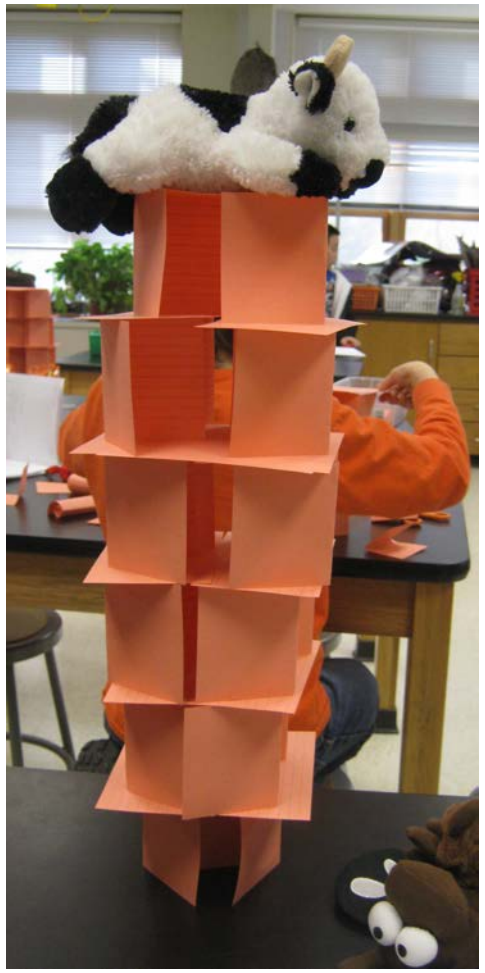
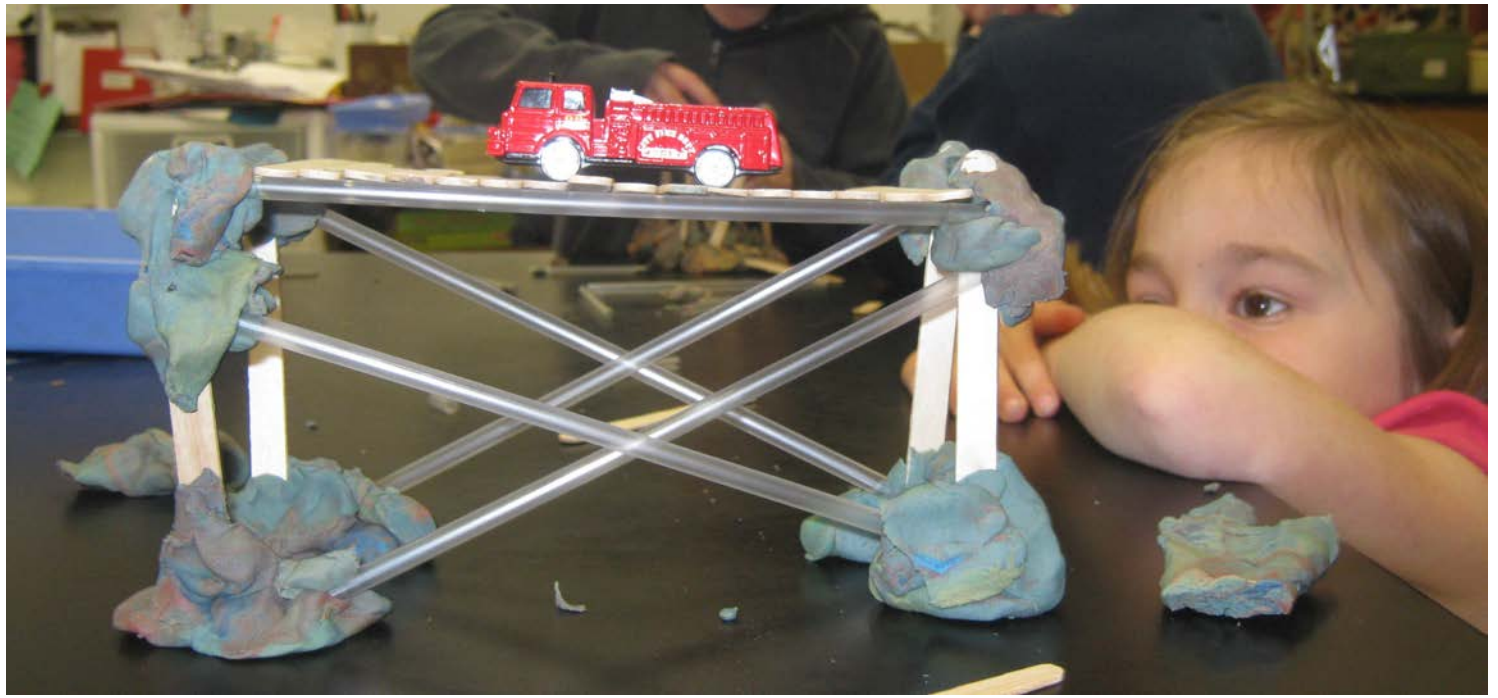
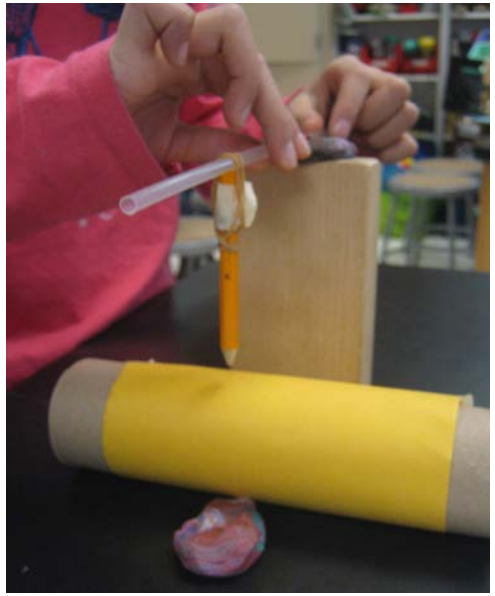
Revising Lessons: Engineering Design & NGSS Alignment



