDENCE – Scientific data that is appropriate and sufficient to support the claim**
- **REASONING – Justification that shows why the data count as evidence to support the claim AND includes appropriate science ideas**
- **REBUTTAL – Alternative claims and/or counter evidence and reasoning for why an explanation is not appropriate**
  - McNeill & Krajcik, 2012; McNeill et al., 2006

Further Research: What do Botanists (plant scientists) Say About It?

- A fruit is the part of the plant that develops from a flower.
- It's also the section of the plant that contains the **seeds**.
- The other parts of plants are all considered vegetables.
- These include the stems, leaves and roots — and even the flower bud.

Checklist

Goals for Productive Discussions and Nine Talk Moves

Talk Science
in the Inquiry Project

Goal One Help Individual Students Share, Expand and Clarify Their Own Thinking

Notes/Frequency of Use

- [ ] **1. Time to Think**
  - Partner Talk
  - Writing as Think Time
  - Wait Time

- [ ] **2. Say More:**
  "Can you say more about that?"
  "What do you mean by that?"
  "Can you give an example?"

- [ ] **3. So, Are You Saying…?:**
  "So, let me see if I've got what you're saying. Are you saying…?"
  (always leaving space for the original student to agree or disagree and say more)

Goal Two Help Students Listen Carefully to One Another

- [ ] **4. Who Can Rephrase or Repeat?**
  "Who can repeat what Javon just said or put it into their own words?"
  (After a partner talk) "What did your partner say?"

Goal Three Help Students Deepen Their Reasoning

- [ ] **5. Asking for Evidence or Reasoning**
  "Why do you think that?"
  "What's your evidence?"
  "How did you arrive at that conclusion?"

- [ ] **6. Challenge or Counterexample**
  "Does it always work that way?"
  "How does that idea square with Sonia's example?"
  "What if it had been a copper cube instead?

Goal Four Help Students Think With Others

- [ ] **7. Agree/Disagree and Why?**
  "Do you agree/disagree? (And why?)"
  "What do people think about what Ian said?"
  "Does anyone want to respond to that idea?"

- [ ] **8. Add On:**
  "Who can add onto the idea that Jamal is building?"
  "Can anyone take that suggestion and push it a little further?"

- [ ] **9. Explaining What Someone Else Means**
  "Who can explain what Aisha means when she says that?"
  "Who thinks they could explain why Simon came up with that answer?"
  "Why do you think he said that?"

Line Plots- Make Data and Patterns Concrete and Visible

- Use one post-it for each specimen you examined.
- Write down the number of seeds you found in that specimen.
- Place each post-it on the line plot.
- How many of today's specimens have only 1 seed? What do we call 1 large seed? Is it good for the plant to have only 1 seed in each fruit? Why?
- How many specimens have many seeds? Is it good for the plant to have many seeds in each fruit? Why?
- About what number of seeds did the most specimens have? Why is this so?

Why is This Important?

- Why is fruit an important part of a plant?
- What does fruit have that is necessary for continued plant survival?
- What role do fruit and seeds play in a plant's life cycle?
- How is there variation among fruit and seeds of different plants? How does these variations help them reproduce?
- What important ideas did you discover about plants?

Using Mathematics and Computational Thinking:

As is:	Opportunity to Include:
•Students estimate, count, record, and graph number of seeds. •Students sort seeds by property.	•Student measure and weigh seeds, then graph and compare. •Think: Does the size or shape of a fruit predict the number or size of its seeds? •Think: Do the same types of fruit have a similar number of seeds? (All apples? All green beans? All peaches?) •Think: Sort seed by attribute. Which fruit have the most similar seeds? Why? The most different?

Did you see these SEPs (Science and Engineering Practices)?	Did you see these CCCs (Crosscutting Concepts)?
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	**6. Structure and function**
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Part 2: The Sprouting Seed

Are Seeds Alive?

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	**2. Cause and Effect**
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 2

As Is	Shift to NGSS 3-Dimensional
Teacher tells the students if seeds are alive or not alive.	Teacher asks students to develop their own claim as to whether seeds are alive or not alive using their prior knowledge and reasoning. Students argue from evidence as to whether seeds are alive or not alive, using evidence. Students explain and defending their reasoning. Students come to a conclusion using all the class evidence and thinking. Students consider the structures and purpose of seeds.

Formative Science Probe: Question- Are Seeds Alive?

- **John: No, seeds don't breathe, move, or eat, so they are not alive. I know that all living things need to do those things, so seeds can't be considered alive.**

- **Ann: I mostly agree with John. Things that are alive all do certain things. But, I think you can say a seed is alive after it starts growing into a plant, because then it is doing all those things. So seeds aren't actually alive until they are planted and start to grow.**

- **Sara- I think you can only say a seed is alive if it is still fresh and is not dried up. If it is a hard, dry seed, with no moisture, it's not alive.**

- **Bob: I disagree. It doesn't matter if a seed is dried up or not. Seeds are alive when they are a seed, and they are also alive when they grow into a plant. Even if the plant dies, the seeds are still alive.**

Which person do you most agree with and why?

Write down your claim, any evidence that supports your claim, and an explanation of how your evidence helps prove your claim could be true. Be prepared to defend your reasoning.

Four Corners Discourse Protocol

- All who agree with John meet in the front-left corner.
- All who agree with Ann meet in the front-right corner.
- All who agree with Sara meet in the back-left corner.
- All who agree with Bob meet in the back-right corner.
- Discuss your thinking and reasoning. Be prepared to defend your ideas. Try and convince others to join your group using your evidence.

What Do Scientists Know About the Properties of Living Things? They All:

- Need food or an energy source
- Grow
- Respond to stimuli
- Reproduce
- Go through a life cycle
- Die

Do seeds have these properties?

Scientific Questions

- Scientific questions can be of two types, investigatable or researchable.
- **Investigatable**- students can perform a scientific investigation to discover the answer to a question (How does the amount of light affect the height a plant will grow?).
- **Researchable**- students need to perform research or confer with experts in a field (Are seeds alive?).

Ask a scientist: Are seeds living or nonliving?

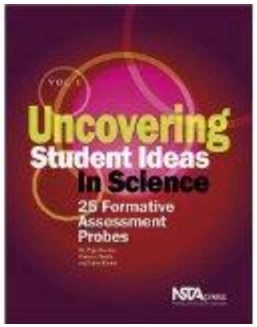
Reply:

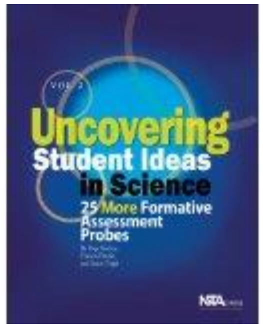
"Seeds are living. Seeds are using very small amounts of stored energy, staying alive and "waiting" for good conditions to begin to grow.

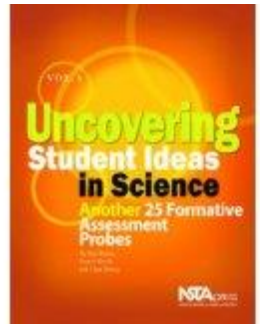
You can think about seeds as being alive but dormant until conditions are right for growing."

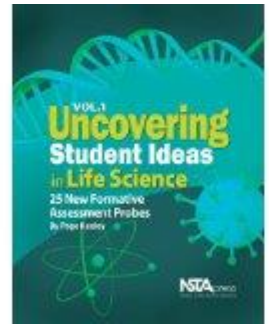
Ellen Mayo US Department of Energy

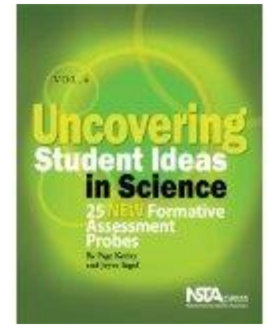
Science Formative Assessment Probes by Page Keeley









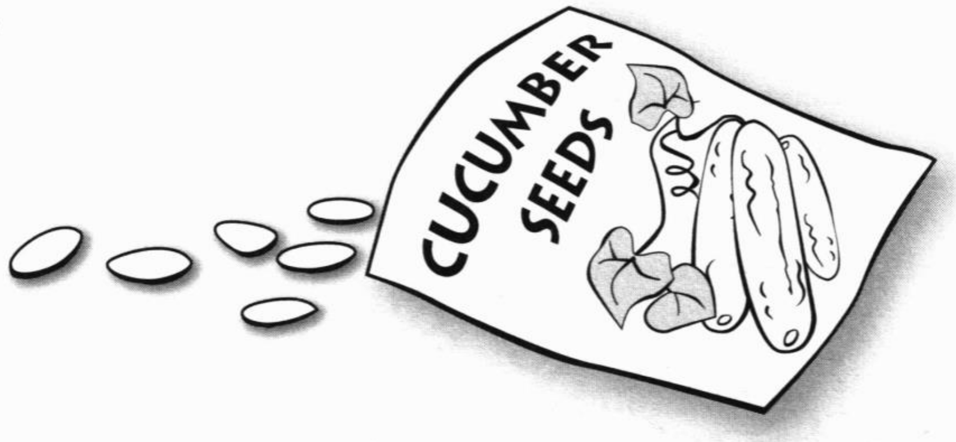


Use formative probes to:

- Determine student prior knowledge
- Uncover scientific misconceptions
- Engage is scientific discourse: claims, evidence, and reasoning
- Assess student learning and thinking

The following three formative science probes come from Page Keeley's books and are referenced in the right corner.

Cucumber Seeds



Two friends bought packets of cucumber seeds. They argued about whether or not the cucumber seeds inside the sealed packets were living. Here is what they said:

Katie: "I think they are alive when they are in the sealed seed packet."

Vaughan: "I don't think they are alive until they are planted in the soil."

Which person do you agree with the most? ____________________

Explain your thinking.

____

____

Page
Keeley:
Life Science

Is It Living?

Listed below are examples of living (which includes once-living) and nonliving things. Put an X next to the things that could be considered living.

___ tree
___ rock
___ fire
___ boy
___ wind
___ rabbit
___ cloud
___ feather
___ grass
___ seed

___ egg
___ bacteria
___ cell
___ molecule
___ Sun
___ mushroom
___ potato
___ leaf
___ butterfly
___ pupae

___ fossil
___ hibernating bear

___ mitochondria
___ river

Explain your thinking. What "rule" or reasoning did you use to decide if something could be considered living?

____

Page Keeley: Volume 1

Needs of Seeds

Seeds sprout and eventually grow into young plants called seedlings. Put an X next to the things you think a seed needs in order for it to sprout.

___ water

___ soil

___ air

___ food

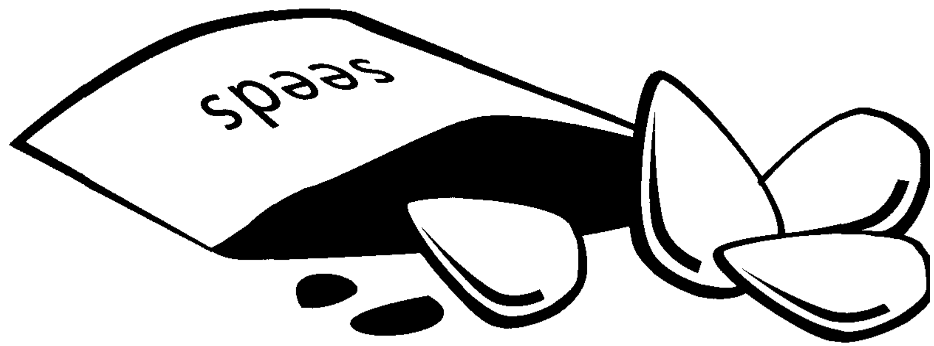
___ sunlight

___ darkness

___ warmth

___ Earth's gravity

___ fertilizer



Explain your thinking. Describe the "rule" or reasoning you used to decide what a seed needs in order to sprout.

____

Page Keeley: Volume 2

If Seeds Are Alive, What Do They Need to Start Growing? Why?

Do they need?

Element	Claim	Evidence	Reasoning (explanation)
Water			
Air			
Dirt			
Light			
Food			

Hands-On: Make Minisprouters

- Materials Management:
  - Each person in your groups needs a science job. Decide who will:
    - Be the getter- go and get science materials needed
    - Prepare the Sprouting Seed Placemat
    - Be the water drainer and minisprouter labeler
    - Be a seed counter (you will need 1-4 people for this)
- Label your minisprouter with your group name/number
- Place a paper towel in the bottom of the minisprouter.
- Place 6 of each seed on the paper towel(bush bean, sunflower, pea, popcorn)
- Let the teacher know you are ready for bleach water.
- The drainer will carefully hold the lid on and drain out all excess water into the sink.
- The placemat person will glue/tape one sample of each seed on the group placemat and write the group member's names.

Class Sprouter Tips

- Wash with hot water, soap, and a weak bleach water rinse.
- Stack trays, put 35 bush beans in the top tray, 35 bush beans in the second tray and 35 **EACH** of the sunflower, pea, and popcorn seeds in the third tray.
- Make sure red caps are on, rotate so drains are not directly below each other.
- Pour ½ liter of weak bleach water into the top tray, water flows down through the other trays and into the bottom. [2L water and 5 mL (1tsp) of bleach]
- When all water has drained (about 10 min) empty bottom tray.
- Repeat watering each day. <u>Immediately remove any moldy seeds</u> and store away from direct sunlight.

Class Sprouter

Why is This Important?

- Why does it matter to know that seeds are alive, but dormant?
- Why do seeds need to have this ability?
- How does this help plants to survive and keep the life cycle going?
- Is dormancy a strategy used by any other living things?

Part 3: The Seed Soak

How does water affect seeds?

*What are the parts of a **seed** and how do they help the seed to grow?*

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
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Modifications to Part 3

As Is	Shift to NGSS 3-Dimensional
Students weigh and compare dry lima beans to beans soaked overnight. Teacher tells students the names of the structures they are observing. Students label part names on a pre-drawn model of a seed.	Teacher introduces the concept of a system. A system is a whole group of related parts that all work together. The students discuss the seed as a system with specific subsystems (parts) that all fill certain roles to help the seed. The students discuss the possible role each subsystem fills that helps the whole system function. Students draw and label a model of the seed system, its parts, and their functions. What might happen to the system if any subsystem were missing or not working properly?

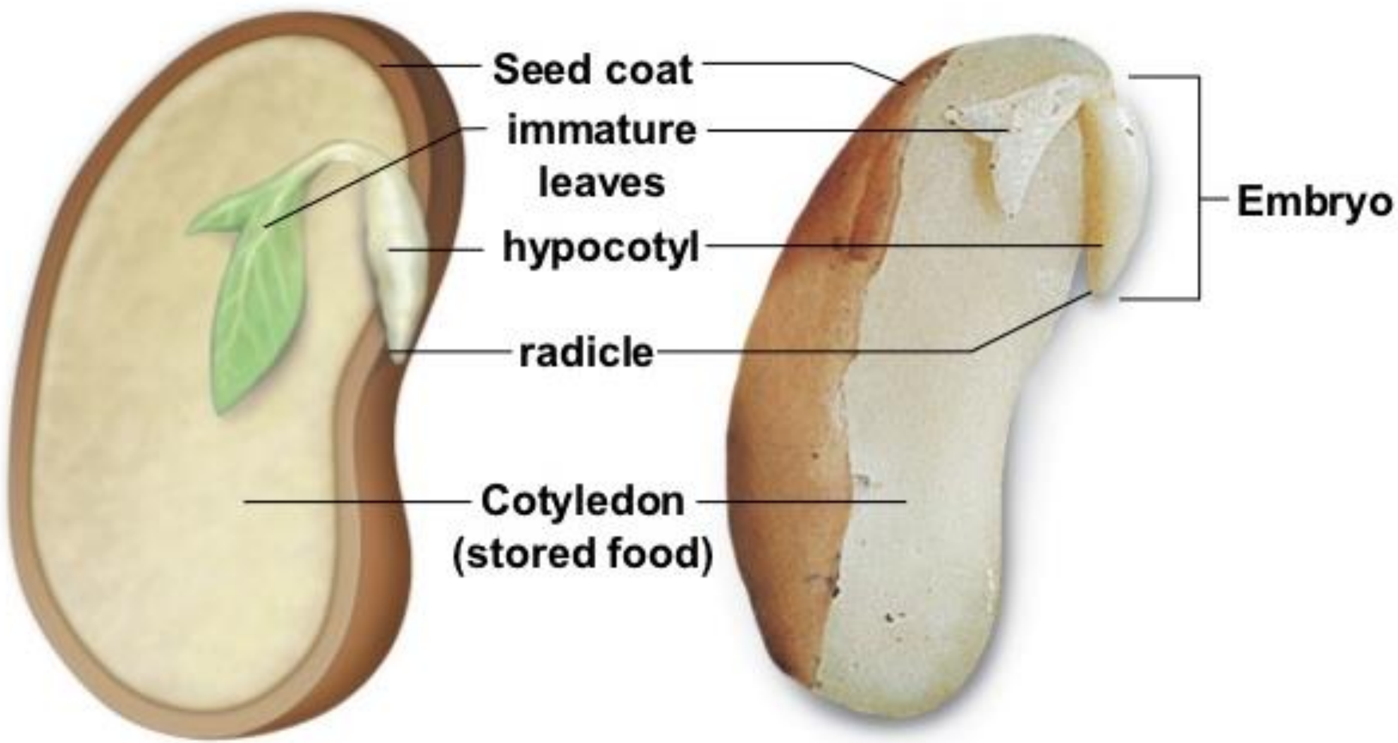
Model: The Soaked Seed

- What effect does soaking in water overnight have on dry beans? Why?
- Trace dry bean in notebooks and label.
  - Measure and record the length and width of the dry bean.
- Trace soaked bean in notebooks and label.
  - Measure and record the length and width of the dry bean.
- What's the difference in size?
  - What caused the change?
  - How did soaking the seed change its properties?

Structures of the Bean:

- Examine your soaked seed carefully to find all of the parts of a bean seed.
  - Carefully open a soaked bean.
  - What structures can you see?
  - What job might each structure do for the seed?
- Draw a detailed model showing each part of the bean you observe.
- Discuss vocabulary and purpose of each part as a class and add to your model.

Develop Vocabulary and Understanding of the Seed as a System with Parts That Do Certain Jobs



Seed Structures and Their Function

- **Seed Coat-** the thin white shell that comes off the seed. It protects the seed.
- **Cotyledon-** the two halves of the seed that store food for the plant to use until it grows leaves and can make its own food. (Bean has two cotyledons and is called a **dicot**, corn has one cotyledon and is called a **monocot**).
- **Embryo-** the baby plant that contains the tiny root and leaves.

