LAUSD Elementary Engineering

BIOMIMICRY CHALLENGE

First Grade – Life Science

PURPOSE

IN THE <u>BIOMIMICRY CHALLENGE</u>, STUDENTS WILL:

- Design and build a problem solution that mimics a plant or an animal using the Engineering Design Process. (EDP)
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate tools and materials to complete task
- Determine effectiveness of their design
- Answer the Focus Question: <u>How can you solve a problem by mimicking a plant or an animal?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

1-LS1-1. **Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*** [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

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

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

- Use materials to design a device that solves a specific problem or a solution to a specific problem.

Disciplinary Core Ideas

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.

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.

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

Connections to Engineering, Technology, and Applications of Science

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

- Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **4.LS1.A** ; **4.LS1.D** ; **4.ETS1.A**

Common Core State Standards Connections:
ELA/Literacy -

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

Students who demonstrate understanding can:

K-2-ETS1-1. **Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

K-2-ETS1-2. **Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**

K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

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 K–2 builds on prior experiences and progresses to simple descriptive questions.
- Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems
- A situation that people want to change or create can be approached as a problem to be solved through engineering. (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)

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-ETS1-2)

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-ETS1-3)

Crosscutting Concepts

Structure and Function
- The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:
Kindergarten: K-PS2-2, K-ESS3-2
Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:
Kindergarten: K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Second Grade: 2-ESS2-1

Articulation of DCIs across grade-levels:
3-5.ETS1.A (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1.B** (K-2-ETS1-2),(K-2-ETS1-3); **3-5.ETS1.C** (K-2-ETS1-1),(K-2-ETS1-2),(K-2-ETS1-3)

Common Core State Standards Connections:

ELA/Literacy —

RI.2.1 Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text. (K-2-ETS1-1)

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1),(K-2-ETS1-3)*

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),*(K-2-ETS1-3)*

SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

Mathematics —

MP.2 Reason abstractly and quantitatively. *(K-2-ETS1-1),(K-2-ETS1-3)*

MP.4 Model with mathematics. *(K-2-ETS1-1),(K-2-ETS1-3)*

MP.5 Use appropriate tools strategically. *(K-2-ETS1-1),(K-2-ETS1-3)*

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1),(K-2-ETS1-3)

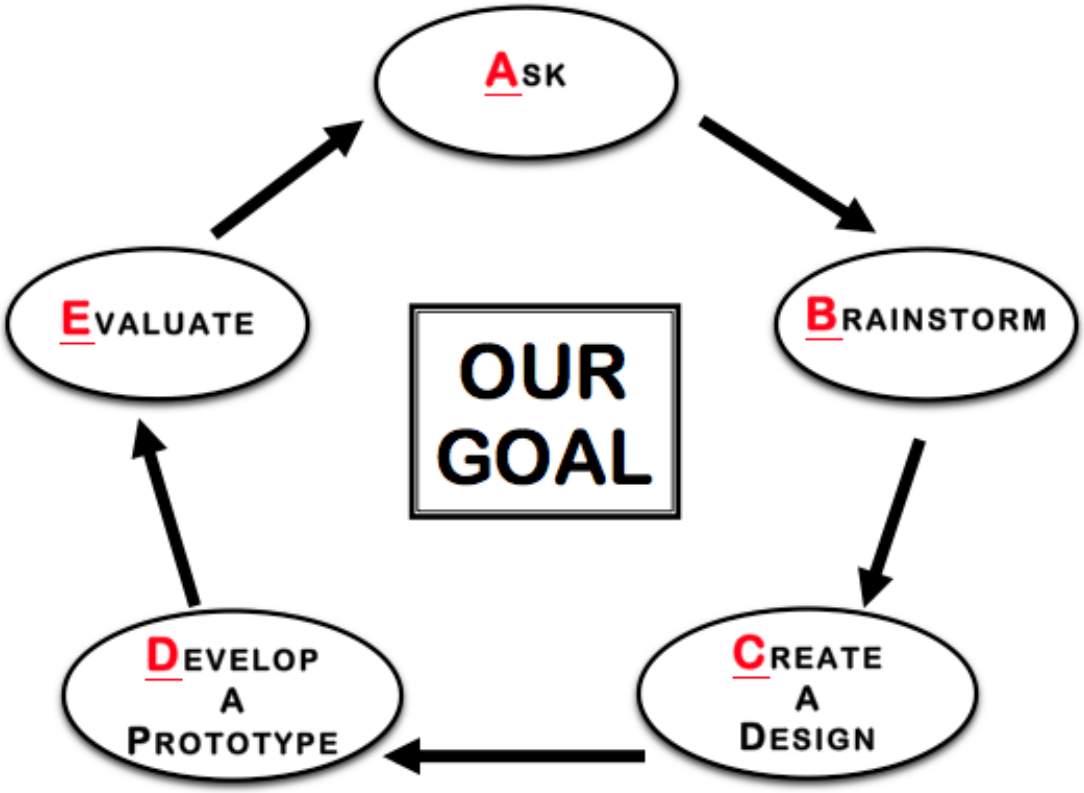
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **ELD.P1.K.A.1**: Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics
- **P1.K.A.3**: Offering and supporting opinions and negotiating with others in communicative exchanges
- **P1.K.C.9**: Expressing information and ideas in formal oral presentations on academic topics
- **P1.K.C.11**: Supporting own opinions and evaluating others' opinions in speaking and writing