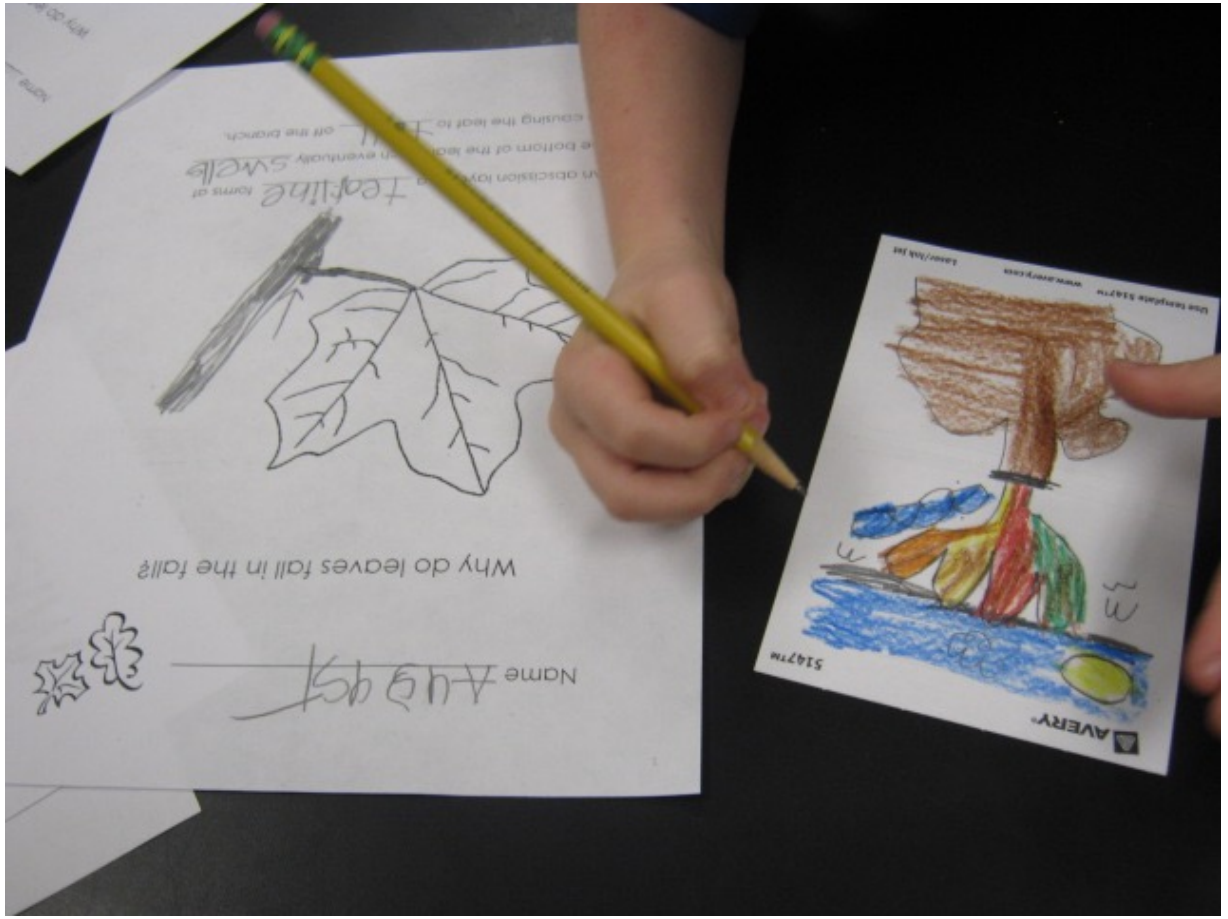


"Doesn't engineering just mean building something?"



Martha Friend
Princeton Public Schools

Before NGSS- 1st Grade tree unit



Life Science	
LS1: From Molecules to Organisms:	
LS1.A: Structure and Function	• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)
LS1.B: Growth and Development of Organisms	• Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)
LS1.C: Organization for Matter and Energy Flow in Organisms	• All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)
LS1.D: Information Processing	• Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)

Within NGSS, what are some of the 1st grade Life Science core ideas?

- Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)
- Plants need water and light to live and grow. (K-LS1-1)
- In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)

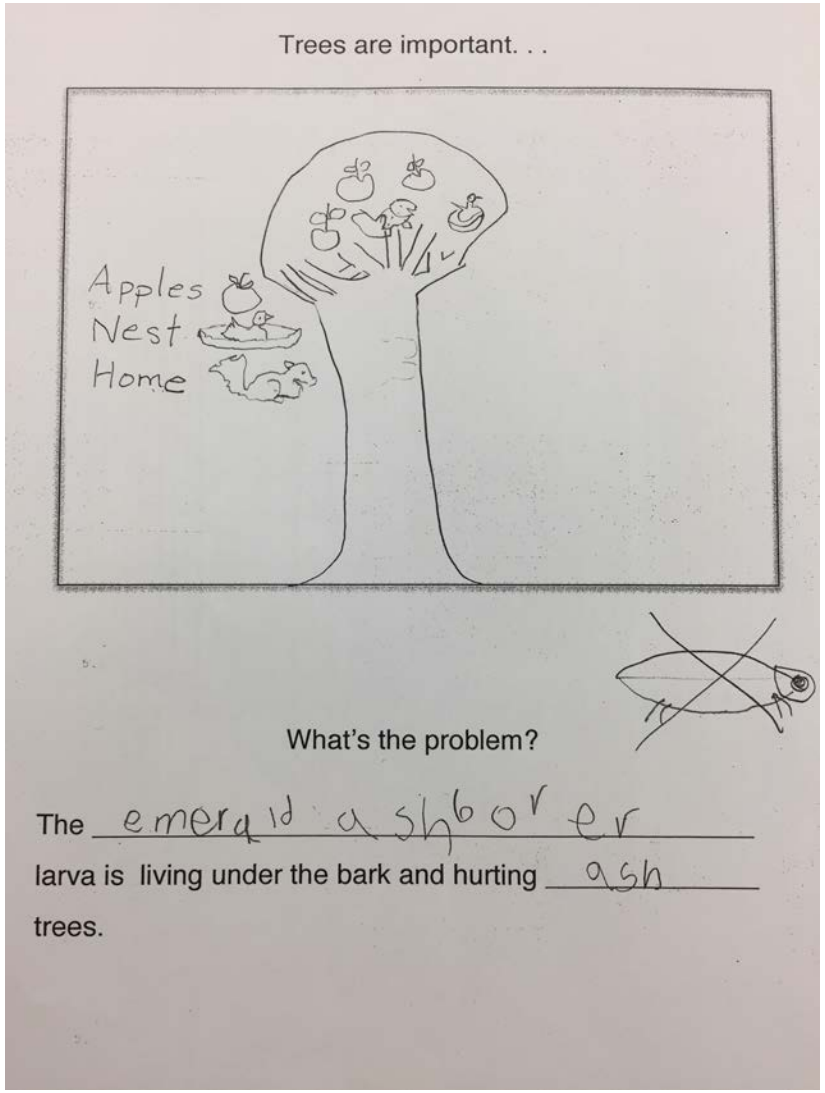
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting an Engineering Problem	• A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1-1) (secondary to KPS2-2) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) (secondary to K-ESS3-2) • Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
ETS1.B: Developing Possible Solutions	• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-1) (secondary to K-ESS3-3) (secondary to 2-LS2-2)
ETS1.C: Optimizing the Design Solution	• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-1) (secondary to 2-ESS2-1)

Within NGSS, what are some of the 1st grade Engineering Design core ideas?