Systems Thinking: A seed is a system

- A **system** is a whole unit or group made up of smaller parts that all work together to keep the whole system working properly.

- A **subsystem** is one of the smaller parts that make up a system. These parts generally serve some specific function that helps the whole system work well. (current 3rd grade standard calls the subsystems "parts")

- What are the subsystems or parts of a seed and what function does each perform?

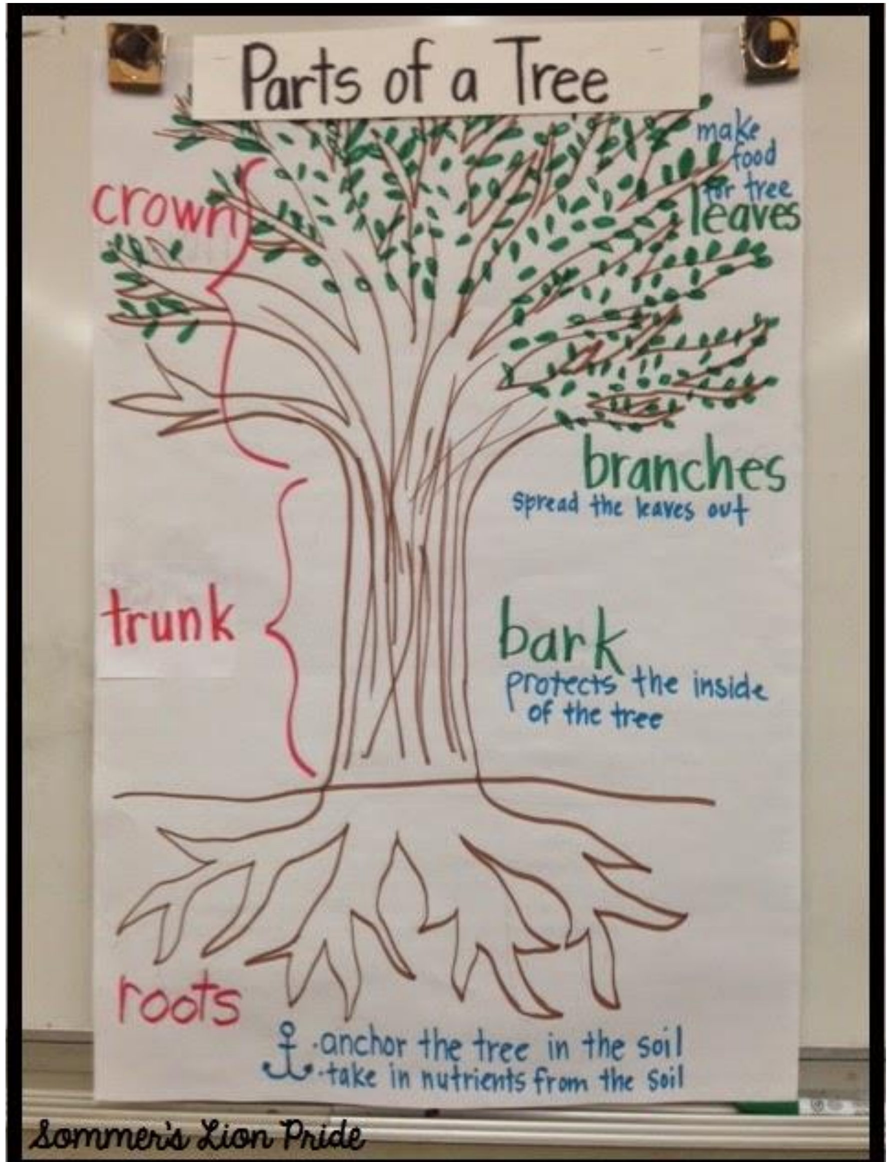
The Bean Seed is a System

- What is the purpose of the whole system- the bean?
- How many parts are there in a bean?
- What job does each part do to help the whole seed do its job?
- Which part of the seed actually grows into the bean plant?

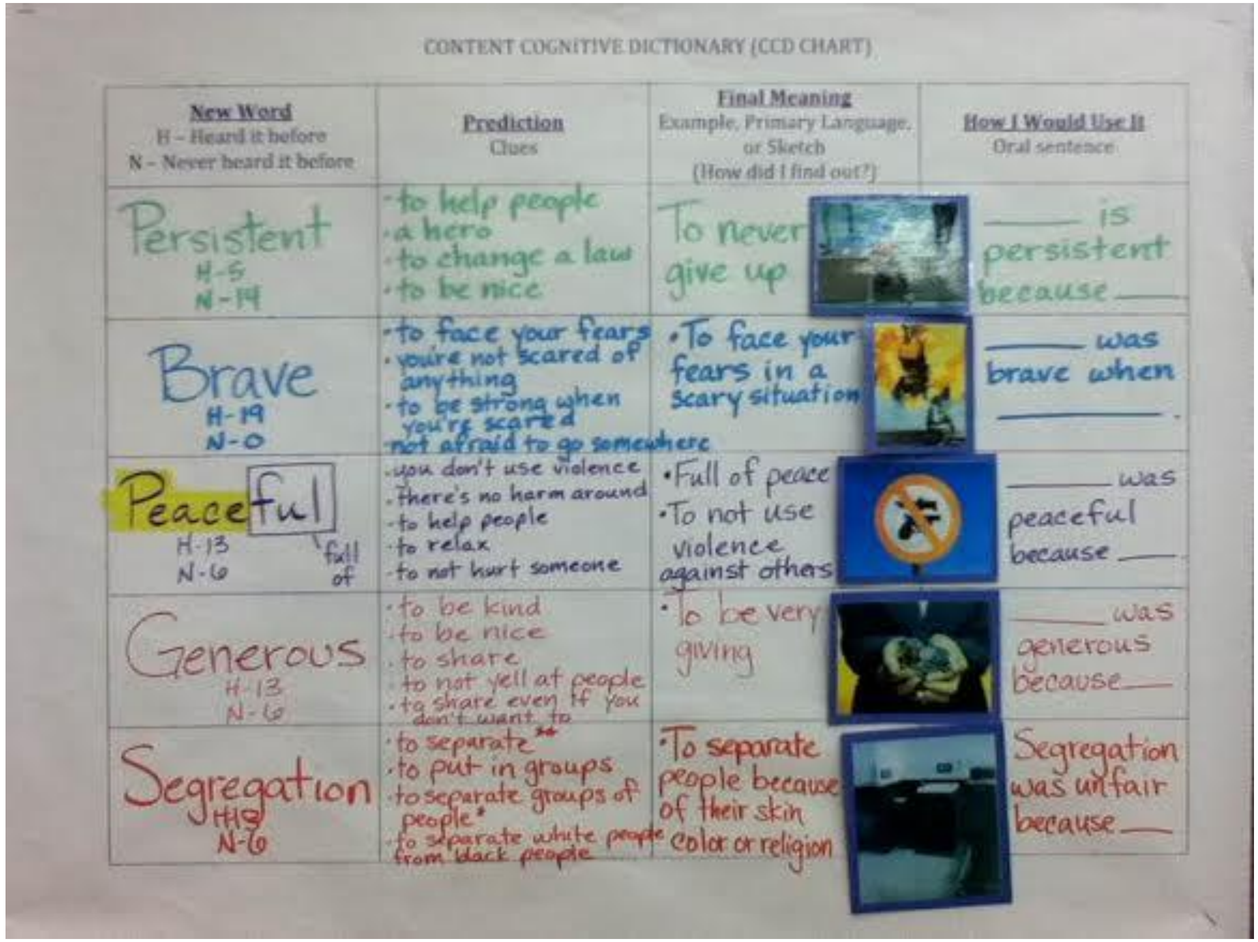
Why is This Important?

- All organisms in nature are a type of living system?
- What happens to the whole system if one of the parts is damaged or missing?
  - What if the seed coat were missing?
  - What is one of the cotyledons were missing? (bean broken in half)
  - What if the embryo were missing?
  - Which is the most important part?
- How do living things count on their parts to function properly?

GLAD Model Example:



GLAD Strategy Examples: Cognitive Content Dictionary



CONTENT COGNITIVE DICTIONARY (CCD CHART)

New Word H – Heard it before N – Never heard it before	**Prediction** Clues	**Final Meaning** Example, Primary Language, or Sketch (How did I find out?)	**How I Would Use It** Oral sentence
Persistent H-5 N-14	·to help people ·a hero ·to change a law ·to be nice	To never give up	____ is persistent because ____
Brave H-19 N-0	·to face your fears ·you're not scared of anything ·to be strong when you're scared not afraid to go somewhere	·To face your fears in a scary situation	____ was brave when ____.
Peaceful H-13 N-6 full of	·you don't use violence ·there's no harm around ·to help people ·to relax ·to not hurt someone	·Full of peace ·To not use violence against others	____ was peaceful because ____
Generous H-13 N-6	·to be kind ·to be nice ·to share ·to not yell at people ·to share even if you don't want to	·To be very giving	____ was generous because ____
Segregation H-13 N-6	·to separate** ·to put in groups ·to separate groups of people* ·to separate white people from black people	·To separate people because of their skin color or religion	Segregation was unfair because ____

Using Mathematics and Computational Thinking:

As is:	Opportunity to Include:
•Students weigh dry and soaked seeds and subtract to find difference.	•Student measure length and width and draw to-scale models of the dry and soaked seeds to find difference in size. •Students could measure how much liquid is missing from the cups. You would need to seal the cup with a lid to prevent evaporation from affecting results. •How many times larger is the soaked seed than the dry seed? Twice as big? Three times as big? How can you tell? •How much more area is taken up by the soaked seed than the dry seed?

INVESTIGATION 2: GROWING FURTHER

How Does a Sprouting Seed Change Over Time?

Part 1: Germination

*What are the parts of a **plant** and how do they help the plant survive?*

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
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Modifications to Part 1

As Is	Shift to NGSS 3-Dimensional
Students sort seedlings for certain properties. Students compare properties in different seedling types. No information is recorded.	Students sort seedlings, then place in order from least amount of change to most. This illuminates the pattern of change for each plant type and makes it more visible. Students may sketch the steps of the pattern as a model of change. Students compare the properties in different seedling types, record their comparisons, and write comparing statements. Students draw labeled models of each seedling type, including length and width.

Observe, Sort, and Compare Patterns in Seed Development

- Carefully observe your seeds and seedlings.
- Sort them into groups by type of plant.
- For each group, place them in order from left to right showing the least amount of change from a dry seed to the most amount of change.
- Compare each group. Do the different types of seeds have similar amounts of change? Are some seed types farther along in the germination process?
- Write comparing statements for your groups. What words do scientists use to compare things?

Patterns in Germination

- Bean seeds follow a natural pattern during germination as they change from a dry seed to a seedling.
- There are 6 steps in the whole process, but you may not see all 6 steps yet in your specimens.
- Look at your bean seed specimens.
- Can you find 6 separate steps in the process? (The first step is a dry seed with no change.) If you don't observe 6 steps, can you infer what they would be?
- Do the other types of seeds follow the same pattern of development?

Bean Seed Pattern of Development

- Check your sorts- did you place them in order from left to right showing this pattern of steps in seed germination?
- Step 1- no change (seed same size)
- Step 2- swollen seed (may be split)
- Step 3- has the seed coat off or partly off
- Step 4- has a root developing
- Step 5- has a root and stem developing
- Step 6- has a root, stem, and leaves developing

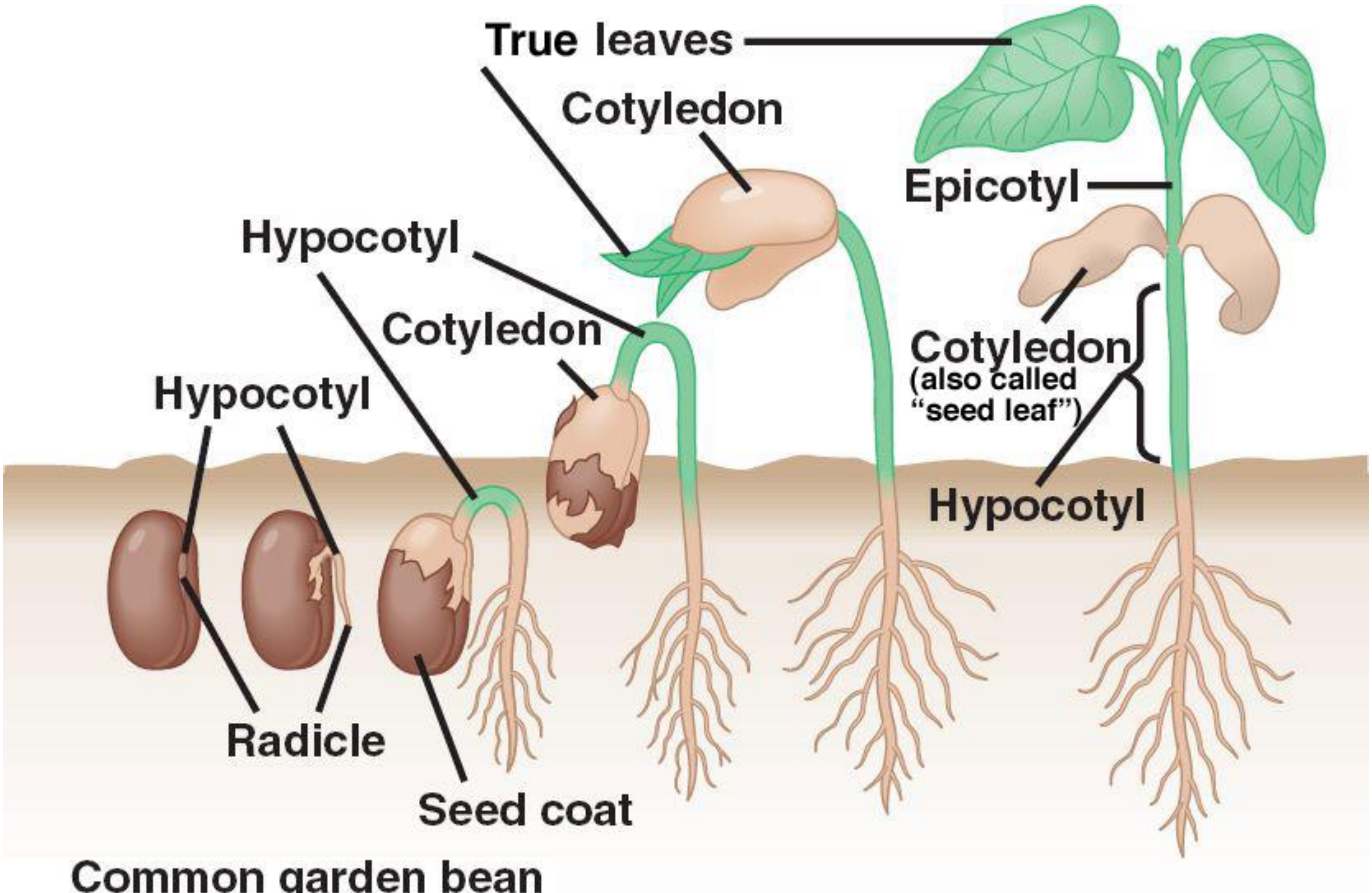
Visual Model of Seedling Systems

- Choose one specimen for each of the four seed plant types to sketch and label.
- Measure the length and width of the specimen.
- Draw and label the model with its name and the names of its parts (subsystems).
- Label the length and width. (You could also draw it to scale –actual size)
- Possible organizer- next slide.

Seedling Models Organizer

Bean Seedling	Pea Seedling
Labeled Diagram Properties and Observations:	Labeled Diagram Properties and Observations:
Sunflower Seedling	**Popcorn Seedling**
Labeled Diagram Properties and Observations:	Labeled Diagram Properties and Observations:

Germination Process



The Structures (parts) of a Plant and Their Function

- **Root or Radicle-** the first part that you see growing from the seed. Grows downward and serves to absorb water and nutrients.
- **Stem-**grows upward and carries water, nutrients, and sugars upward and downward in the plant.
- **Cotyledon-**serves as the food source until the plant's leaves can begin making food (sugars).
- **Leaves-** Convert sunlight into food (sugars) using water, and carbon dioxide through the process of photosynthesis.

Why is This Important?

- How and why do patterns occur in nature?
- How are patterns seen in life cycles?
- Do all seeds have patterns of germination?
- Why do scientists study the life cycles of plants and animals?
- What happens if life cycles are interrupted?

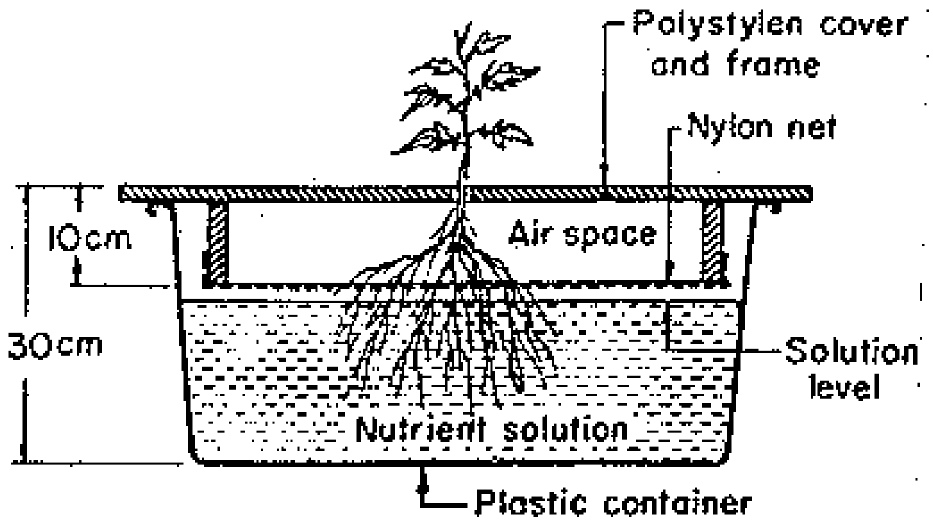
Seed Sprouter Tips from FOSS

- It is very important to make sure the seed sprouter is clean before using it. A few drops of bleach in the cleaning water will help.
- Bleach water recipe-2 Liters of water to 5 mL of bleach (1 teaspoon)
- Remove any moldy seeds immediately and use the bleach water as directed at that time.
- Friday afternoon care is important if the sprouter is to go over a weekend.

Investigation 1: Science Text

- Pages 3-21 in Structures of Life Text

Part 2: Hydroponics



How does water help plants grow?