SPECIAL EDUCATION (SPED):

To make accommodations or modifications for students with special needs, provide simple directions, instructions, provide multiple opportunities for repetition, make frequent checks for understanding, use visuals to accompany all vocabulary, simplify questions, be specific with sequence and steps, provide opportunity for paraphrasing, and adjust time and pacing.

THE ENGINEERING DESIGN PROCESS (EDP)



ENGINEERING DESIGN PROCESS (EDP)

ASK

- What is the **problem** or **need**?
- What is already out there?
- What are the **requirements (criteria)** and **restrictions (constraints)**?

BRAINSTORM

- What are possible **solutions**?
- Choose your two best solutions.

CREATE - A - DESIGN

- **Draw** a diagram with labels.
- Have a critical design review (peer review & input).
- What materials are available?

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **build** a prototype.
- **Test** the prototype!

EVALUATE

- **Improve** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

You may teach lesson once students have completed:

FOSS CA – Plants and Animals

- **Investigation 3, Part 2**

As students progress through FOSS CA – PLANTS AND ANIMALS, they will grow their knowledge about the different plants and animals in our natural world, focusing on various organisms' unique structures and their functions. At the end of Investigation 3, Part 2, students will read the chapter, Plants and Animals Around the World (pp. 28-46). This chapter describes different organisms that can survive in their unique habitats due to special physical and/or behavioral adaptations. Student engineers will find inspiration in these animal adaptations and mimic structures of a selected organism to solve a human problem.

MATERIALS

FOR EACH TEAM (2 students)

- Various objects/materials, including but not limited to:
  - egg cartons
  - toilet paper/paper towel rolls
  - empty cereal boxes
  - index cards
  - popsicle sticks
  - straws
  - pipe cleaners
  - felt
  - cotton balls
  - straws
  - small paper bags -or- small plastic baggies
  - cafeteria paper trays
  - empty milk cartons
  - construction paper
  - disposable gloves (can be obtained from cafeteria/plant manager)
  - ½" – ¾" masking tape (unlimited)

FOR THE LESSON

- Individual student engineering notebooks
- Scissors
- Pencils
- Science Resource Books
  - pages 17-18 (How Seeds Travel)
  - pages 28-46 (Plants and Animals Around the World)
- Habitat Organism Cards – select cards exhibiting structural or behavioral adaptations (one for every two students). Suggestions follow:
  - **Pond**:
    - Cattails (structures to carry seeds in the wind)
    - Aquatic snail (closes opening to shell for protection)
    - Mallard duck (webbed feet for swimming)
  - **Forest**:

- Sundew (tiny, sticky structures to catch prey)

- **Rain Forest**:
  - Caracolus snail (strong shell for protection)
  - Walking sticks (camouflage by mimicking nature)
- **Desert**: n/a
- **Grassland**:
  - Ferruginous hawk (strong claws to catch prey)
- **Ocean**:
  - Turban snail (radula – tongue with rough surface – for scraping)
  - Octopus (suckers on tentacles)
  - Purple sea urchin (sharp spines for protection)
  - Kelp crab (camouflage)
- **Wetland**:
  - Apple snail (closes "door" to shell for protection)
  - Green anole (color helps in camouflages)
  - Snail kite (beak shaped to get its prey out of its shell)
  - Roseate spoonbill (beak shape helps scoop up food)
- **Tundra**:
  - Ptarmigan (color change helps camouflage throughout seasons)
  - Snowshoe hare (hair camouflage and keeps them warm)

GETTING READY

1. **Schedule the Engineering Challenge**
   The challenge will take about three 45-minute sessions to complete: one session for planning (Ask, Brainstorm, Create-a-design), one session to build (Develop-a-prototype) and test, and one session to improve (Evaluate).