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

1st grade Engineering Design Investigation using a SCENARIO involving trees and insects

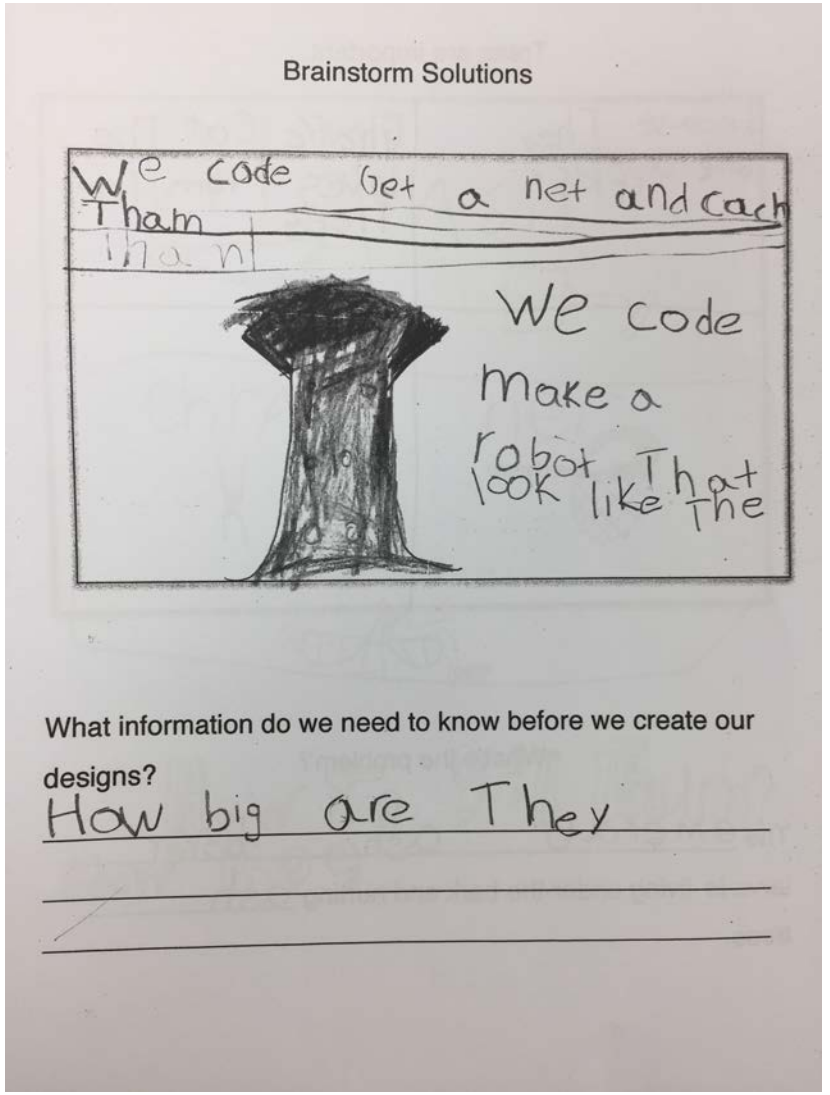
Students defined the problem (with my help) and brainstormed solutions


Trees are important. . .

Apples
Nest
Home

What's the problem?

The emerald ashborer larva is living under the bark and hurting ash trees.