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Modifications to Part 2

As Is	Shift to NGSS 3-Dimensional
Students put together hydroponics tubs.	Students discuss and identify how the new hydroponics tubs are systems. Students draw labeled diagrams of the hydroponic systems and explain how they work. What are the subsystems of the system? What is the role of each subsystem? What happens to the system if one of these subsystems is missing or not working correctly? Opportunity for Investigation: Students may perform a scientific investigation comparing hydroponically–grown plants to those grown in soil. Or, they may grow the other seeds hydroponically and compare them to the bean seeds. Does one seed type do better hydroponically?

Activate: How will plants react to growing in water only?

- ***John-*** I think some of the plants will die without soil.
- ***Ann-*** I think the plants will be shorter and less green. I also think they will have leaves that are smaller in size.
- ***Sara-*** I think the plants will grow normally, the same as they would grow in regular soil.
- ***Bob-*** I think they will grow even better in water instead of soil. They will be taller and greener, with larger leaves.

Which person's claim do you most agree with and why?

Write down your claim, any evidence that supports your claim, and an explanation of how your evidence helps prove your claim could be true.

Science Misconceptions

What do plants need to grow?

- Sun
- Water
- Air
- Good Soil with nutrients
- Temperature
- What do kids need to be healthy?

*Can you spot the science misconceptions on this slide taken from the Internet? What do plants actually **need** to live and grow? Why?*

Student Notebooks- What do plants actually **need** to grow and why?

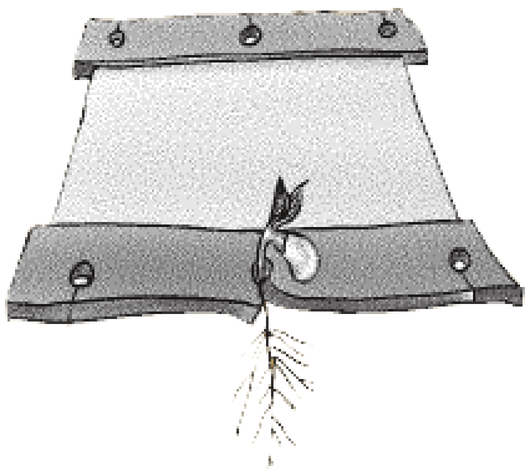
Element	Function
Water	Holds nutrients, Needed for photosynthesis (making food) Needed for plant cells
Light	Needed for photosynthesis
Air	Needed for photosynthesis
Temperature	Must be in range of plant tolerance
Soil	Holds plant upright Holds nutrients

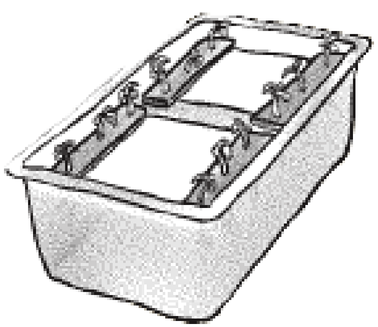
Which element could replace one of the other elements and why?

Recipe for plants to make their own food (photosynthesis) in their leaves.

Water + Light + Air (Carbon Dioxide) = Glucose (sugar)

Hydroponics Systems





FOSS Teacher Preparation Video

- http://archive.fossweb.com/modules3-6/StructuresofLife/teacher_videos_old.html

Insert Seedlings

- Carefully insert a seedling into the floating holder.
- The root should be below the holder and the stem and leaves above.
- The roots can break off, this is a good opportunity to discuss what will happen to a seedling that loses its roots.
- Are roots a critical subsystem of plants? Why?

Investigation Opportunity

- This offers an excellent opportunity to compare plants grown in soil to plants grown hydroponically (manipulated variable).
- Be sure to choose seedlings the same size and health to compare(controlled variable).
- Be sure to water the soil-grown plant with nutrient water (controlled variable).
- Collect descriptive and numerical data and compare(responding variable).
- Discuss and write conclusions.
- An alternate question would be, "Which plant type will grow the best hydroponically?" (define best)

Why is This Important?

- What do plants actually need to grow and be healthy?
- How do they obtain these things in nature?
- What happens if they cannot obtain one or more of these things?
- If plants cannot grow, how does that affect:
  - Animals
  - People
  - Other plants
  - The environment

Part 3: Life Cycle of the Bean

How do bean plants change over time?

3-LS1 From molecules to Organisms: Structures and Processes

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Students who demonstrate understanding can:

3-LS1-1. **Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.** [Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop models to describe phenomena. (3-LS1-1)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns. (3-LS1-1)

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)

Crosscutting Concepts

Patterns

- Patterns of change can be used to make predictions. (3-LS1-1)

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.LS1.B (3-LS1-1)

Common Core State Standards Connections:

ELA/Literacy —

RI.3.7 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). *(3-LS1-1)*

SL.3.5 Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details. *(3-LS1-1)*

Mathematics —

MP.4 Model with mathematics. *(3-LS1-1)*

3.NBT Number and Operations in Base Ten *(3-LS1-1)*

3.NF Number and Operations—Fractions *(3-LS1-1)*

3-5-ETS1 Engineering Design

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Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

3-5-ETS1-3. **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K- 12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- 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. (3-5-ETS1-1)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

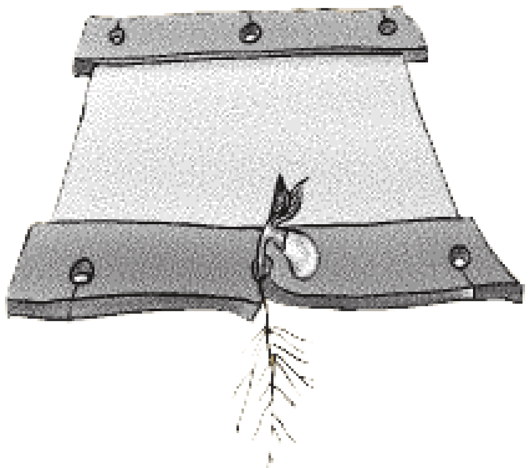
- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

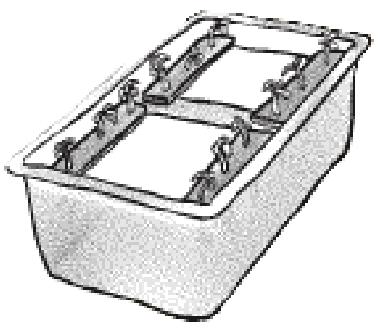
SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. **Constructing explanations and designing solutions.**	6. Structure and function
7. Engaging in argument from evidence	**7. Stability and change**
8. Obtaining, evaluating, and communicating information	

Modifications to Part 3

As Is	Shift to NGSS 3-Dimensional
Students measure plant and water heights using string or post its. Students are told how to build a bean pole support using straws.	Students use standard measurement tools and units to measure and record data in a table, then graph to show change over time. Is there a pattern to plant growth? Can the amount of growth be predicted? Students solve the problem of bean plant support by engineering a bean pole system using available materials and constraints.

Hydroponics Systems





FOSS Teacher Preparation Video

- http://archive.fossweb.com/modules3-6/StructuresofLife/teacher_videos_old.html

Insert Seedlings

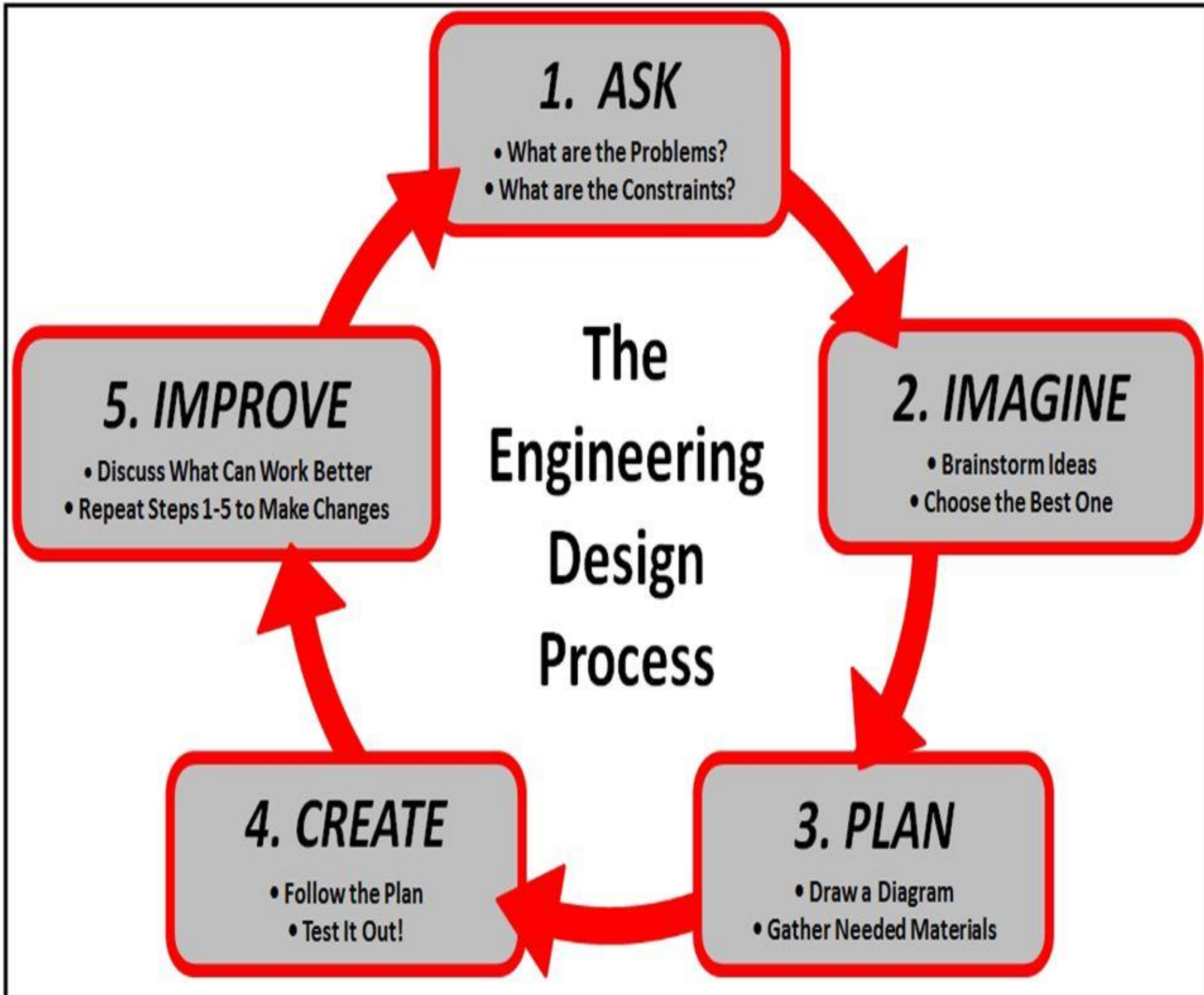
- Carefully insert a seedling into the floating holder.
- The root should be below the holder and the stem and leaves above.
- The roots can break off, this is a good opportunity to discuss what will happen to a seedling that loses its roots.
- Are roots a critical subsystem of plants? Why?

Opportunity for Engineering

- Instead of telling students how to construct bean poles using straws and string, ask students to become engineers to solve the problem themselves. Assign each group to design and construct a prototype (possibly using shoe boxes as basins).
- ***How can we build a support system using available materials that will hold up the bean plants when they start getting too tall to support themselves?***
- What properties will be needed in the construction materials? Why?
- Teams present their prototype and labeled model.
- Discuss prototypes. Select a final design or final two designs to actually use with the 2 hydroponic basins.

Steps to Engineering

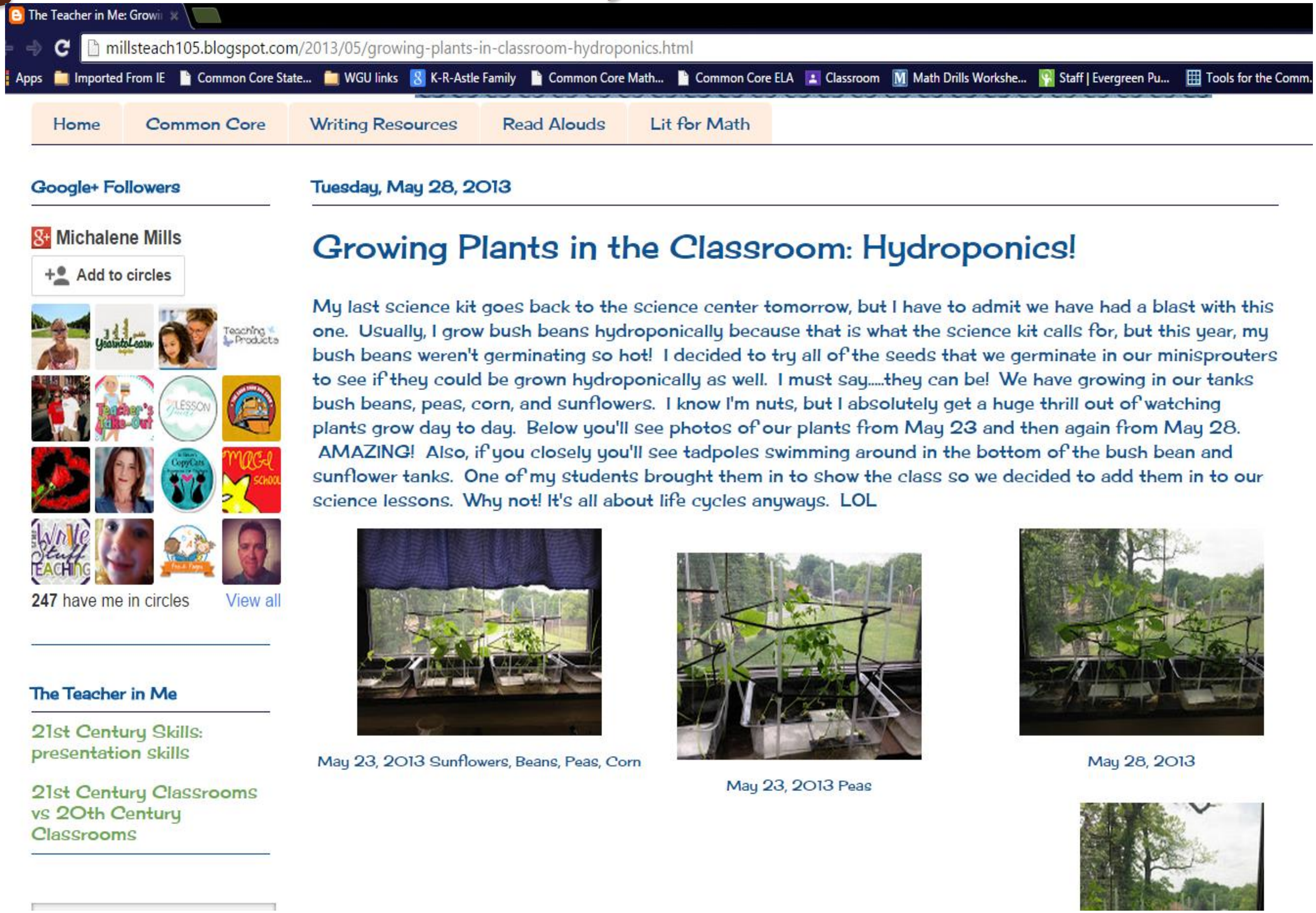
- **Ask a question** or identify a problem or need.
- **Visualize** several possible solutions or plans, **draw labeled models** of these possible solutions.
- **Choose** the solution that seems most likely to work. **Develop a plan.**
- **Build** the solution plan.
- **Test and improve** the plan as many times as needed- or abandon and select a new plan.
- **Share** final results.


1. ASK
• What are the Problems?
• What are the Constraints?
2. IMAGINE
• Brainstorm Ideas
• Choose the Best One
3. PLAN
• Draw a Diagram
• Gather Needed Materials
4. CREATE
• Follow the Plan
• Test It Out!
5. IMPROVE
• Discuss What Can Work Better
• Repeat Steps 1-5 to Make Changes
The Engineering Design Process

Engineer a Bean Support System:

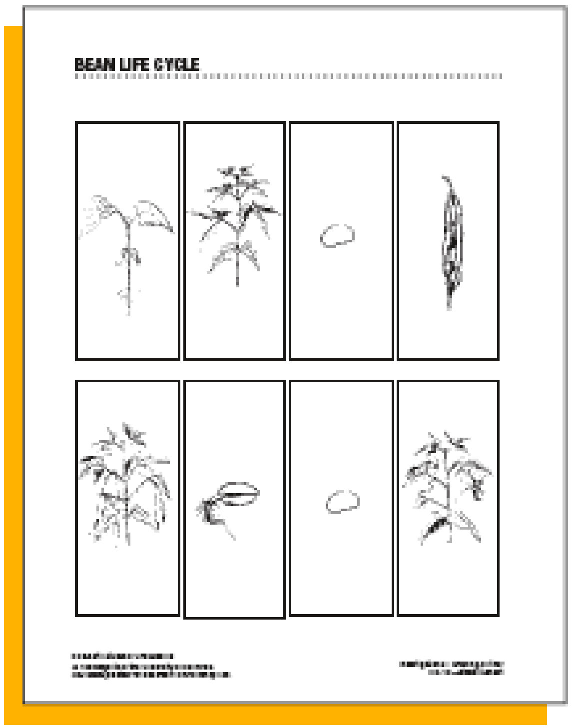
- With your small group, design a support system that will securely hold up the long, drooping bean stems and leaves.
- You must use materials readily available in your kit, in your classroom, or brought from student homes.
- No materials may be purchased for the support system. Consider what materials will work well near water.
- Draw a labeled model of your system. Include an explanation for each part and its role. Prepare to share your design.

Blog- *The Teacher in Me, The Teacher in You*



- http://millsteach105.blogspot.com/2013/05/growing-plants-in-classroom-hydroponics.html

Bean Life Cycle Challenge



1. Cut out the steps in a bean's life cycle.
2. Place them in order from left to right, tape down when you are sure.
3. Below each step, write a complete sentence to describe what is happening in this step.
4. Use sequencing words: first, next, then, after that, soon after, finally.

Bean Life Cycle

Why is This Important?

- Engineers solve problems and provide for needs through design and material use.
- How has our lives changed because of engineering?
- How does engineering affect nature?
- How do plants obtain their needs for survival?
- What structures help them obtain their needs?
- How do plants change over time?

Using Mathematics and Computational Thinking:

As is:	Opportunity to Include:
•Students use a string to measure approximate height of plants, then use the string to record height on a growth chart.	•Student use centimeters to measure the height of plants and record in a table. •Students graph plant height using data from the table. •Students could measure, record, and graph length and width of specific leaves. Do all leaves grow the same amount? •Do plants grow a predictable amount each week? Can we see a pattern? •Students could measure and record the changing height of the water level. Is there a pattern to water loss?