Brainstorm Solutions

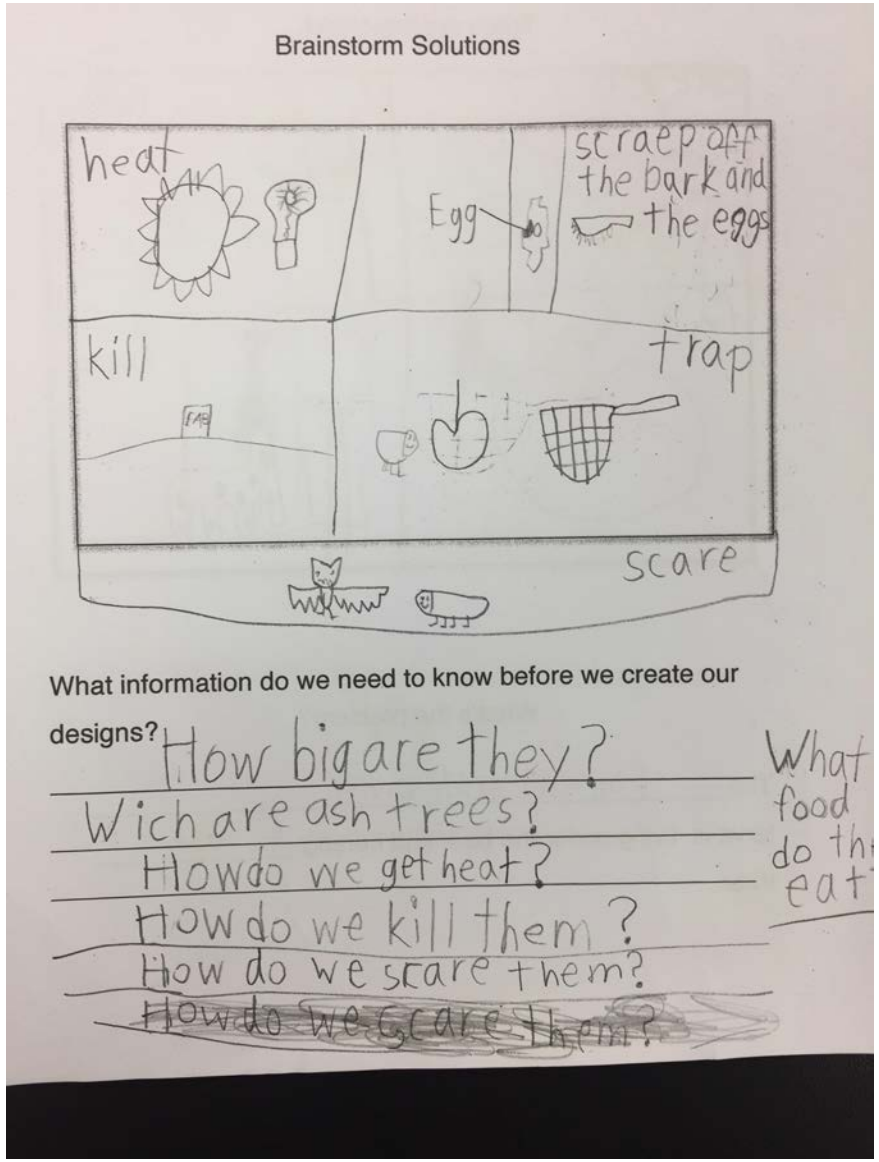
We code Get a net and cach Tham Than

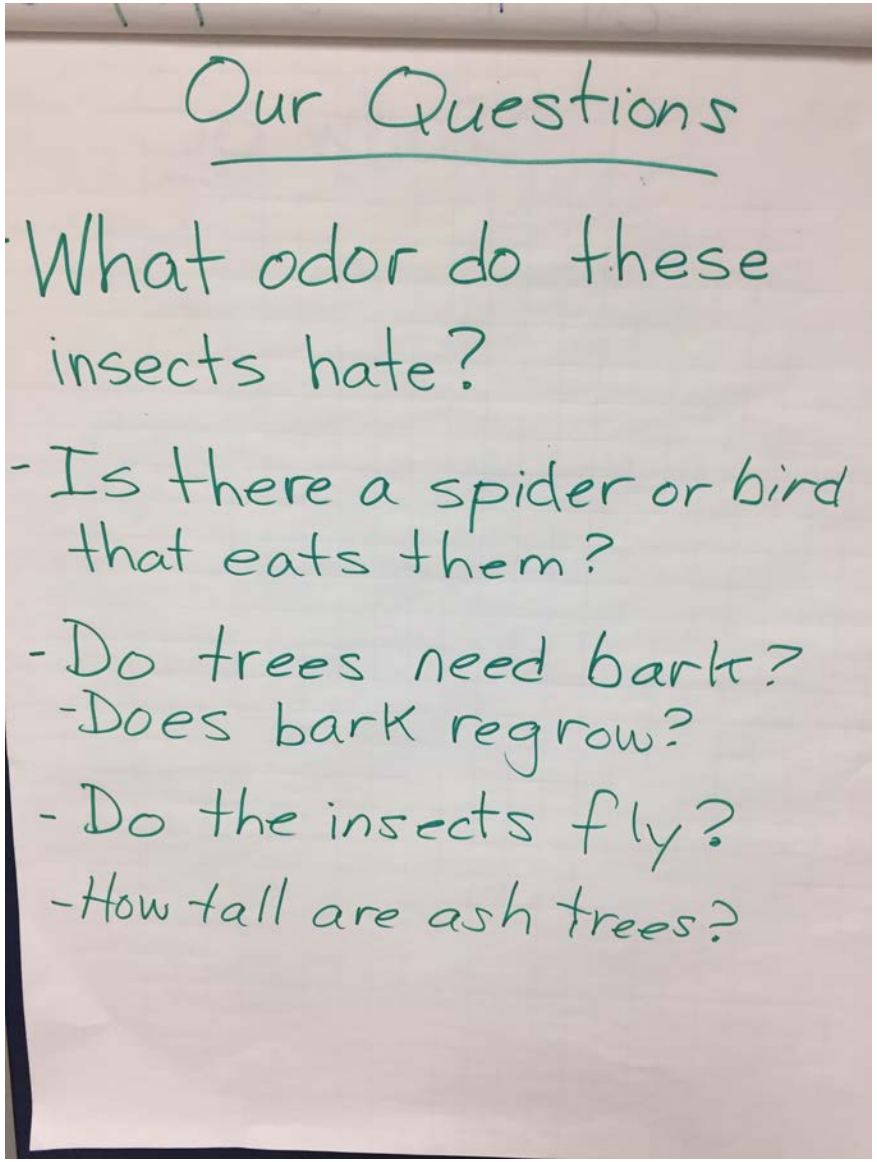
We code make a robot look like That The

What information do we need to know before we create our designs?

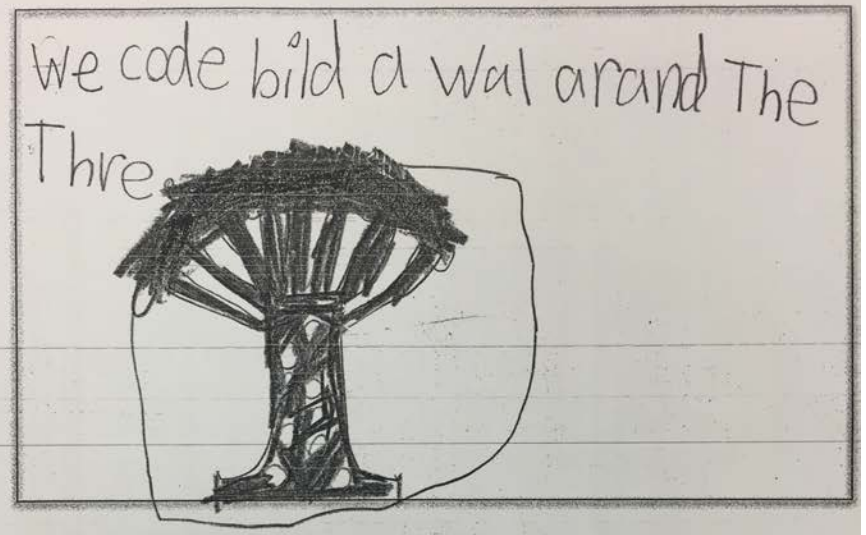
How big are They

After brainstorming, students had questions





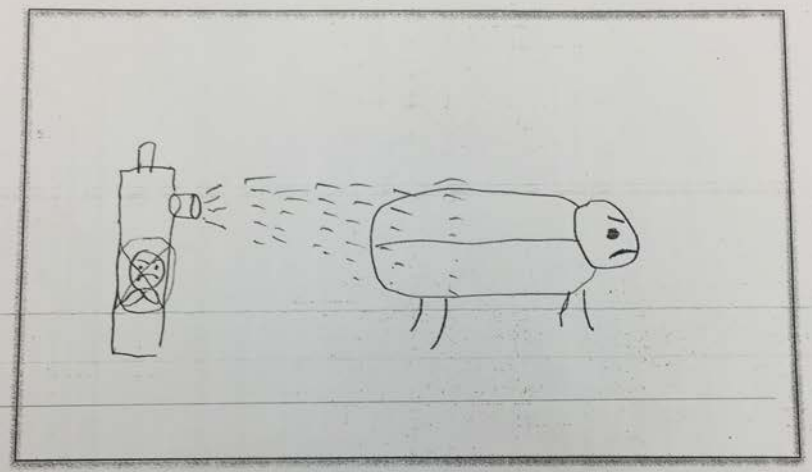
Brainstorm Solutions



What information do we need to know before we create our designs? Do The groups fly or Clim.

Let's work to create a solution to this problem and save our Princeton ash trees.

Brainstorm Solutions



What information do we need to know before we create our designs? -How big are the insects?

NGSS 3-Dimensions

Disciplinary Core Ideas

- **Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)**
- **Plants need water and light to live and grow. (K-LS1-1)**
- **In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)**
- **A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1- 1)**
- **Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)**
- **Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)**

Crosscutting Concepts

- **Structure and Function**
- **Systems and System Models**

Science and Engineering Practices

- **Asking Questions and Defining Problems**
- **Obtaining, Evaluating, and Communicating Information**

Life Science		
LS1: From Molecules to Organisms: Structures and Processes		
LS1.A: Structure and Function	• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)	• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)
LS1.B: Growth and Development of Organisms	• Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)	• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)
LS1.C: Organization for Matter and Energy Flow in Organisms	• All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)	• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1) • Plants acquire their material for growth chiefly from air and water. (5-LS1-1)
LS1.D: Information Processing	• Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	• Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)

Within NGSS, what are some of the 4th grade Life Science core ideas?

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

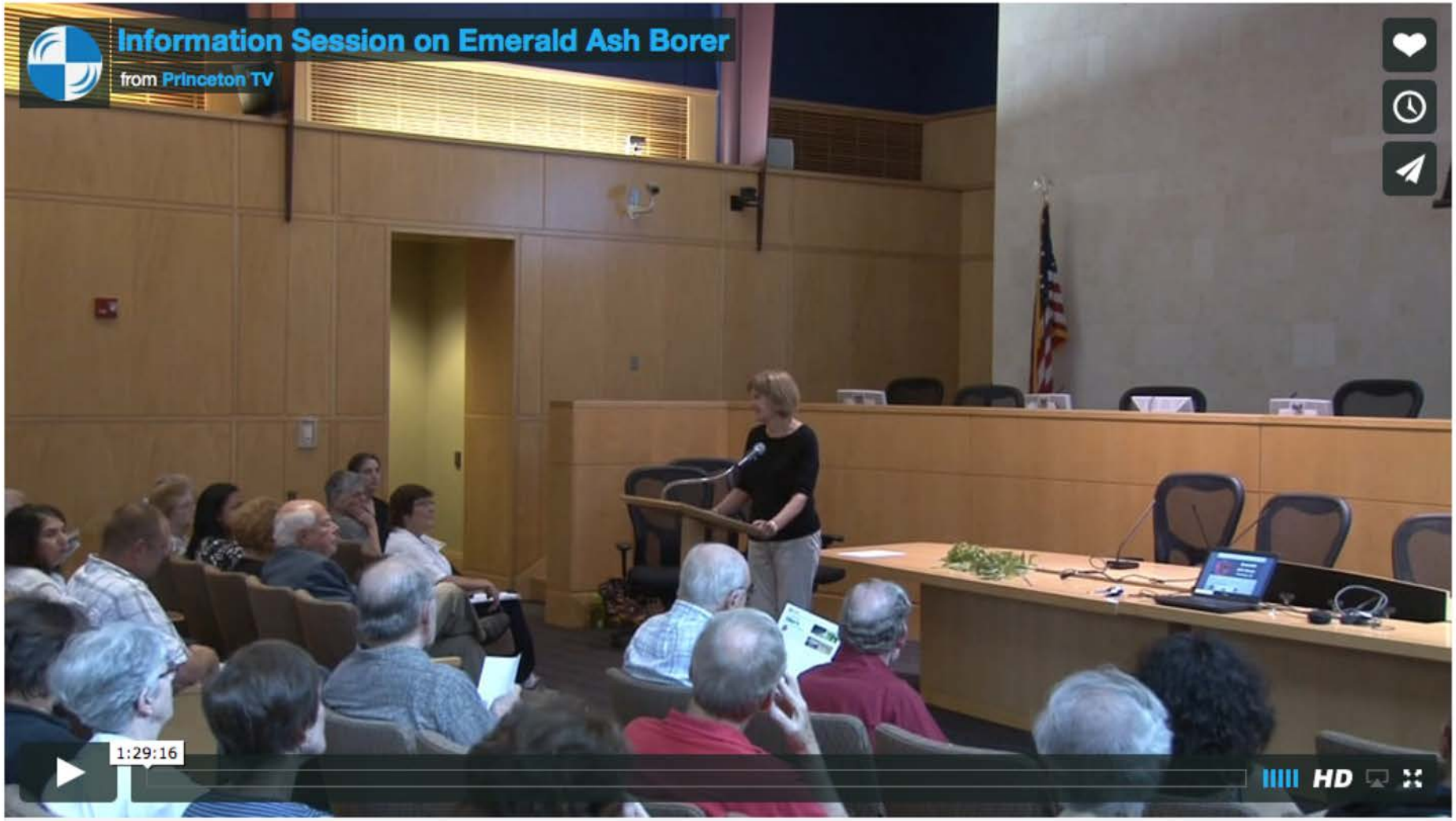
- Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)