Investigation 2: Science Text

- Pages 22-33 in Structures of Life Text

INVESTIGATION 3: MEET the CRAYFISH

Crayfish Arrival

- **Preparing for crayfish arrival.** A day or two before you expect the crayfish to arrive, prepare their habitat. Fill two bus trays about one-third full of cold tap water (3–4 cm deep). Keep the trays out of sight in a cool, dark place. **Let the water sit for a day or more to release chlorine from the water (aged water**).

- **What to do when they arrive**. The crayfish will arrive in a cardboard box packed with damp paper or moss. Alert the school secretary to notify you as soon as they come. Immediately upon arrival, cut open plastic bag to provide air. Carefully remove crayfish from the bag, grasping each from behind to avoid the strong pincers. Place them gently in their new home. Aquatic plants (Elodea) shipped with the crayfish can be rinsed in clean dechlorinated or spring water and used as both food and "hiding" places for the crayfish.

- **Find a place for the crayfish**: Plan where the bus tray(s) with the crayfish will reside in your room for up to several months. They need to be cool, out of direct sunlight, and safe from being spilled.

- **Escape Artists! Crayfish are climbers and will climb out of their tray at night if there is anything for them to stand on or grab onto (Evergreen- bubblers). Cover their tray with the FOSS kit lid at night to prevent them from escaping and dying.**

Crayfish Handling and Habitat

- **Handling the crayfish**. Practice picking up the crayfish so that you can demonstrate the proper technique for your students. Approach the crayfish from behind. Grasp it firmly on the carapace (body shell) behind the pincers. Pick it up. Crayfish pose no health hazard for students. They do not carry diseases. Occasionally you will see white wormlike animals attached to the crayfish carapaces and pincers. They are harmless to both humans and crayfish.

- **Provide aquatic plants**. Buy or collect from a local pond some small aquatic plants for the crayfish. We recommend getting 6–12 sprigs of Elodea. **You can store the extra Elodea in a separate basin of aged water to keep it healthy. If you add all the Elodea at once to the crayfish tub, they will eat it quickly.**

Crayfish Care and Feeding

- Crayfish need ample clean, cool water and sufficient food in order to be healthy in your classroom. It is impossible to get the water too cold (short of freezing), but it is easy for it to get too warm. Try to keep the temperature between 5°C (41°F) and 20°C (68°F).

- Crayfish like to eat frozen or canned corn and peas and pieces of raw potato. They also love small pieces of hot dog. **Always move the crayfish out of their home tray and into a basin with 3–4 cm of water to feed them.** Leave them there for about 1/2 hour. (If they don't eat, they aren't hungry.) Then return them to their home tray. The other food source that is always available is the Elodea that stays with the crayfish in their home trays. **Cat food is in your kit, and is recommended by FOSS, but crayfish don't like it and won't eat it.**

- **Make sure there is Elodea in their tub over the weekend as a food source.** An alternative green food source that seems to work with crayfish is Swiss chard. The leaves serve as a food source and shelter for the crayfish. Remove the chard after several days in the water.

- This feeding routine can be followed every day other day if the crayfish are actively eating, and less frequently if they are not. While they are in the feeding basin, the home tray can be rinsed and filled with fresh water. This should be done about once a week-more often if the water begins to smell bad.

Maintain Their Habitat/Oxygen

- The Crayfish habitat should have the water replaced with clean, aged water every few days while they are in their food tub to provide oxygenated water and to remove waste.
- Be sure to replace the water on Fridays so they have enough oxygen over the weekend.
- If you don't have a bubbler, make sure they have something to stand on in the middle of the tub so they can get oxygen if your water is low on oxygen.
- They can get oxygen from the air, but their gills have to be wet to pass the air over them.
- Note that being able to climb out of the water is an essential requirement if the water is not aerated or filtered; crayfish need lots of oxygen, and in still water conditions, such as in a tank without a filter or airstone, they will get the oxygen they need from the air. But if they can't climb out of the water easily, they will effectively drown.

Crayfish and Molting

- Periodically the crayfish slides out of its old, hard shell in a process called molting. The "naked" crayfish that emerges is actually covered in a complete and perfect shell, but it is soft and flexible, allowing the crayfish to expand and grow.

- **The crayfish is soft and vulnerable and should be removed to its own basin along with its molt. It needs to eat the molt to reclaim the calcium and help it re-harden. Crayfish are known to attack and eat just-molted crayfish.**

- After a day or so the new shell will become hard, again affording the animal the protection of an armored exterior.

- In preparation for molting the crayfish withdraws most of the calcium from its shell, and stores it in **two white "tablets" in the sides of its head**. Calcium is a major hardener in the crayfish shell, as it is in strong human bones and teeth. With this precious supply of calcium the new shell can harden in a matter of hours instead of days or weeks.

Part 1: Meet the Crayfish

How do the structures(parts) of a crayfish help to keep it alive?

3-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can:

3-LS3-1. **Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [*Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.*]

3-LS3-2. **Use evidence to support the explanation that traits can be influenced by the environment.** [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)

Disciplinary Core Ideas

LS3.A: Inheritance of Traits

- Many characteristics of organisms are inherited from their parents. (3-LS3-1)
- Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)

LS3.B: Variation of Traits

- Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)
- The environment also affects the traits that an organism develops. (3-LS3-2)

Crosscutting Concepts

Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1)

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2)

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
1.LS3.A (3-LS3-1); **1.LS3.B** (3-LS3-1); **MS.LS1.B** (3-LS3-2); **MS.LS3.A** (3-LS3-1); **MS.LS3.B** (3-LS3-1)

Common Core State Standards Connections:

ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS3-1),(3-LS3-2)
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS3-1),(3-LS3-2)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1),*(3-LS3-2)*
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS3-1)*,(3-LS3-2)
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS3-1),(3-LS3-2)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS3-1),(3-LS3-2)*
MP.4	Model with mathematics. *(3-LS3-1),(3-LS3-2)*
3.MD.B.4	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. *(3-LS3-1),(3-LS3-2)*

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
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5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

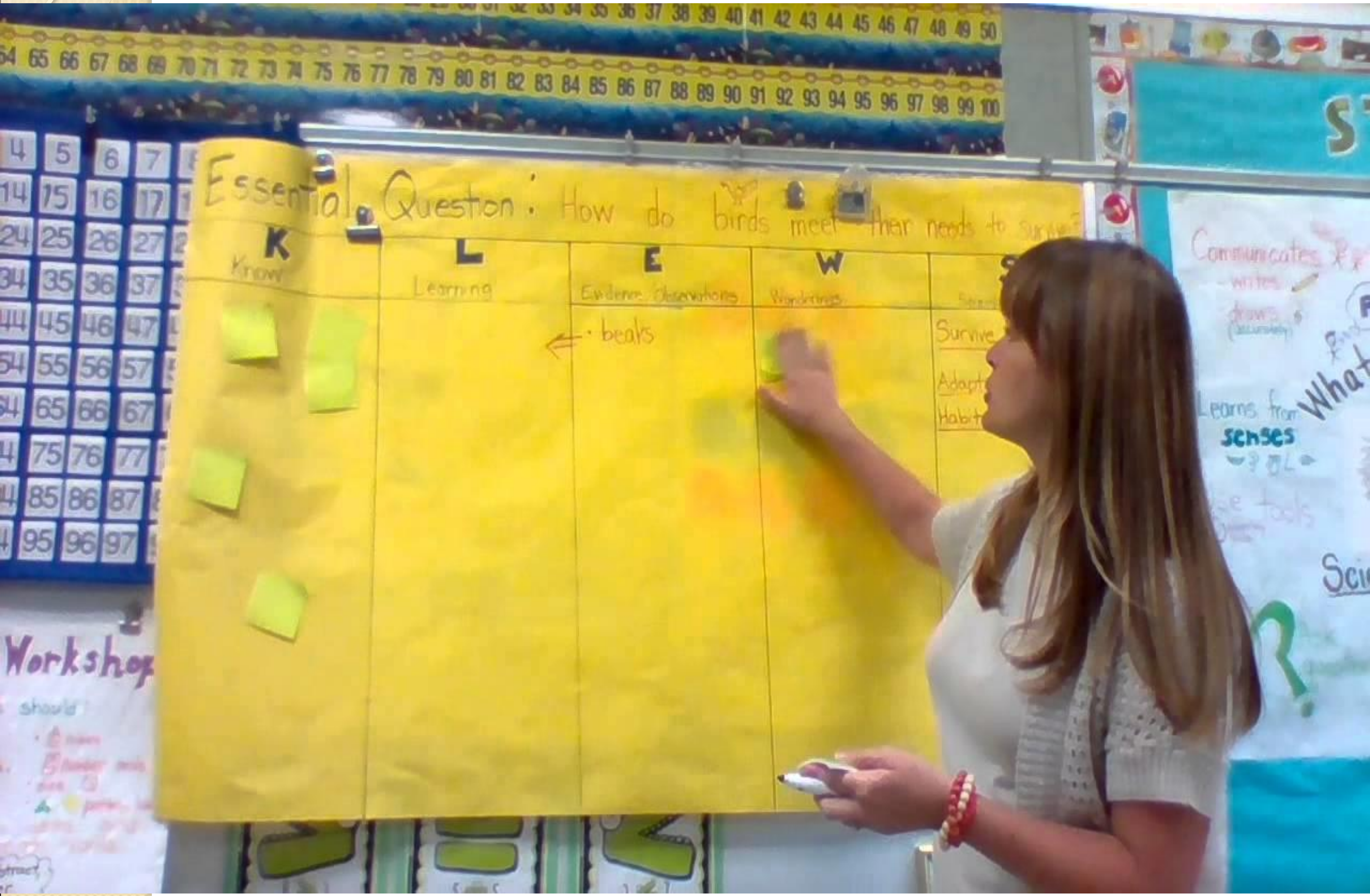
Modifications to Part 1

As Is	Shift to NGSS 3-Dimensional
Students observe crayfish, add labels to a drawing, and answer questions about their structures.	Students draw their own model of a crayfish and label the parts. They write to explain their functions as well. Students use a Claims-Evidence-Reasoning format to discuss structures. Students use a KLEWS chart to engage in claims, evidence, questioning, and concept-building over the course of the investigation. Add a math investigation: *What's the Area of a Crayfish?*

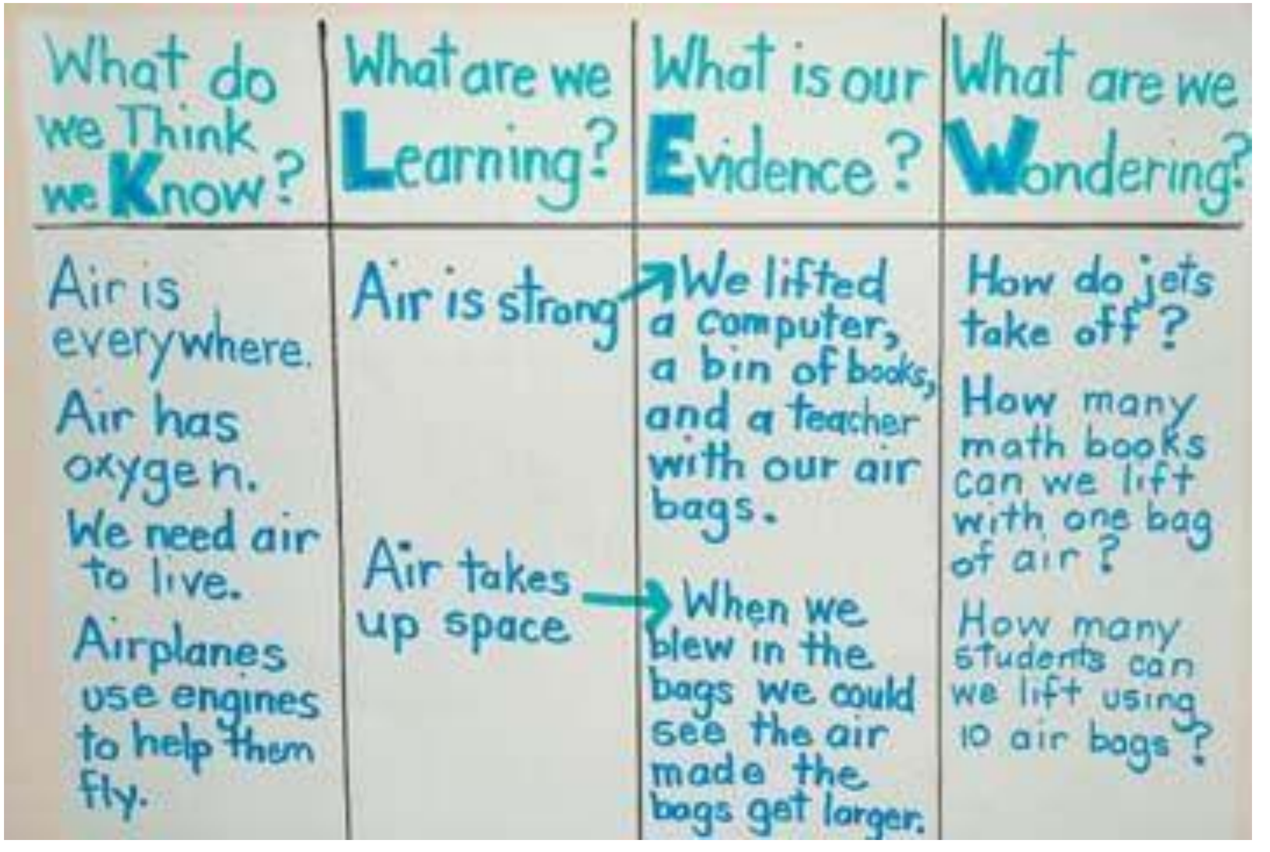
KLEWS Charts (5 columns)

- **K (KNOW)-** What do we THINK we know? (Beginning ideas and prior knowledge)
- **L- (LEARN)**What did we learn/discover? (claim)
- **E- (EVIDENCE)**What is our evidence for this claim?
- **W- (WONDER)**What do we wonder about the phenomena? (testable or researchable questions)
- **S- (SCIENCE WORDS and IDEAS)**What science ideas and words make our explanation stronger? (vocabulary, terminology, and science concepts)


ADAPTATIONS
What makes it an insect?
What we think we Know
(Claims) Learning
Evidence
Wondering
Science words/
Concepts
Insects have:
-3 body parts-
-exoskeleton
-antennae
-6 legs
Are cockroaches insects?
Yes. They are insects because they have 6 legs, 3 body parts (head, thorax, abdomen), antennae, and an exoskeleton.
What adaptations do cockroaches have to help the species to survive?
exoskeleton
thorax
helmet for head
antenna
6 legs
When we touched the cockroaches we heard them "hiss". We observed the head under the helmet.
What makes an animal an insect?
What are the body parts of an insect?
How many legs does an insect have? Are their legs like straight lines?
Do insects have skin and bones?
What is the difference between moths and butterflies?
Are spiders insects?
What kind of larva do moths have?
Why do moths like light?
How many legs on a
Do all adult insects have wings?
What is an adaptation?
Adaptations are features that help plants or animal species to survive. They can be structural or behavioral.
Creepy Crawlies
Butterflies
INSECTS



Essential Question: How do birds meet their needs to survive?
K
Know
L
Learning
E
Evidence Observations
W
Wonderings
· beaks
Survive
Adapt
Habit
Communicates
Learns from senses
What
Workshop
should



What do we Think we Know?	What are we Learning?	What is our Evidence?	What are we Wondering?
Air is everywhere. Air has oxygen. We need air to live. Airplanes use engines to help them fly.	Air is strong →	We lifted a computer, a bin of books, and a teacher with our air bags.	How do jets take off? How many math books can we lift with one bag of air?
	Air takes up space →	When we blew in the bags we could see the air made the bags get larger.	How many students can we lift using 10 air bags?

Crayfish and Kids

- Crayfish look scary and weird, you **will** have students who are very afraid of them.
- Yes, they **will** pinch you! It's their defense mechanism. Some of them are very flexible.
- They also flap their tail to try and swim away, so this can seem scary to students and may splash water all over which can surprise students.
- You may wish to discuss with students ahead of time as to why crayfish have behaviors such as pinching and flapping their tail.
- Prepare them ahead of time and practice what they will do if they get pinched or if the crayfish does a tailflap.

What Are Crayfish?

- **Crayfish**, also known as **crawfish**, **crawdads**, **freshwater lobsters**, or **mudbugs**, are freshwater crustaceans resembling small lobsters, to which they are related.

Crayfish Observation

- Scientists learn from carefully observing things they want to understand.
- What might we be able to learn about crayfish from observing them?
- Their structures?
- Their behaviors?
- How they react to things?
- How they are the same and different from other crayfish?

Set up a Claims-Evidence-Reasoning Chart (C-E-R)

Crayfish Observations

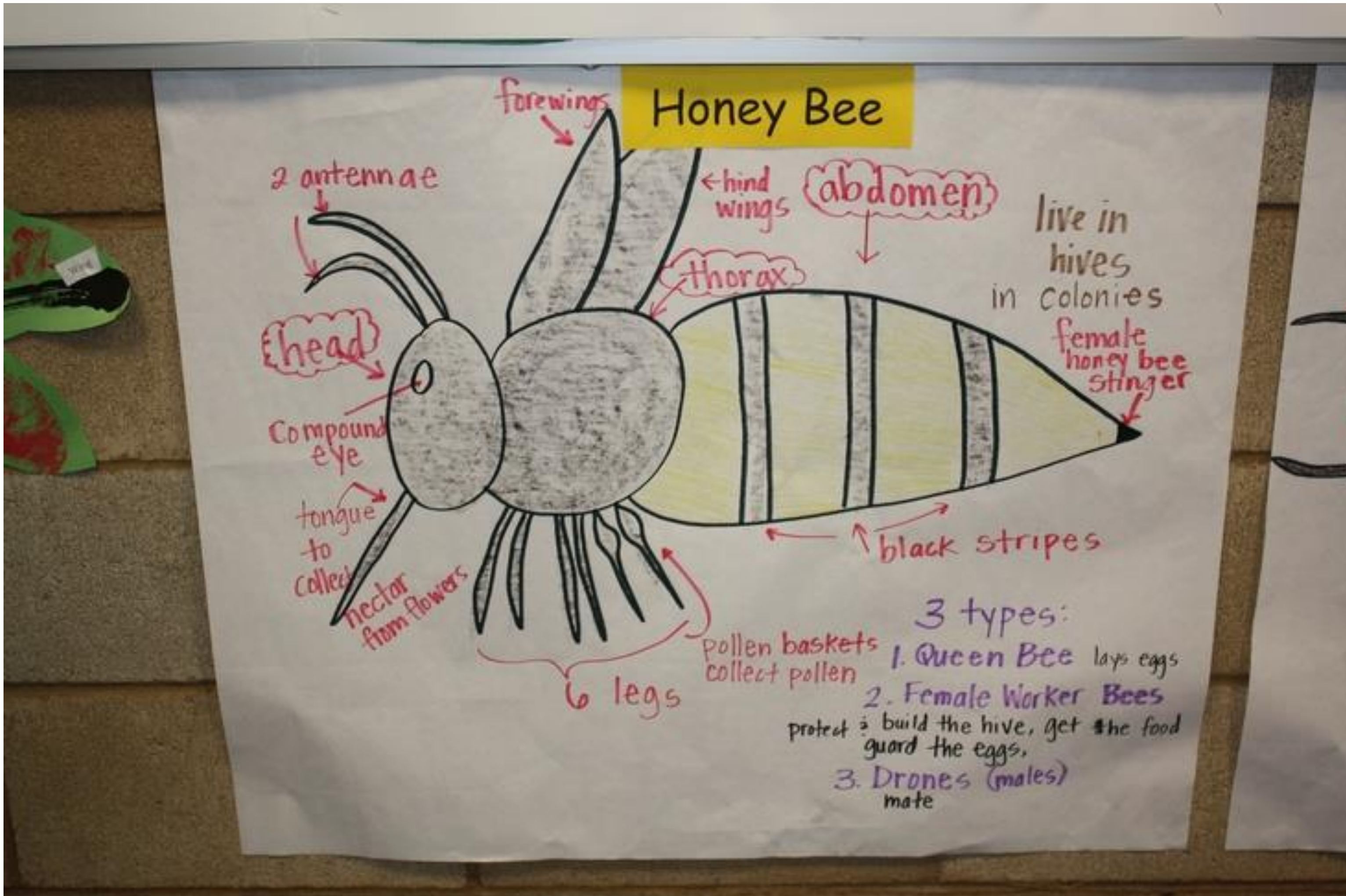
Claim	Evidence	Reasoning (explanation)

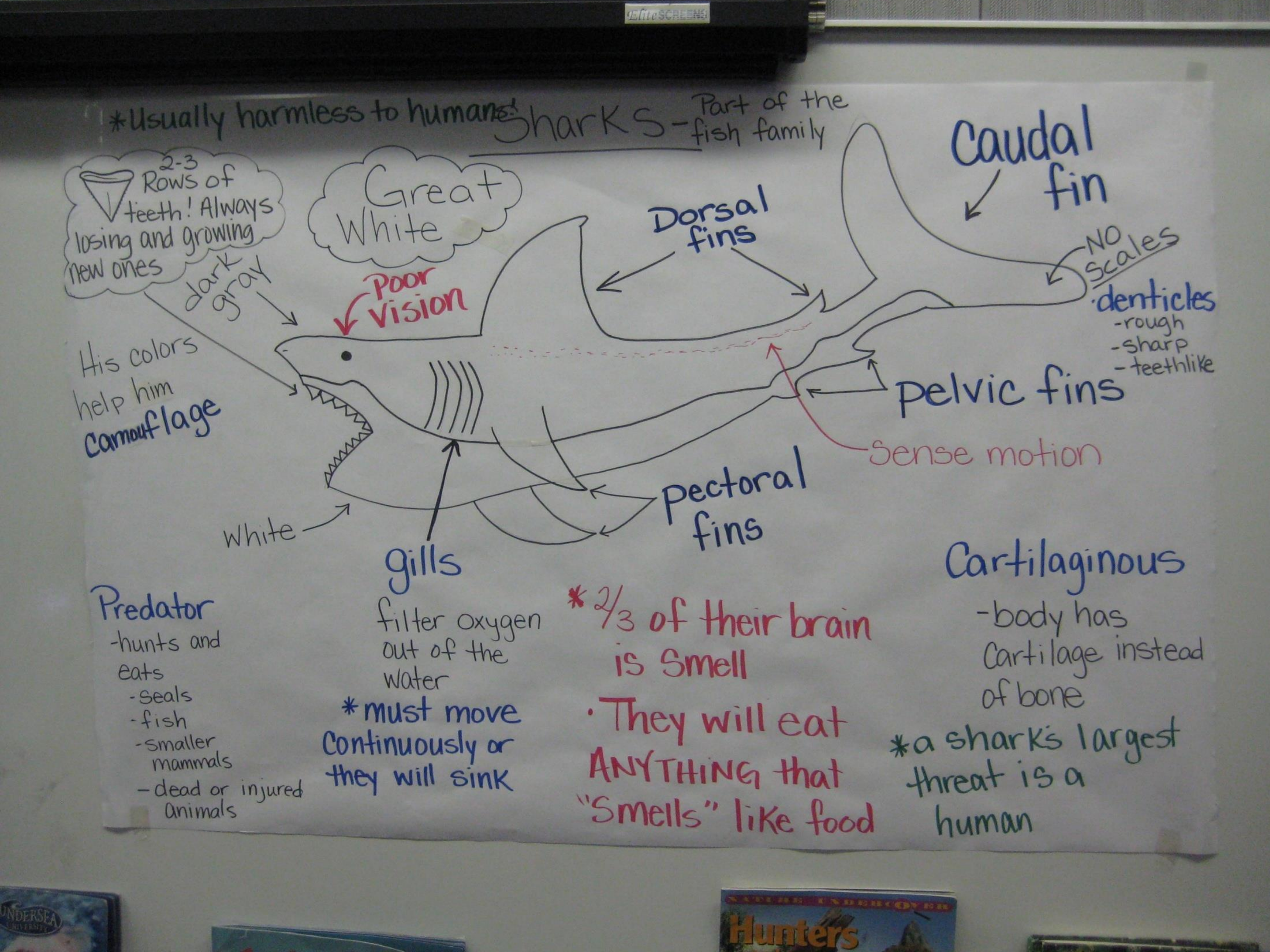
Claims and Evidence Questions

1. Do crayfish have **ears**? Can they hear? What's your evidence?
2. Do crayfish have **eyes**? Can they see? What's your evidence?
3. How many **legs** do you think they have? What's your evidence?
4. What **swimming structures** do crayfish have? How many? What's your evidence?
5. What do they use their **antenna** for? What's your evidence?
6. Do you think your crayfish is a **male or a female**? What's your evidence?
7. Where is their **mouth**? What do you think they might **eat**? What's your evidence?
8. Do you think crayfish have **bones**? Why? What's your evidence?

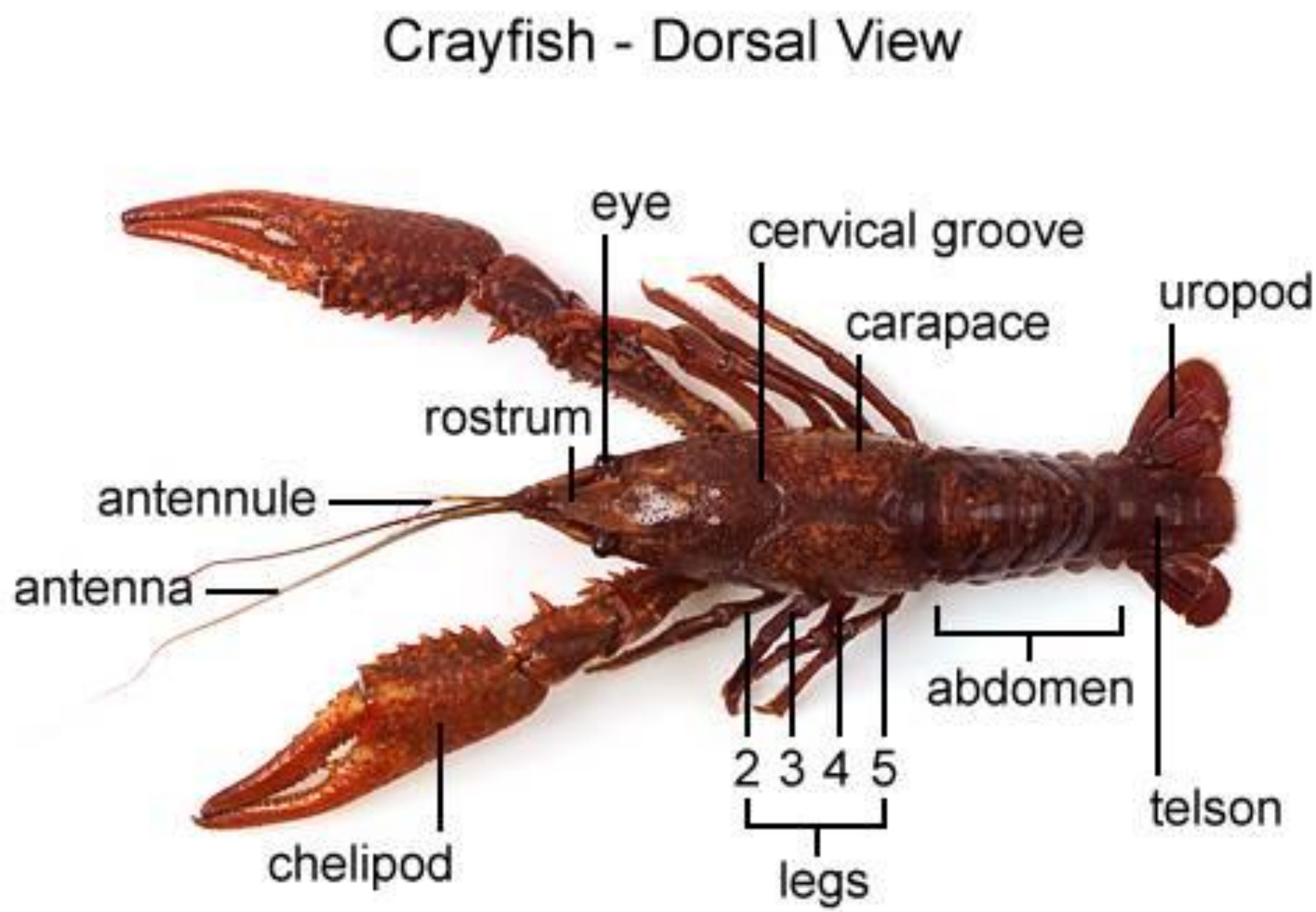
Record any other claims and evidence you think of during your crayfish observation time.

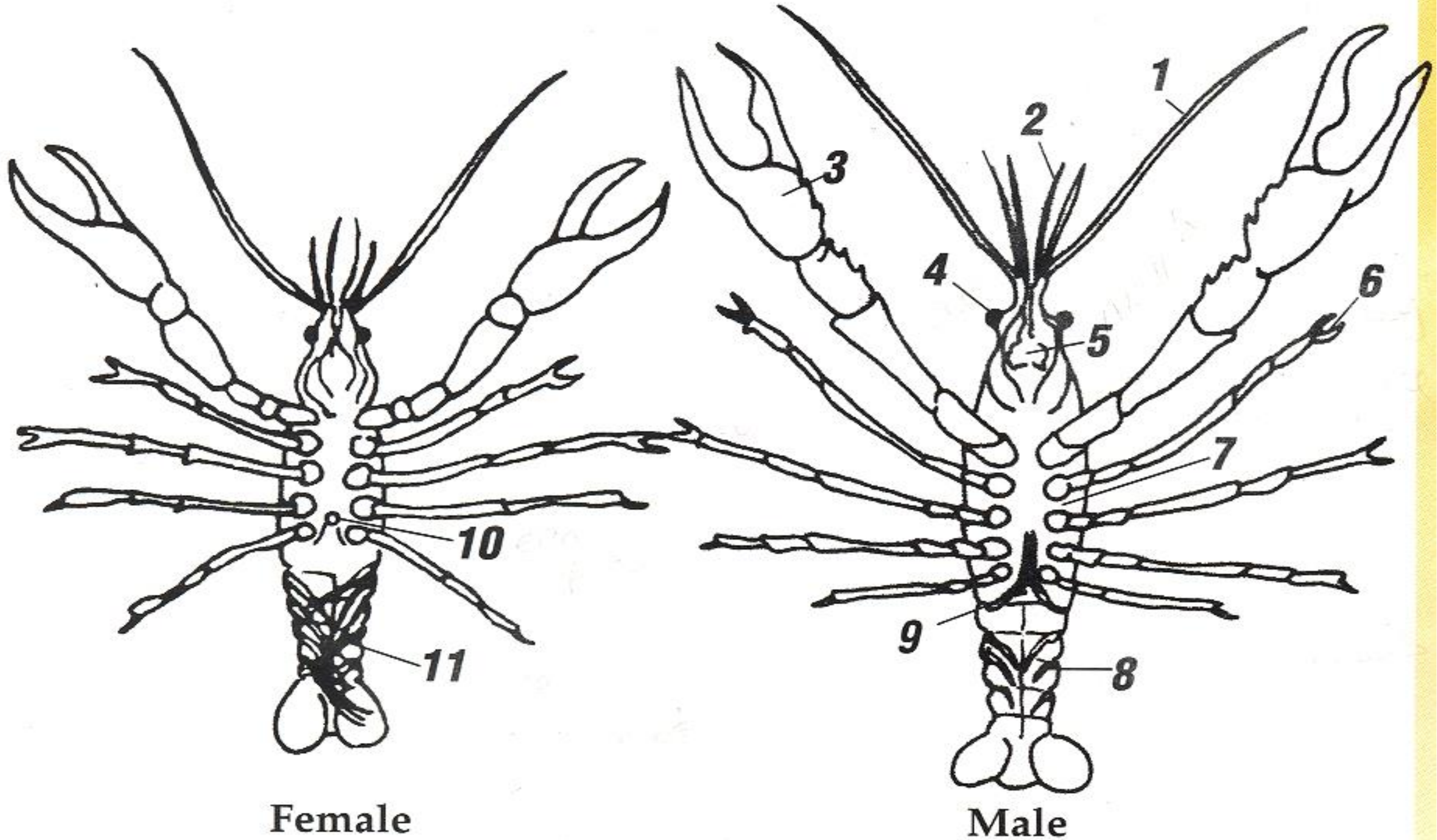
GLAD Strategy Examples: Pictorial Input




*Usually harmless to humans!
Sharks - Part of the fish family
2-3 Rows of teeth! Always losing and growing new ones
Great White
dark gray
Poor vision
His colors help him camouflage
White
Dorsal fins
Caudal fin
NO scales
·denticles
-rough
-sharp
-teethlike
Pelvic fins
Sense motion
pectoral fins
gills
Predator
-hunts and eats
-seals
-fish
-smaller mammals
-dead or injured animals
filter oxygen out of the water
*must move Continuously or they will sink
*2/3 of their brain is Smell
·They will eat ANYTHING that "Smells" like food
Cartilaginous
-body has Cartilage instead of bone
*a shark's largest threat is a human
Hunters

Crayfish Structures





1. Long antenna 2. Short antenna 3. Pincer 4. Eye
5. Mouth 6. Walking Leg 7. Carapace 8. Short Swimmeret
9. Modified Swimmeret 10. Egg Pore 11. Long Swimmeret
(page 13 teacher's manual)

Thinking Question

- Why does the female crayfish have such long swimmerets?
- She holds her eggs and baby crayfish close to her body with her long swimmerets.

Why is This Important?

- What structures do crayfish have that help them stay alive? How?
- What happens to the crayfish if a part is missing or damaged? Why?
- How are living things in the same species the same? Why? How are they different? Why?
- Could a difference help one crayfish survive over another crayfish without that trait?
    - How could this change a group of crayfish over time?

Crayfish Math: What Size is My Crayfish?

CCSS.MATH.CONTENT.3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

- Place the clear bin with water over centimeter or inch grid paper. Place a crayfish in the bin. Photograph from a bird's eye view.
- Or place cm or inch grid paper in a plastic sleeve and place crayfish on top to photo. Do with multiple crayfish so each group can have their own crayfish to measure.
- Print the photo on paper and provide copies to groups to work on.
- Develop the concept of length and width. Students measure, label, and record in a chart the lengths and widths of their crayfish structures as well as the entire length of the crayfish.
- Students find the estimated area covered by the crayfish.(How much ground space does my crayfish take up?) Include the legs for more challenge (fractions of a centimeter). Students can use a ruler to draw in the grid lines covered by the crayfish body, or you can do this before you copy it.
- What about just the area of the carapace? The pincers? Tail? How does the area of the pincers compare to the area of the carapace? Male vs female area?
- Gather data for each group's crayfish in a common class chart. Graph, write comparing equations, create word problems, look for patterns, make claims.

Using Mathematics and Computational Thinking:

As is:	Opportunity to Include:
•Students count parts of crayfish.	•Students measure and record crayfish parts using standard measures (cm) and compare them against other crayfish . •Students find area of crayfish parts using square centimeters.

Part 2: Crayfish Habitat

What do crayfish need in their habitat to be happy and healthy?

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8. Obtaining, evaluating, and communicating information	

Modifications to Part 2

As Is	Shift to NGSS 3-Dimensional
Teacher tells students how to make a crayfish habitat.	Teacher presents students with the need for a healthy habitat. Students engineer the habitat themselves using available materials and constraints.

3-5-ETS1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

3-5-ETS1-3. **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K- 12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- 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. (3-5-ETS1-1)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Opportunity for Engineering

- ***How can we build a habitat system using available materials that will meet crayfish needs and keep them healthy and happy?***

- You may wish to do Part 3 of this investigation first, where students observe crayfish behaviors.

- This would give students more information about crayfish that would assist them in designing a suitable habitat.