ETS1: Engineering Design		
ETS1.A: Defining and Delimiting an Engineering Problem	• A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1-1) (secondary to KPS2-2) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) (secondary to K-ESS3-2) • Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)	• 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) (secondary to 4-PS3-4)
ETS1.B: Developing Possible Solutions	• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-1) (secondary to K-ESS3-3) (secondary to 2-LS2-2)	• 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) • Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)
ETS1.C: Optimizing the Design Solution	• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-1) (secondary to 2-ESS2-1)	• 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) (secondary to 4-PS4-3)

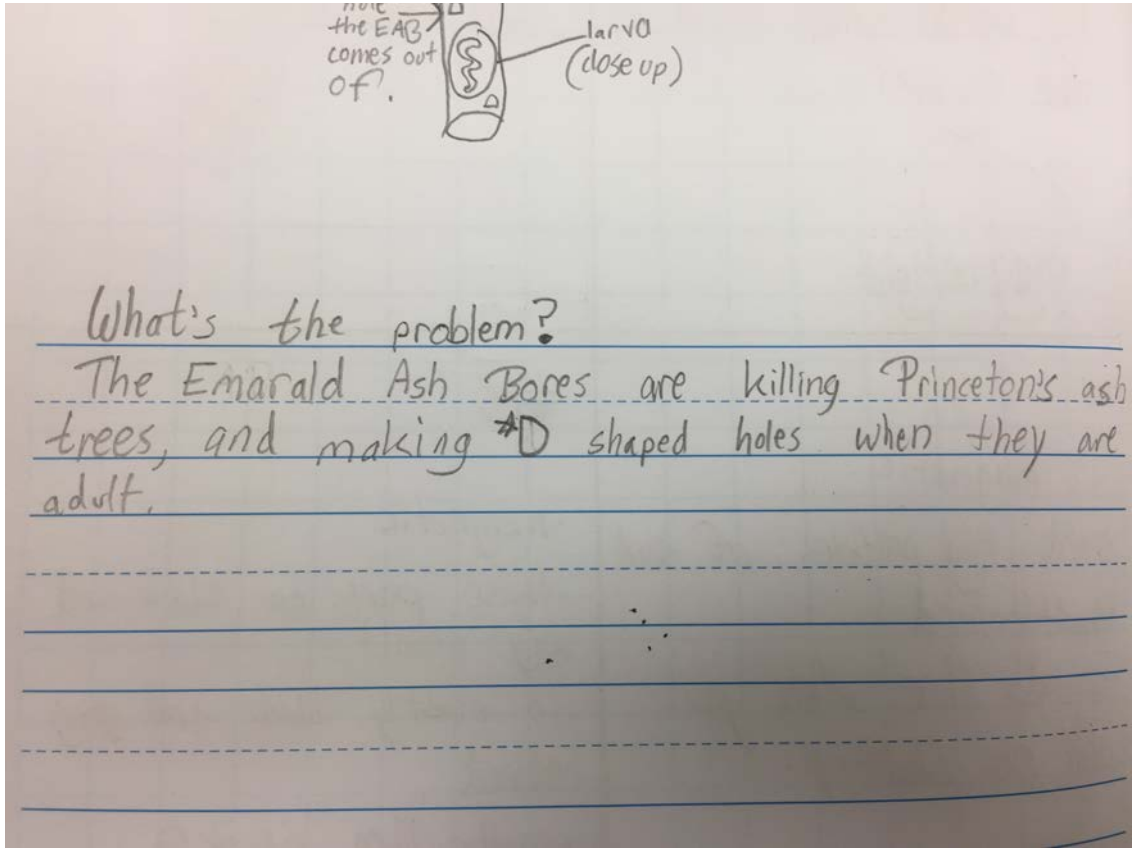
Within NGSS, what are some of the 4th grade Engineering Design core ideas?

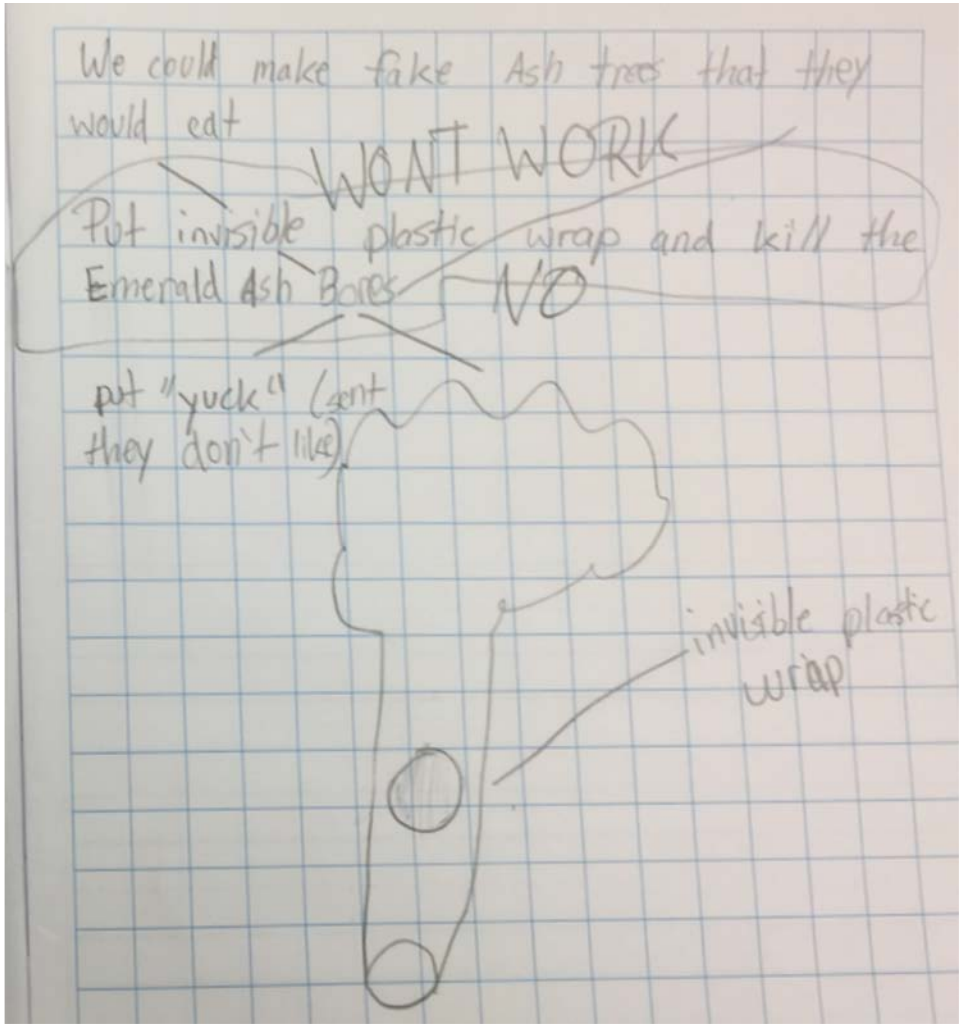
- Possible solutions to a problem are limited by available materials and resources (constraints). (3-5-ETS1-1)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