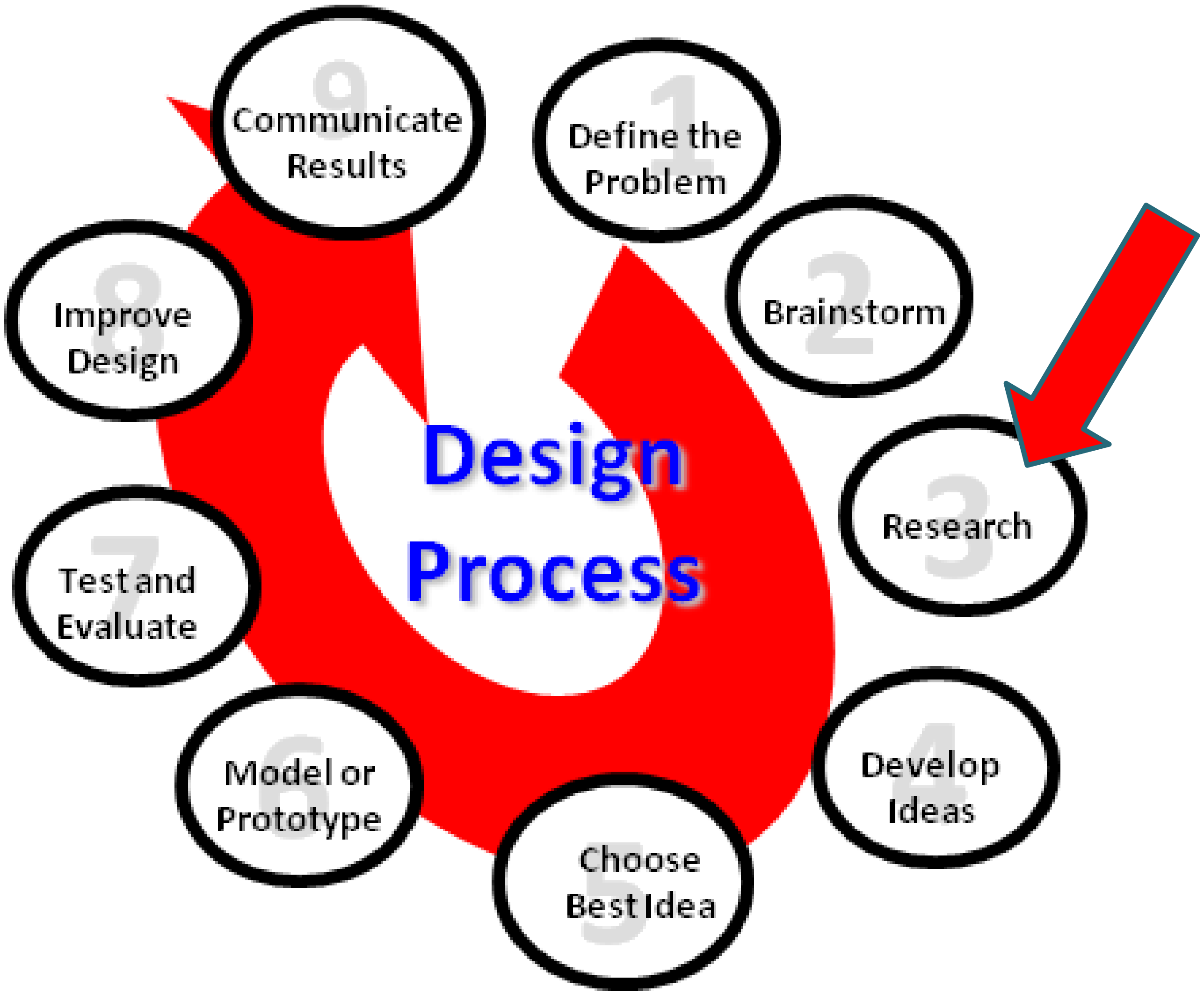
Needs of Crayfish

- What do crayfish need to stay alive and be healthy?
- What elements do we need to think about for their habitat?
  - Food-
  - Water-
  - Air-
  - Space-
  - What else might they like in the habitat?

Engineers and Research

- Engineers often do some research as part of the design process.
- You may wish to assign some investigative questions about crayfish for students to research and share. Or, you can perform some simple experiments to find out.
- What kind of water do they like, fresh or salty?
- Do they like light or dark environments?
- Do they need oxygen? Do they need to stay underwater? Can crayfish drown?
- What temperature do they need?
- What other elements do they like in their habitat?
- You could also observe photos of crayfish in their natural habitats and make inferences about needed elements.

Engineering Process with Research



Crayfish in Natural Environments

Crayfish Class Habitats

Why is This Important?

- Living things need certain elements in their ecosystem to survive and be healthy?
- What happens to the living things if their ecosystems are affected by: drought, pollution, loss of trees or plants, erosion, temperature change?
- Do people cause any of these changes?
- Can people help protect ecosystems?
- Can plants and animals change to survive if their ecosystem changes?

Part 3: Crayfish at Home

How do their behaviors help animals survive?

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	**2. Cause and Effect**
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 3

As Is	Shift to NGSS 3-Dimensional
Students observe crayfish reactions to stimuli.	Students observe crayfish reactions to stimuli and reason about how that behavior helps the animal survive.

Name ____________ Date 11-6-07

CRAYFISH BEHAVIOR

Part 1. What did your crayfish do when you

Left it alone in the basin? Trying to get out

Reached toward it? It stands up and trys to pinch you

Touched its back? It colmes down

Touched its tail? he tacks it under his bottom.

Touched its antennae? it trys to pinch you

Put it on the table? walks around

First put a house in the basin? he haddles up in a corner

Left it for 5 minutes with the house? he went in and curled up

First put another crayfish with it? They both go in diffrent coners

Describe the different ways crayfish can move. forwerd and backwerds

Part 2. Pick a crayfish behavior and explain how the behavior helps the crayfish survive.
They are tute so they can catch food

4

Cause and Effect

Cause	Effect	Purpose: How the behavior might help the crayfish survive
We left it alone in the basin.	The crayfish walked all over and felt around with its feet.	It might have been searching for any food or shelter in a new place.

Why is This Important?

- Animals adopt certain behaviors to help them survive- these are called adaptations.
- How do animal adaptations help them survive in nature?

Part 4: Crayfish Territory

How do scientists learn about crayfish?

Do crayfish like one shelter better than another?

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
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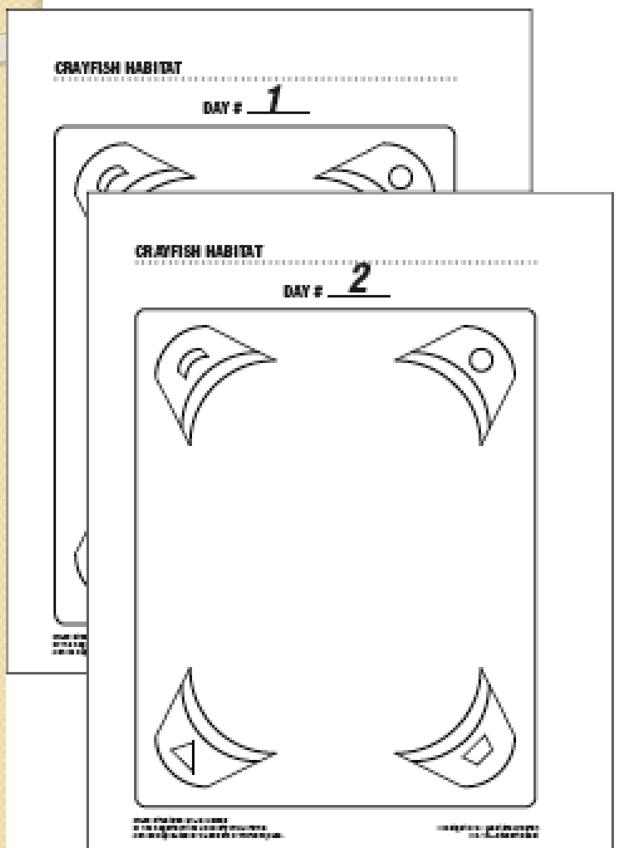
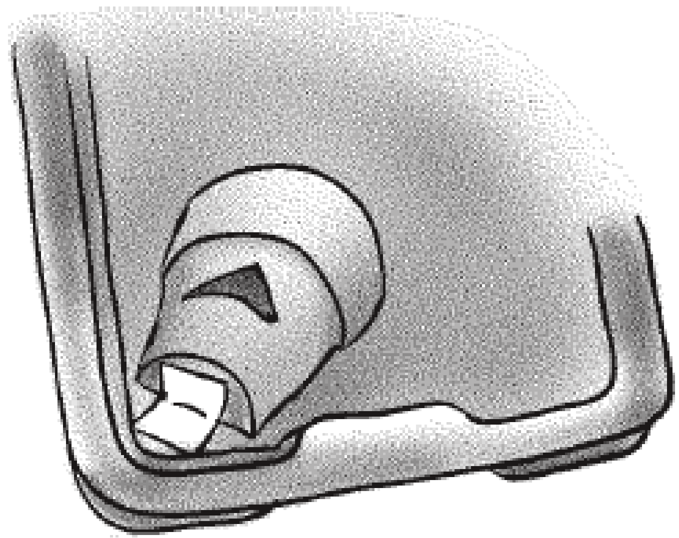
Modifications to Part 4

As Is	Shift to NGSS 3-Dimensional
Students plan an investigation to record crayfish behavior over time- testing crayfish preferences for habitat locations.	
Students record data by drawing a picture of crayfish location.	Students record data mathematically using a table system Students compare the numbers and use them to reason and make claims about crayfish territory and preferences. Students reason about the purpose of territoriality in nature.

Crayfish and Territory





Data Tables

Date	Crayfish 1	Crayfish 2	Crayfish 3	Crayfish 4
Day 1	Square house	Triangle house	Rectangle house	Circle house
Day 2				
Day 3				
Day 4				
Day 5				

Total Number of Times in Each House

Crayfish 1	Crayfish 2	Crayfish 3	Crayfish 4
Square			
Triangle			
Circle			
Rectangle			

Conclusion

- I claim that____________________. I know this because____________________________. Since________________________, this shows that____________________________________.

- This discovery is important because____.

Why is This Important?

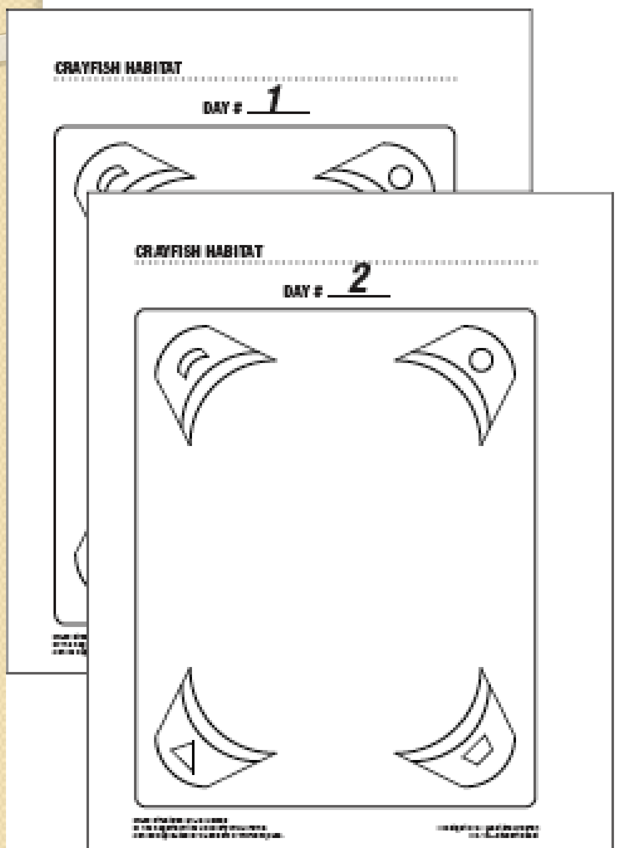
- Students use numerical data to infer about a scientific phenomenon.
- Students make claims and support with numerical evidence.
- How is territoriality a behavior that can help animals survive?

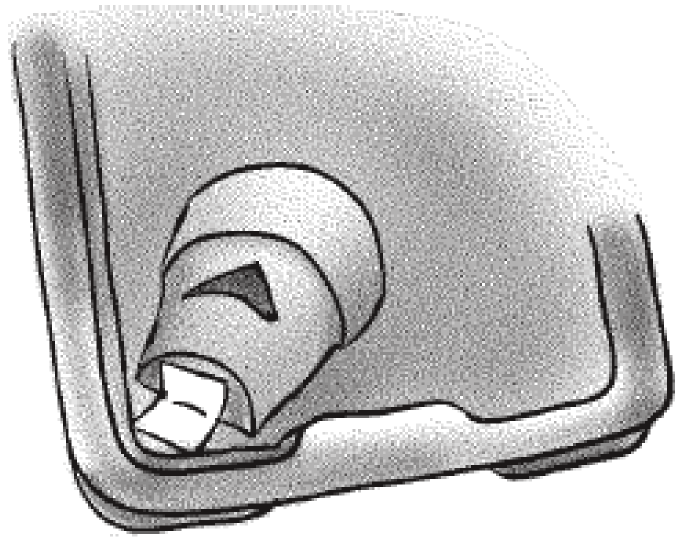
Investigation 3 Science Text

- Pages 34-63 in Structures of Life Text

INVESTIGATION 4: MEET the LAND SNAIL

Crayfish and Territory





What to do when they arrive.

- Land snails are quite hardy and can survive for many days with little food or water. In your classroom, they will live in two clear terrariums with covers (the same type of basins as used for the hydroponic plants).

- Once the snails arrive, place moist paper towels on the floor of each terrarium and spray the interior walls with water. Distribute the snails into the terrariums and provide a few small pieces of carrot or other vegetable for them to eat.

- **Secure the cover with two large rubber bands stretched around the terrariums. If you don't, they will push off the lid and crawl all over your room ☺**

Food

- Snails eat a variety of fruits, leaves and vegetables -- which is why they're commonly regarded as garden pests.

- In captivity, land snails enjoy bits of apple, carrots, lettuce (not iceberg) and cucumber.

- **Supplement their diet with chalk or egg shells.** These contain calcium or lime, which strengthen your snails' shells, help the snails grow and provide nutrients for their eggs.

Maintenance

- Feed the snails two or three times a week. Replace any old food with new food.
- **Spray the walls of the habitat with water two or three times a week, or whenever they seem dry.**
- Always keep the cover on the habitat, with two rubber bands (at least) holding it on.
- **If you don't keep the habitat moist or feed the snails, they will estivate for days or weeks at a time.** This is where they seal themselves into their shell with a thick white fluid to preserve what moisture they do have. No they are not dead, they are dormant.

Cleaning and Handling

- Clean out your snails' terrarium every few days, at least weekly. If they're on the walls or leaves, slide them to the top edge and then pick them up rather than peel them off.
- If they look messy, rinse them quickly under cool water. Spray the walls of the habitat and wipe them clean with paper towels. If you are using paper on the floor of the habitat, replace it with new paper towels.
- Spray the walls with water, and use paper towels or cloth to clean off mucus trails. Throw away uneaten food, clean out waste and replace the leaves.
- **Wash your hands well after touching or moving your snails, and after you clean the terrarium. Snails can pass along salmonella and bacteria.**

Part 1: Land Snails At Home

What structures help a snail survive?

What does a snail need in its habitat to survive?

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1. Asking questions and defining problems	1. Patterns
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4. Analyzing and interpreting data	**4. Systems and system models**
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 1

As Is	Shift to NGSS 3-Dimensional
Students observe snails in a cup. Teacher tells students how to make a snail habitat.	Ask for students to make claims about their snail from observation alone. What's their evidence and reasoning? Begin a KLEWS chart for snails. Add an inquiry activity investigating the question, *"Does the same type of species (snail) have differences among their traits?"* Students observe a snail closely through the lens of traits and measurable characteristics. They record these and use them to identify their own snail from other snails. *What traits did all the crayfish have in common and why? What differences were there ? Why do you think these differences exist in the same species?* Students may repeat the engineering task from Investigation 3. Have students engineer a habitat for the snails. It would be best to wait until after Part 2 to do this, as students observe structures and behaviors in Part 2 that will help them design a habitat.

What Are Snails?

- Mollusks are a large and diverse phyla of invertebrate animals, featuring over 110,000 species.
  Their phylum name, Mollusca, means "thin-shelled," though many species lack shells entirely.
- Mollusks include clams, oysters, scallops, mussels, snails, squid, octopuses, and slugs.
- Some mollusks — snails and slugs — have even adapted to life on land.
- The defining characteristics of mollusks are a muscular foot, especially obvious in the case of snails, and the mantle, a protective dorsal body wall covering the main body from the outside

Land Snail Interaction Tips

- Pick them up by their shell, but don't squeeze too hard.
- If the snail is holding tightly to the desk or cup, slide it sideways as you lift to loosen it.
- If the snail won't come out of its shell, dip it into water for 5 seconds.
- You may wish to spray the inside of the cups with water.

Snail Traits Inquiry

- Investigative question- ***Do living things in the same species (snails) have differences in their traits?"*** (NGSS DCI for 3rd grade)
- Adapted from a unit lesson on Madagascar Hissing Cockroaches by Kimber Hershberger, author of What's Your Evidence?

- Put 1 snail in a clear cup for each group. Label each cup using letters A - ___.
- Develop the meaning of the word "traits".
- Each group gathers observational data for one snail. They draw a detailed, labeled model and record as many traits and characteristics as possible for their snail. (coloration, pattern on shell-both sides, number of whorls on shell, length/width/height of shell, unusual formations etc… with the goal of identifying their snail again later.

Snail Traits Inquiry

- Keep a record of which snail each group actually has, then shift the snails into different labeled cups, keeping a record of which snail was moved to which cup.
- Groups examine each snail and determine if it is their snail or not, using its traits and characteristics.
- They make a claim for each snail,(yes or no) provide data that supports their claim, and explain how the data supports their claim.

Are there differences among traits in snails?

- Draw a detailed model of your group's snail. Include:
  - Number of whorls on shell
  - Color patterns on shell
  - Length, width, and height of shell
- Be prepared to identify your group's snail from among other snails using its traits.

Claims and Evidence: Is This Our Snail?

Specimen Name	My Claim (yes or no)	My Evidence	How my evidence proves my claim
Specimen A			
Specimen B			
Specimen C			
Specimen D			
Specimen E			

Can you find your cockroach?

Observations of your cockroach: ours is a female and her abdomen is liteish and turns dark at the bottom $6\frac{1}{2}$ cm. one of her antenae is shorter than the other.

Letter of cockroach	Is it your team's cockroach?	What is your evidence?
D	no	she is to dark.
B	no	to big
E	no	much to big
C	yes	right size right coulour
A	no	to dark to big

Conclusion

Do cockroach species have individual differences? yes because we were able to identify our teams cockroach. our evidence was that our cockroach diferent coulor and size. The differences are because they inhereted genes from their Parents that gave them different Color patterns.

Why is This Important?

- Students investigate structures of a different living organism.
- Students consider how the different structures of a snail require different elements in its habitat than crayfish.
- Students provide for habitat needs through engineering design.

Snail Math: What Size are the Snails?

CCSS.MATH.CONTENT.3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

- Place cm grid paper in a plastic sleeve and place snails of different sizes on top to photo.   Do with multiple snails on one paper.
- Print the photo on paper, label each snail with a number or letter, and provide copies to groups to work on.
- Review the concept of length and width. Students work in partners to measure, label, and record in a chart the lengths and widths of each snail.
- Students find the estimated area covered by each snail.(How much ground space does each snail take up?). Students can use a ruler to draw in the grid lines covered by each snail's body, or you can do this before you copy it.
- Graph, write comparing equations, create word problems, put in order from least to greatest length/width/area, make claims.
- Point out that the area taken up by a snail can change, as they stretch out and shrink down their foot size as they move.

Part 2: Comparing Crayfish and Snails

What are the structures of a land snail?

How are the structures of crayfish and snails alike? Different? What purpose do they serve?

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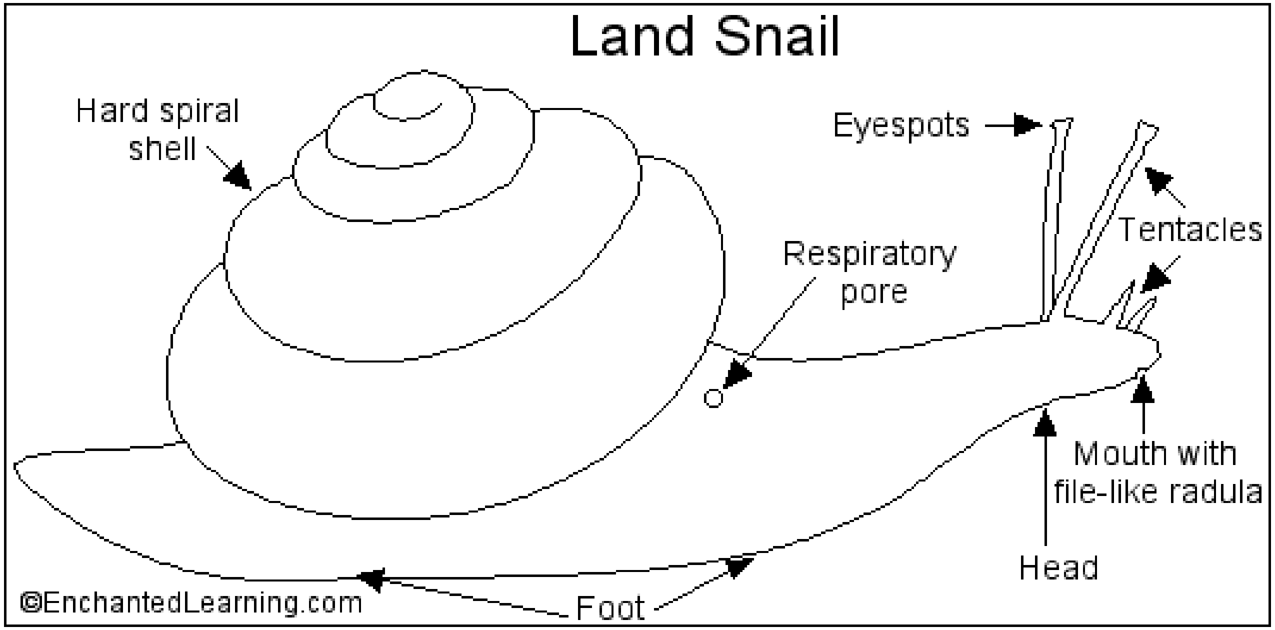
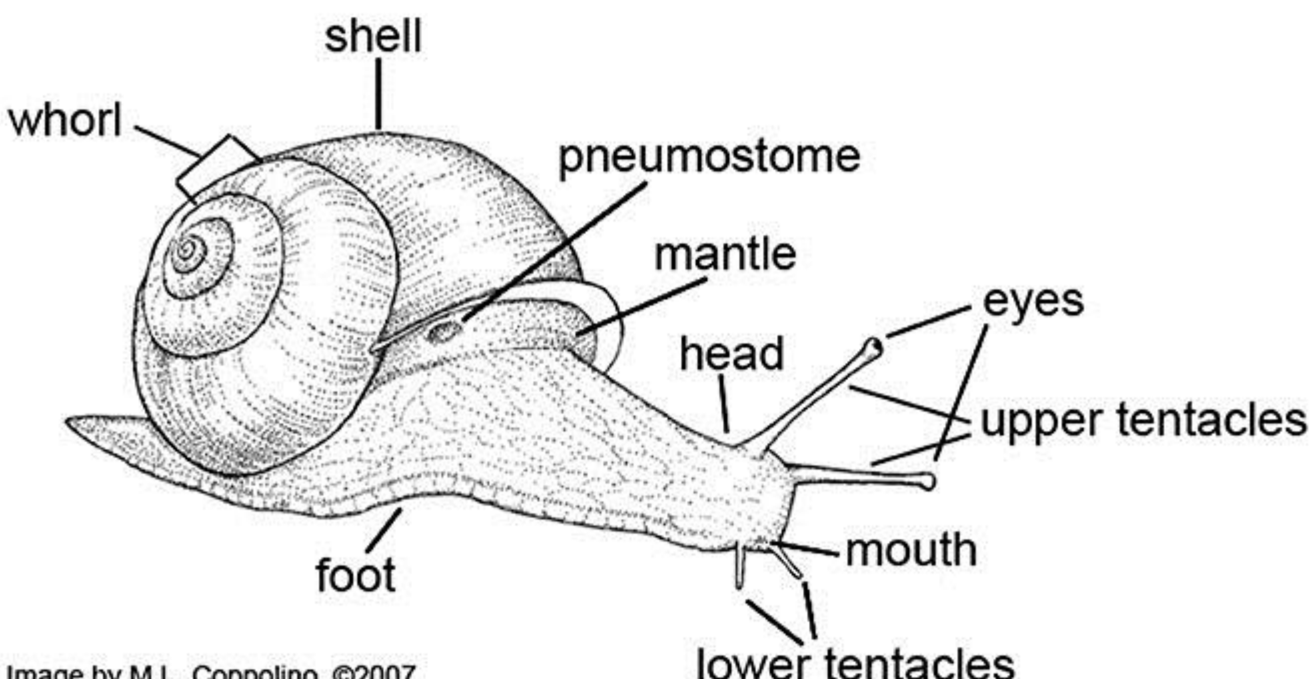
Modifications to Part 2

As Is	Shift to NGSS 3-Dimensional
Students observe snails and their parts. Students observe and record snail behaviors.	Students draw a labeled model of the snail with its parts and the functions of each part. Develop structure vocabulary at this time.
Students describe how one structure or behavior helps the land snail survive. Students use a Venn Diagram to compare snail and crayfish parts.	Have students interpret the information from the Venn diagram in order to compare and contrast snail structures with crayfish in writing (paragraphs). Why do these differences exist?


Land Snail
Hard spiral shell
Eyespots
Tentacles
Respiratory pore
Mouth with file-like radula
Head
Foot
©EnchantedLearning.com


shell
whorl
pneumostome
mantle
eyes
head
upper tentacles
mouth
foot
lower tentacles
Image by M.L. Coppolino, ©2007

Land Snail Structures

- Most land snails have interesting projections on the fronts of their heads. They have two long ones on top of the head reaching up, and two smaller ones reaching down. Technically they are **tentacles**, but "feeler" is a pretty good description of their function because they are touch sensitive.

- **The two longer ones have light-sensitive organs at their tips, making them the snail's version of eyes, although their function is limited to light perception rather than image generation**.

- **The shorter tentacles feel, taste, and smell the environment** in the never-ending search for food and water, and guarding against dangers.

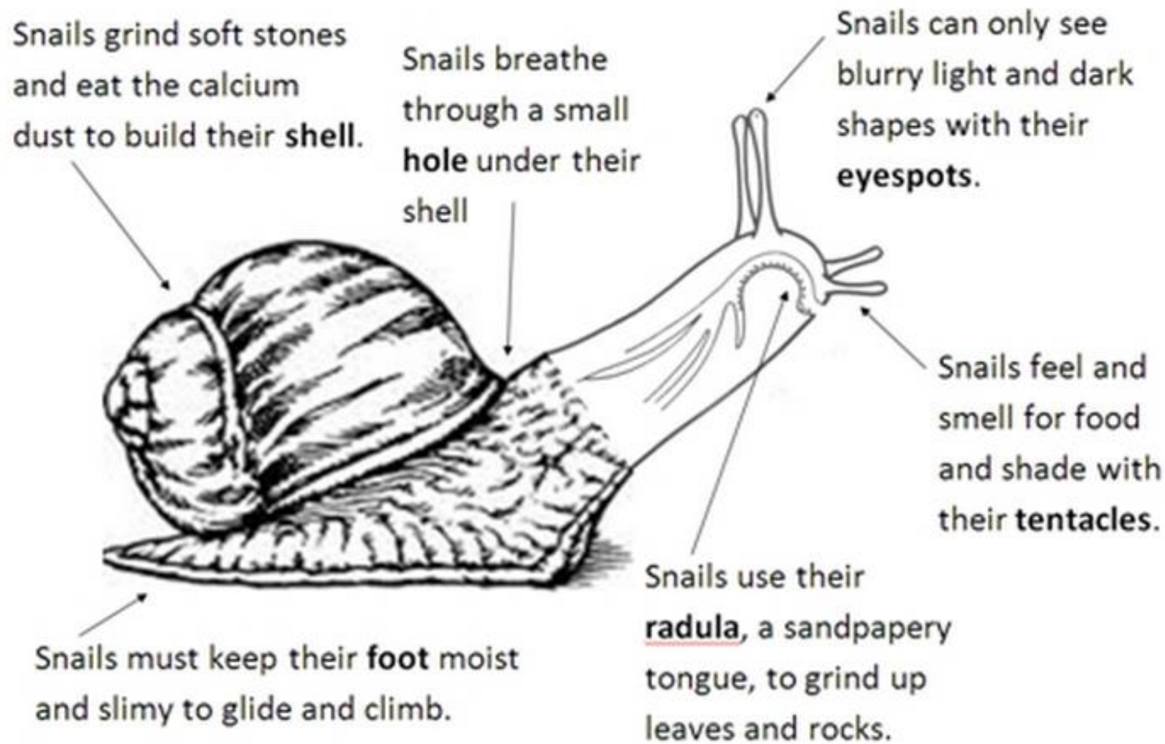
- **The snail's mouth is on the bottom of the head right up by the short tentacles.**

- **Inside the mouth is a specialized eating tool, the radula. The radula is a muscular structure covered by thousands of tiny, sharp teeth.** The snail eats by pressing the radula against a leaf or other desirable bit of vegetation and **rasping** it to scrape away small particles. This action can be seen if students feed a hungry snail some lettuce or apple.

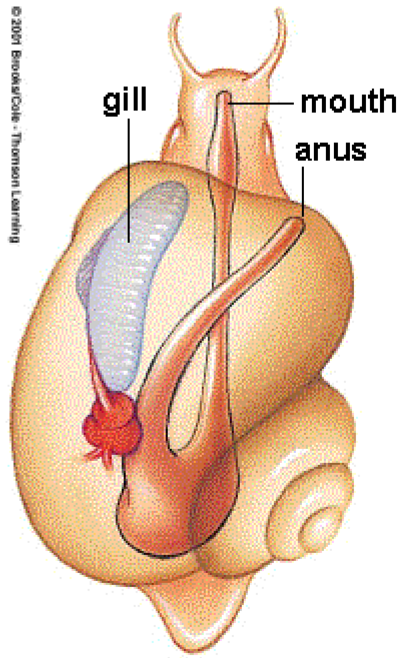
Land Snail Structures

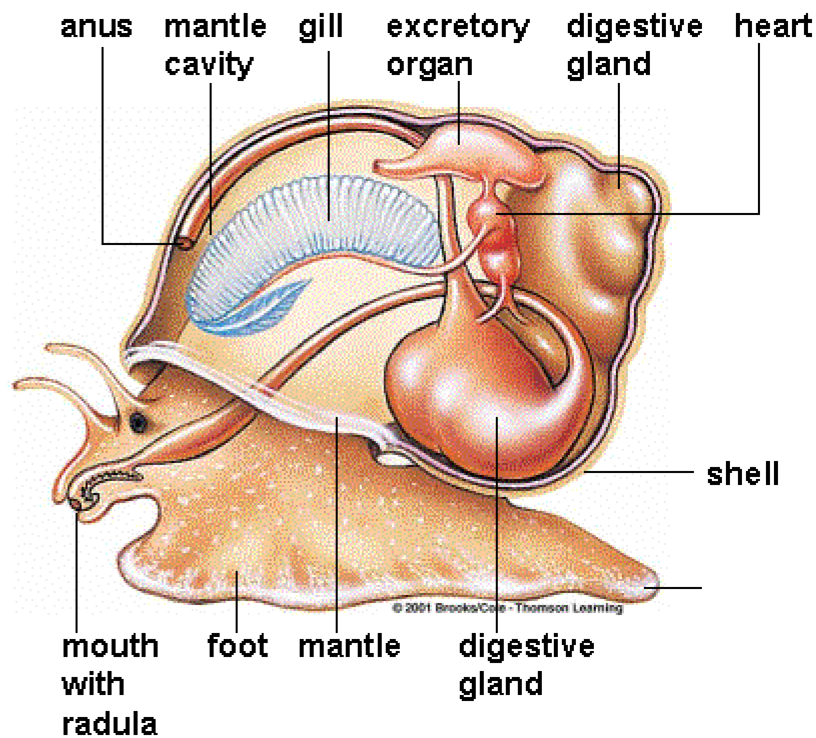
- Most other interesting snail structures are hidden inside the shell, but some can be observed with a flashlight.
- Snails breathe by taking air into a visceral cavity that is richly supplied with blood vessels—the snail's version of a lung. **When the snail extends from the shell, the access pore can be seen opening and closing just below the margin of the shell on one side.**
- **Also, the snail's heart can be seen pumping blood by placing a snail on the lens of a flashlight and carefully looking through the translucent shell.**
- Most land snails are **hermaphroditic**, holding under one shell both male and female reproductive potential. However, snails must mate in order to fertilize each other's eggs. Eggs, the size of BBs, deposited in soil, will hatch in a few weeks into perfectly formed little snails, fully mobile.

Snail Anatomy



Body Plan of a Snail





Why is This Important?

- What similarities exist among living things? Why?
- What differences exist among living things? Why?
- How do these differences help living things take advantage of different parts of an ecosystem?
- How do these differences prevent competition for resources?

Part 3: The Snail Pull

How can you measure the strength of a snail?

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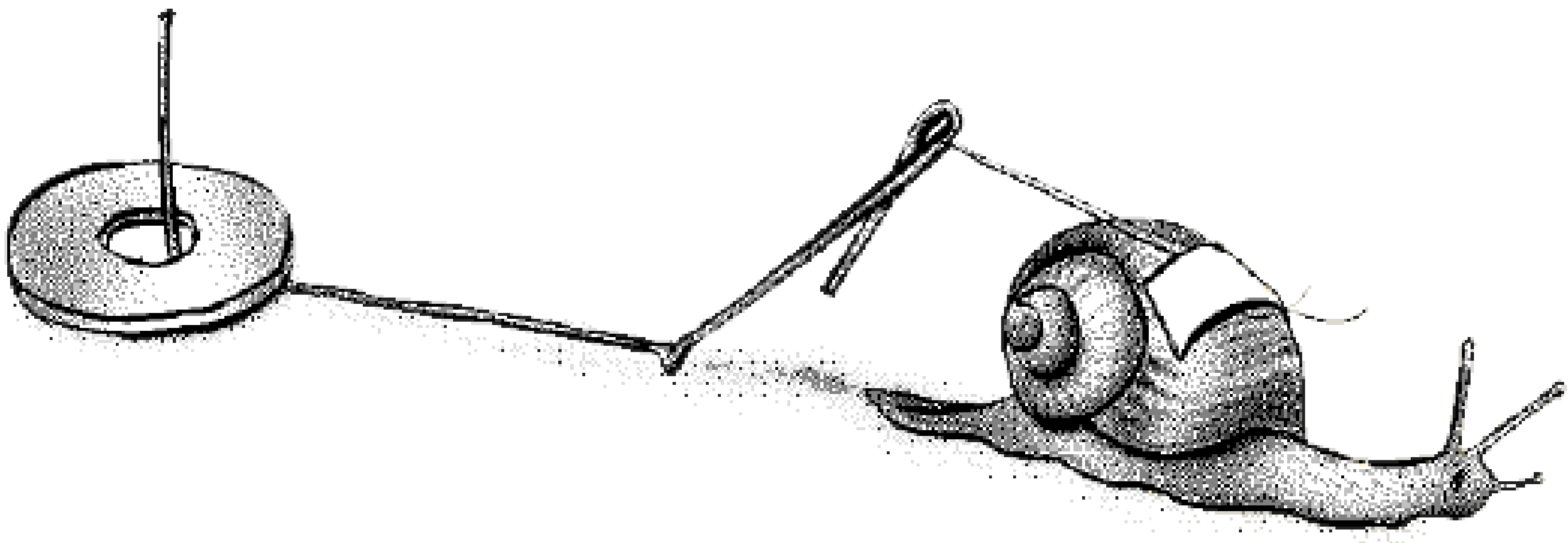
Modifications to Part 3

As Is	Shift to NGSS 3-Dimensional
Teacher attaches thread harness to snail shells prior to lesson. Teacher shows how to hook up snails to a washer and explains procedure. Students weigh mass of their snail and their washers.	Allow students to experience the investigation process. Teacher presents investigative question, such as ,"How much weight can a snail pull?". Students make predictions and provide reasoning. Students and teacher collaboratively develop an investigation design, setup, procedure, and data collection plan. Students conduct the experiment and gather data Students draw a conclusion based on data.

The Snail Pull



Science Inquiry Process

We want to find out: How strong is a snail? How can we measure its strength?

Question : How many washers can a snail pull?

(Weigh one washer, and pass them out so students can feel their weight.)

Prediction

I think a snail can pull _____

washers because_________________.