4th grade Engineering Design Investigation

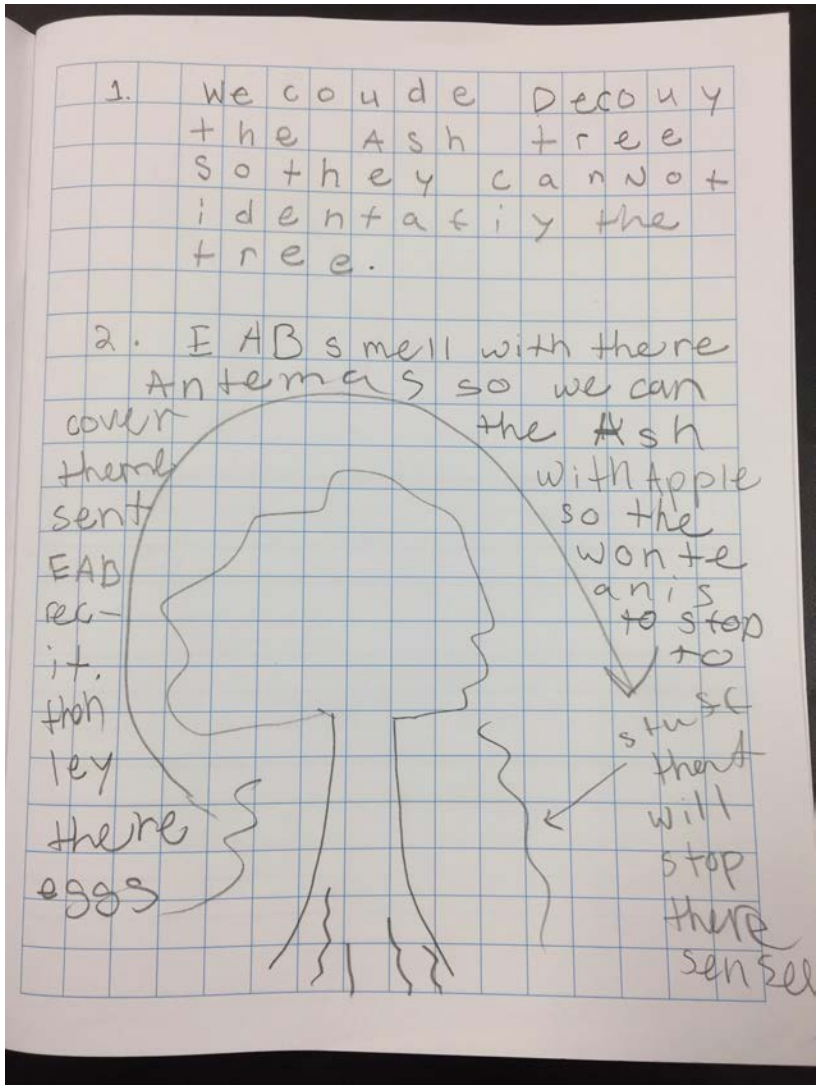


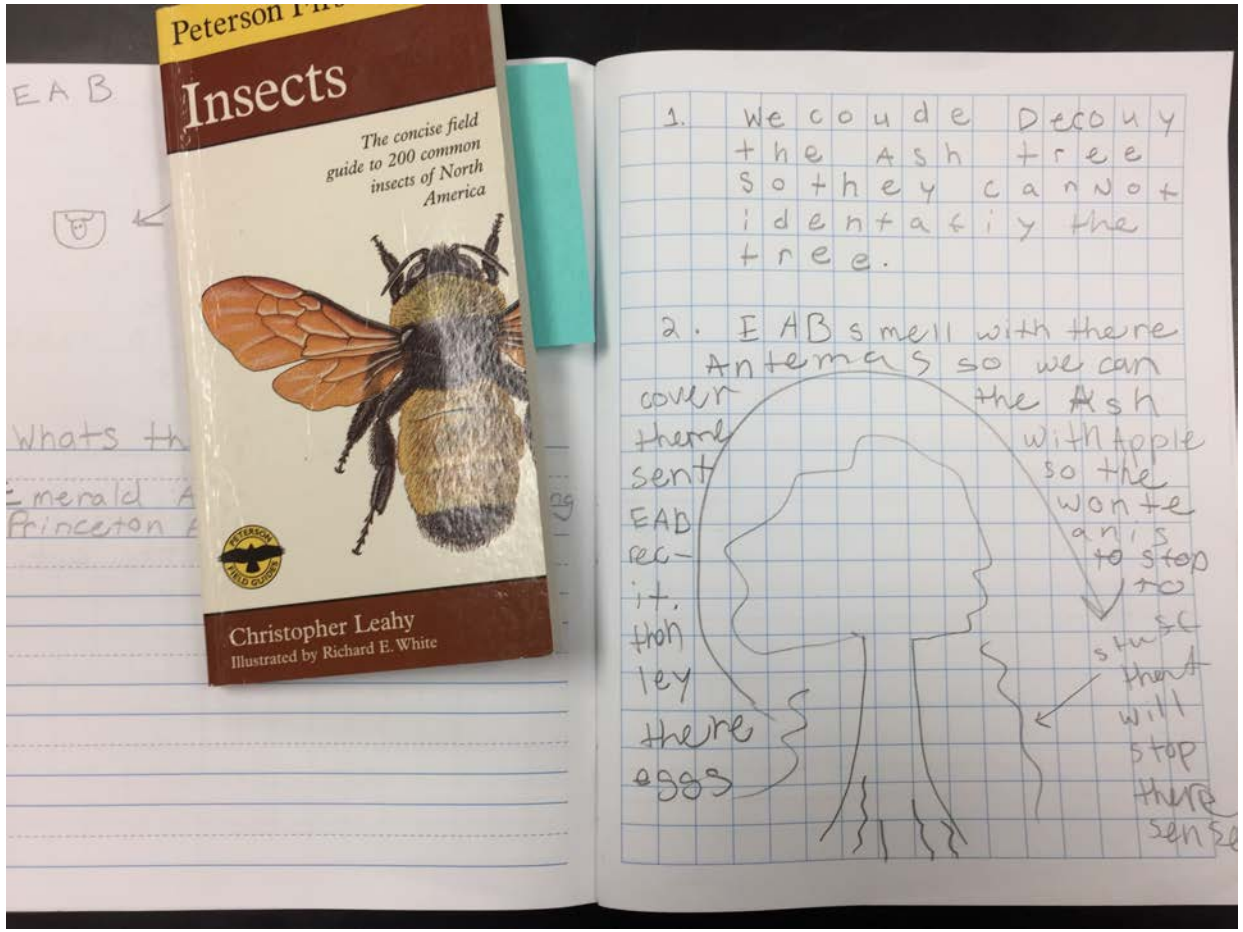
4th graders defined the problem and brainstormed solutions