FOSS Procedure

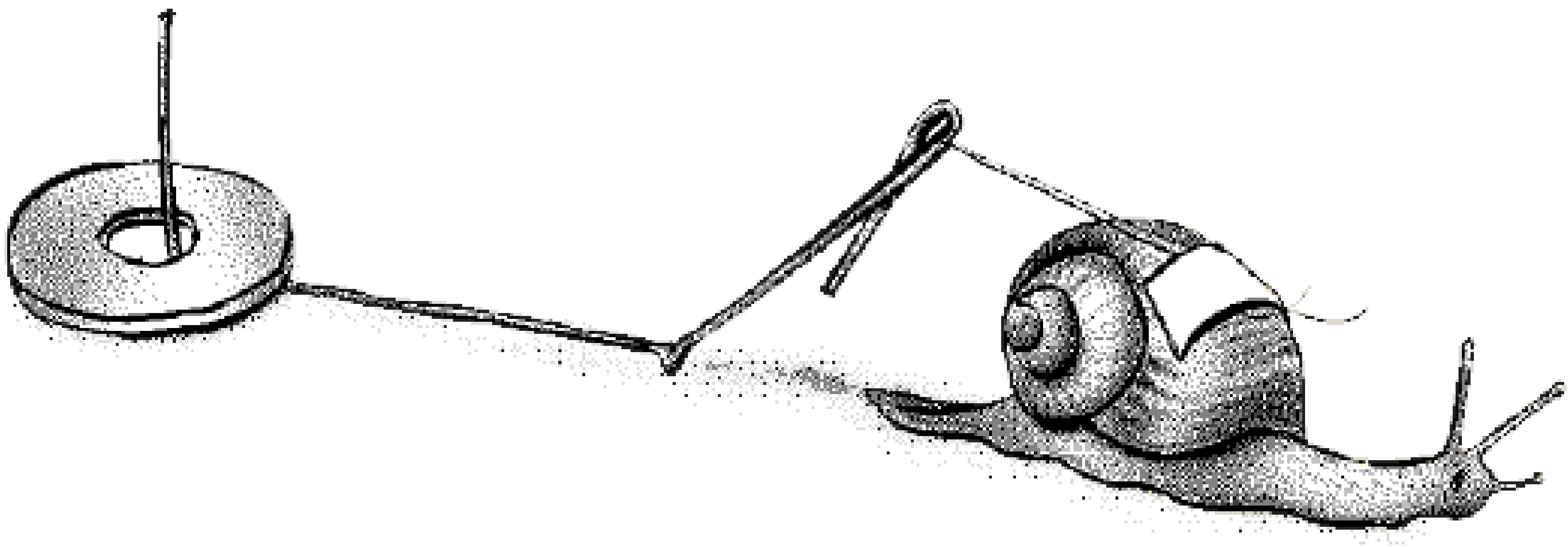
- The following slides display the FOSS procedure for this investigation. This is one way to test the investigative question.
- You may choose to design a different investigation setup or procedure collaboratively with your class. What will your students think of???

FOSS Materials List:

Each partnership will need:

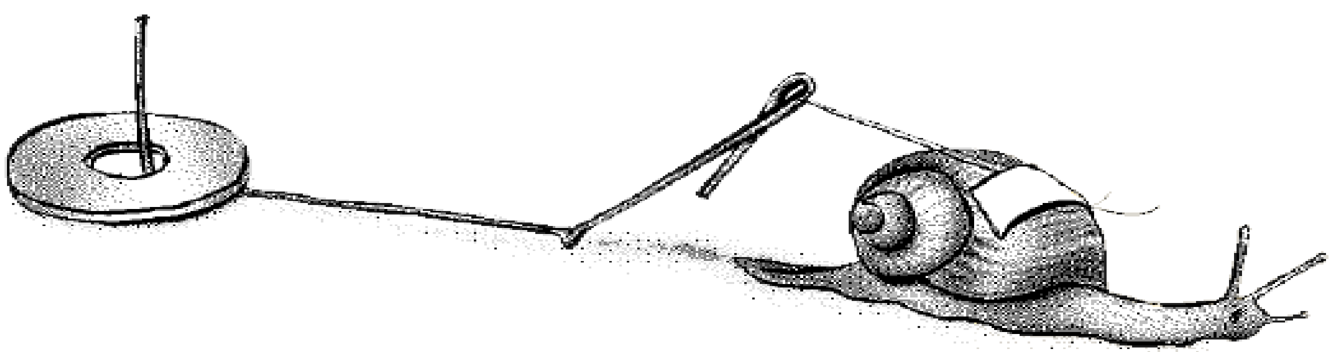
- **1 snail**
- **1 large paper clip**
- **Washers**
- **8-10 inches of thread**
- **Paper towel to dry the snail shell**
- **Duct tape piece to tape thread to snail's shell**

Labeled Setup



FOSS Procedure (Steps to do the investigation)

1. Cut 10 inches of thread. Tie the two ends together to make a loop.
2. Dry the snail shell with the paper towel.
3. Use duct tape to tape the thread loop to the top of the shell.
4. Open up one paper clip so that one end hooks onto the loop and the other end acts as a post for stacking the washers.



FOSS Procedure (Steps to do the investigation)

5. Slide the thread loop onto the paper clip loop
6. Put 1 washer on the paper clip sled.
7. If your snail is not active, dip it in water for 5 seconds.
8. Observe and record what happens.
9. If your snail can pull 1 washer, keep adding washers until your snail cannot pull any more.
10. Record your data.
11. Weigh your snail and a washer to compare weights.

Data Table

Trial Number	Number of Washers Pulled
1	
2	
3	
4	
5	
6	
7	
8	
9	

Class Debrief

- Share out all data and record in a table.
- Which snail pulled the most weight?
- What was the range(least to most) of weight pulled?
- Why can snails pull more weight than their own body weight?
- What structures allow then to do this?
- How does this trait help them survive?

Conclusion-What's the answer to the question?

- A snail can pull ______washers. This shows that_______________________________. This is important because_______________.

Why is This Important?

- Students experience an investigatable science question.
- They experience the steps of a scientific investigation.
- What structural adaptations does a snail have to survive in nature?
- How do these adaptations help it survive?

Part 4: Choosing Your Own Investigation

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
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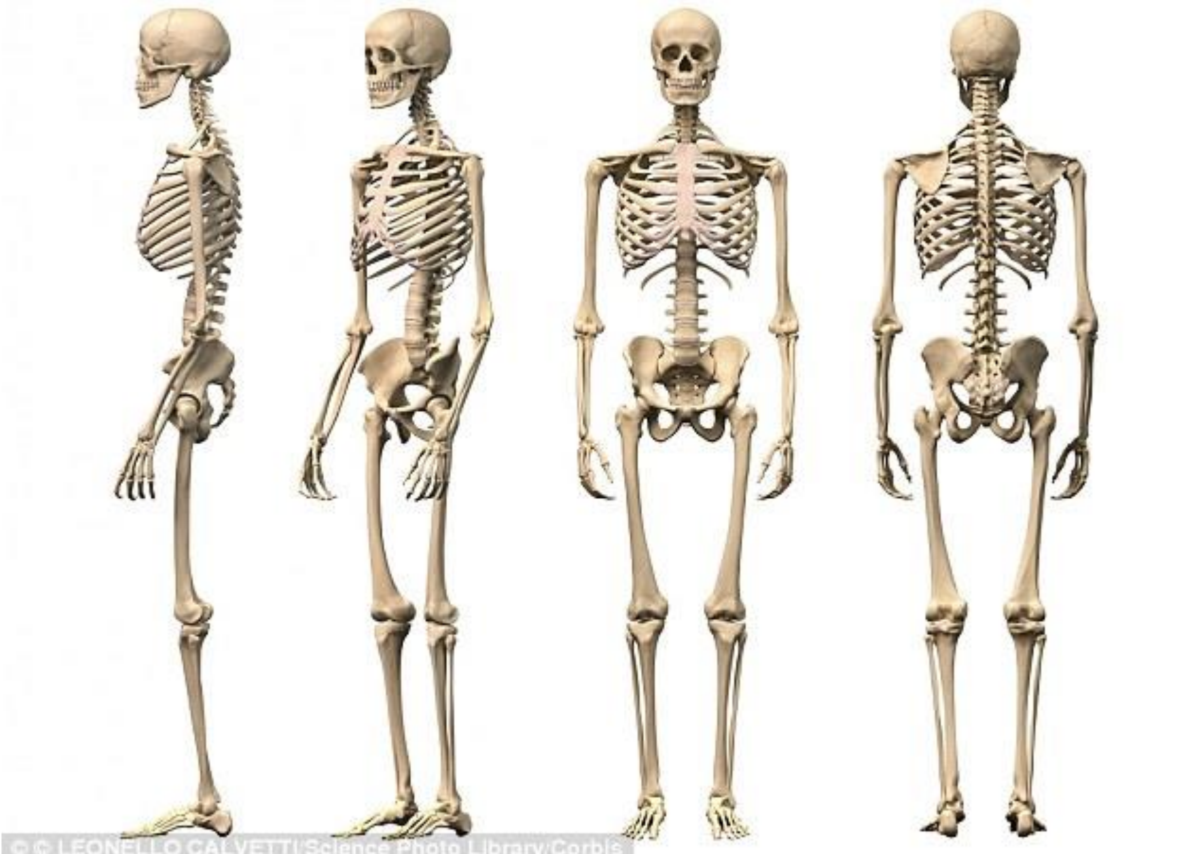
Modifications to Part 4

As Is	Shift to NGSS 3-Dimensional
Teacher passes out a Project Ideas sheet and students choose one. Students work independently on projects. Students present projects to the class.	Revisit the student wonderings from the KLEWS chart. Which wonderings can be investigated or researched? Develop investigations collaboratively as a class or in small groups or partners.

Investigation 4: Science Text

- Pages 64-73 in Structures of Life Text

INVESTIGATION 5 (new): BONES



What structures do similar jobs in crayfish, snails, and humans?
What purpose do external exoskeletons and shells, and internal bones have in common?

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. **Systems and system models**
5. **Using mathematics and computational thinking**	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 1

As Is	Shift to NGSS 3-Dimensional
Students jump rope and observe what parts move. Students count the bones in their arms/hands, legs/feet, head, and torso using their sense of feel. They try and determine how many bones are in the whole body. Students use posters to evaluate and revise their counts.	Skip the jump rope activity- it does not connect to the study of the skeletal system. Instead, start with an investigative question, "How many bones do you think are in the human body?" Ask students to predict and give reasoning for their prediction. How can we find out? Start a KLEWS chart for the skeletal system.

Part 1: Counting Bones

- Point out to students that they have been studying the **external** or outside structures of living systems. These are structures they can see.
- They will now study an **internal** structure of a living system-people. Internal structures cannot be seen just by looking at something.
- The structure they will study is called the skeletal system. How is our skeleton a system?
- What structures in crayfish, snails, and people do similar jobs? How are these structures different? Why?

Connect to Prior Learning

- ***What purpose does external exoskeletons and shells, and internal bones have in common?***
- What does our skeletal system do for us?

Subsystem Prediction

- How many bones do you think are in the human skeletal system?
- Write down a prediction and be ready to share. What evidence or reasons do you have for your prediction?
- Record predictions on the board.
- How can we find out? How can we gather data that will help us?

Make Physical Observations

- Assign groups to specialize in one part of the body.
  - Arm and hand
  - Leg and foot
  - Torso
  - Head
- Each group will use their sense of feel to identify and count the bones in their part of the body.
- Groups will report their data to the class.

Confirm or Revise Data

- Why is it hard to get an accurate count of the bones?
- How can we check and adjust our counts?
- Propose using a model of the skeletal system to help.
- Display the photograph of a real skeleton. Does this help?
- How can we look closer at the subsystems?
- Propose zoomed-in models- close up photographs of just one part of the body.
- Provide groups with subsystem photos. You may also wish to provide books and other visual references.
- Each group will count and record the bones in each subsystem. Revise number totals.
- How can we find the total number of bones? Compute. Compare to the prediction totals. What did we discover?

Hand Math: What Size is My Hand?

CCSS.MATH.CONTENT.3.MD.C.6 Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

- Tell students they will examine the size of one part of the skeletal system- the hand.
- Have students work with a partner to trace around their hand on centimeter grid paper. Have students lightly shade the area taken up by their hand with colored pencil.
- Review the concept of length and width. Students work in partners to measure, label, and record in a chart the lengths and widths of each finger (measure starting from the web between fingers), and the length and width of the whole hand.
- Students find the estimated area covered by their hand. Strategies: will students find the area of each finger, then the palm and add? Will they break it up into sections? How will they keep track of the centimeter units already counted? How will they account for parts of a cm covered (fractions)?
- Graph, write comparing equations, create word problems, put in order from least to greatest length/width/area, make claims.
- Is there a relationship between a person's height and the size of their hand?

Why is This Important?

- What is the function of bones in humans?
- How do our bones compare to snail and crayfish parts?
- How are our bones put together in a system?

Part 2: Mr. Bones Puzzle

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	**4. Systems and system models**
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	6. Structure and function
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 2

As Is	Shift to NGSS 3-Dimensional
Students put together a paper puzzle model of the human skeletal system.	Activate knowledge and curiosity by asking students to label a unlabeled diagram of the skeletal system using prior knowledge. Have students to observe how the skeletal system is put together. Students work on the puzzle models. As students finish or become stuck, allow them to confer with resources to self-evaluate their models and revise if needed. Avoid simply telling them if they are correct or not correct. Close by together developing a labeled model of the human skeletal system using class learning and resources.

What Parts of the Skeletal System Do You Know?

- Visualize the human skeletal system.
- What parts or subsystems do you have names for?
- You will receive an unlabeled diagram of the human skeletal system.
- Work in partners or groups to label as many parts as you can.
- While you are working, notice how the parts go together to form a whole system

Skeletal System Puzzle Challenge

- You will receive a puzzle made up of the parts of the human skeletal system
- You will work with a partner to put the model together.
- Lay out all the parts where you think they go. Look and think. Adjust.
- Raise your hand if you stop making progress or when you think you are finished.

Confer with Resources and Revise

- As partners finish or become stuck, allow access to resources to self-evaluate model accuracy and make revisions.
  - Ask guiding questions that may help them progress.
  - Skeleton photo poster, subsystem photos
  - Books
  - 3-D models
  - Technology
  - Other student scientists

Class Model

- Pass out unlabeled diagrams.
- As a class, label and discuss the parts of the human skeletal system.
- What role or job does each part have?
- What happens when a part is damaged or broken? How does that affect the whole system?
- Which parts are the most critical subsystems of the skeletal system?

Formative Assessment

- Provide Response Sheet no. 6.
- Students identify the errors in a given skeletal system model and explain how to correct them.

Why is This Important?

- How do our bones work as a system?
- What if something happens to one of our bones?
- Why are our bones put together the way they are?

Part 3: Owl Pellets

SEPs- Science and Engineering Practices	CCCs- Crosscutting Concepts
1. Asking questions and defining problems	1. Patterns
2. Developing and using models	2. Cause and Effect
3. Planning and carrying out investigations	3. Scale, proportion and quantity
4. Analyzing and interpreting data	4. Systems and system models
5. Using mathematics and computational thinking	5. Energy and matter
6. Constructing explanations and designing solutions.	**6. Structure and function**
7. Engaging in argument from evidence	7. Stability and change
8. Obtaining, evaluating, and communicating information	

Modifications to Part 3

As Is	Shift to NGSS 3-Dimensional
Students examine and dissect owl pellets to find rodent bones. Students try to compile a complete skeleton using a model drawing as support. Students glue rodent bones onto a diagram Students compare rodent and human bones.	No adaptations needed.

Set Purpose and Build Background Knowledge

- Read Barn Owls on pages 78-80 of the Structures of Life text.
- What do Barn Owls have to do with studying skeletal systems?
- Visualize a mouse's body.
- How do you think the bones of a mouse will be similar to human bones. How do you think they will be different? Do you think any mouse bone will look almost the same as a human bone? Why?

Tips for Successful Excavations

- Be aware of students with fur allergies. You may wish to communicate with these parents ahead of time and possibly arrange for the students to take allergy medication. Provide gloves/eye goggles if possible.
- Soak in water overnight first or spray with water periodically to diminish dust/ airborne fur.
- Open windows/door if possible.
- Observe students for nausea, allergic reactions, or distress.
- Show enthusiasm and a positive attitude.

Owl Pellet Excavating:

- Students will work independently so they all have a model at the end of the activity to take home.
- If you have extra bones you don't need, share with others.
- Create an extra bone area where students can go to look for bones they are missing.
- Heads-up, some of the bones are quite tiny.
- Record properties of owl pellets before beginning.
- Consider shading in areas on the model that you have found bones for, or consider gluing the bones actually on the part where they belong if the scale size allows.
- You may wish to review the Rodent Bone Identification sheet with students before beginning.
- Copy student sheet 7, *Owl-Pellet Observation* for each student or have them work in notebooks.
- Compare mouse and human bones. How are they the same?

Investigation 5: Science Text

- Pages 74-105 in Structures of Life Text
- Technology Resource: Virtual Owl Pellet Dissection

  http://kidwings.com/nests-of-knowledge/virtual-pellet/

Why is This Important?

- How do animal bones compare to human bones?
- How do they serve the same functions? Different functions?
- Are any bones the same? Why?
- Are any bones different? Why?

Unit Assessment Ideas

- FOSS Assessments in Manual
- Science Formative Assessment Probes
- Observation and anecdotal notes
- Class discussions and discourse
- Science Notebooks and journaling
- Response and Recording sheets
- Written report or other research project
- Text-dependent questions or other response format for science reading texts
- Exit tasks
- I used to think__________, but now I know_________ because____________.

FOSS Science Stories and NEW NGSS Aligned BOOKS

- See teacher's manual tab, Science Stories
- Source of informational text for ELA standards
- Have students read after they have experienced the concepts hands-on in class.
- Can implement the science stories during Literacy block
- Have students do informational writing on science concepts or living organisms.
- You can search the Internet for more informational text to print off for students.

Common Core ELA: Informational Reading

1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 3 topic or subject area*.

9 Compare and contrast the most important points and key details presented in two texts on the same topic.

10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2-3 text complexity band independently and proficiently.

Common Core ELA: Informational Writing

- 3.2
Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- 3.2.A
Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.
- 3.2.B
Develop the topic with facts, definitions, and details.
- 3.2.C
Use linking words and phrases
(e.g., *also*, *another*, *and*, *more*, *but*) to connect ideas within categories of information.
- 2.D
Provide a concluding statement or section.

Common Core Speaking and Listening

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

- 3.1.A
  Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- 3.1.B
  Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
- 3.1.C
  Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- 3.1.D
  Explain their own ideas and understanding in light of the discussion.

Math Extensions

- FOSS has a math extension for each Investigation, found at the back of the investigation masters section in the teacher guide.

Inventory and Kit Return

- Inventory list in each kit.
- **Clean and dry all items!**
- Count and check that all items are in the kit, mark on the inventory sheet.
- Broken items go in the broken bag.
- Animals that have died do **NOT** go in your kit.
- Crayfish may be disposed of in the trash.
- All snails, alive and dead, must be returned to your Critter person. Watch out for eggs.

Revisit Objectives

- Experience the three-dimensional learning found in the Next Generation Science Standards (NGSS).
- Understand alignment to WA state and NGSS.
- Understand the overall structure of the unit and the investigations.
- Gain content knowledge needed to teach the kit.
- Develop understanding of the physical structures of the living organisms (systems and subsystems).
- Learn how to prepare and care for the living organisms.
- Experience kit investigations and NGSS adaptations.
- Gain management and assessment ideas.

Clock Hours and Evaluations

- Thank You!

- Good luck with your Structures of Life kit this year!