Questions came up as they worked on design solutions





We need to know...

① How do EABs identify Ash trees?

② Is there a chemical that kills/hur only EAB?

③ How much harm does a woodpecker ~~to~~ do to a healthy tree?

④ Is there a smell that EABs don't like?

⑤ Do trees breathe through the bark?

⑥ Will salt dessicate the larva?

Images by David Cappaert

Adult beetle

D-shaped exit hole

Larva

Woodpecker damage on an EAB infested tree

NGSS 3-Dimensions

Disciplinary Core Ideas

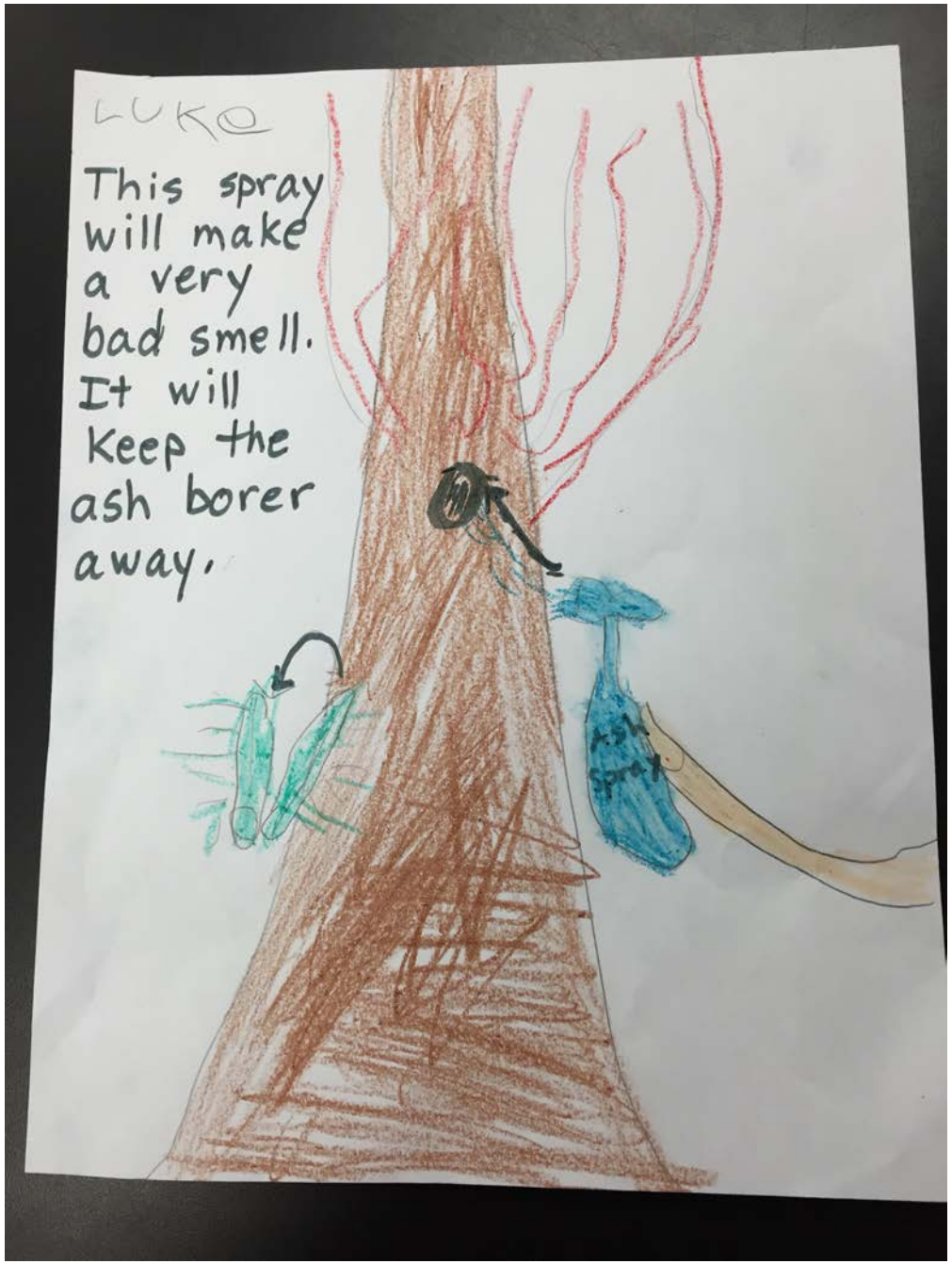
- **LS1.A: Structure and Function**
- **LS2.A: Interdependent Relationships in Ecosystems**
- **ESS2.E: Biogeology**
- **ESS3.A: Natural Resources**
- **ETS1A: Defining and Delimiting Engineering Problems**
- **ETS1B: Developing Possible Solutions**
- **ETS1C: Optimizing the Design Solution**

Crosscutting Concepts

- **Structure and Function**
- **Systems and System Models**
- **Energy and Matter**

Science and Engineering Practices

- **Asking Questions and Defining Problems**
- **Developing and Using Models**
- **Constructing Explanations and Designing Solutions**
- **Obtaining, Evaluating, and Communicating Information**


LUKE
This spray will make a very bad smell. It will keep the ash borer away.