2. **Gather/Obtain materials**
   Ask students to begin collecting toilet paper/paper towel rolls, egg cartons, cereal boxes from home one month prior. Cafeteria trays and milk / juice cartons can be collected a week or two prior to activity (set up a collection box with student attendants during lunch time).

3. **Download YouTube videos onto your computer**
   Videos should be downloaded at home to avoid firewall issues and wifi issues at your school site.

- Video resources:
  - www.youtube.com/watch?v=fRX2JtKFUzk (animal adaptations) [2:20]
  - www.youtube.com/watch?v=2d1VrCvdzbY (biomimicry) [9:21]
  - www.youtube.com/watch?v=4vq8ci4RTUs (biomimicry) [3:06]

4. **Complete FOSS CA: Plants & Animals through Investigation 3, Part 3.**
   Pay attention to:

- Investigation 2-Part: Students read "How Seeds Travel" and answer questions at end of chapter (pages 86-87 in Teacher's Guide)
- "Background for the Teacher" about animal adaptations on pages 108-110 in the Teacher's Guide
- Investigation 3-Part 2: Recording Changes (beginning on page 124 in Teacher's Guide), Step 13 shows a Structures Chart (page 125) to be completed whole class. Display this chart as a resource for engineering activity.
- Complete Investigation 3-Part 3, including:
  - Watching the video "How Plants Live in Different Places"
  - The Habitat Match activity.

5. **Prepare materials station**
   Tape may be pre-cut into yard long strips. Materials can be organized using cafeteria trays.

6. **Print Focus Questions**
   Have Focus Questions printed on self-stick labels OR precut labels for gluing into Engineering Notebook –
   How can you solve a problem by mimicking a plant or an animal?

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP).

- **Setting the Context**
  - Remind students that humans solve problems all the time, and humans who solve problems using their knowledge of science, technology, and math are called engineers.
  - Ask students if plants or other animals besides humans solve problems.
    - Have students discuss with partners and share out. (SL.K.1)
  - Review with students about how plants and animals have solved problems.
    - Refer to STRUCTURES CHART (from Investigation 3, Part 2 - see below)
    - ADD a 4th column on the right – "Problem that Needed Solving"

Plant/Animal	Environment	How does it survive?	Problem that Needed Solving
cactus	Desert	long roots take in lots of water	*water is scarce or far away*
green frog	rain forest	catches insects with long, sticky tongue	*prey was out of reach*
water lily	Pond	leaves at surface of pond to catch sunlight	*sunlight at surface of water*
prairie dog	grassland	strong claws for digging tunnels	*difficult to dig*
tundra plant	tundra	stops growing in the winter	*harsh conditions*
caribou	tundra	migrates to warm places	*too cold*
(add notes from Habitat Organism cards below)			
(add notes from Animal Adaptation video below)			
(camel)	(desert)	(notes from video)	
(giraffe)	(grasslands)	(notes from video)	
(penguin)	(Antarctic)	(notes from video)	

- Student pairs research other animals/plants solving problems by referring to Habitat Organism cards
  - Refer to list MATERIALS section. Pair of students can share an organism card.
  - Pairs share out what they have researched on the cards. (W.K.8)
  - Teacher adds organism and adaptations to Structures Chart.
- Show student the "Animal Adaptations" video (duration = 2:20)
  - < https://www.youtube.com/watch?v=fRX2JtKFUzk >
  - Add new data to Structures Chart
- Direct students to look at the Structures Chart they have compiled, and then speak with a partner about specific times in their lives they have experienced problems similar to those of these plants and animals that needed solving. (W.K.8) (SL.K.1)
  - Students share out and teacher scribes on board -OR- place ✓next to the "Problem Solved"
- Ask students what they would do if they needed to drink water, but the water was far away but they were unable to bring it closer or get closer to it? What if they needed to reach food, but it was also too far away to reach with your mouth? (students may find inspiration from cactus or green frog)
- Inform students that engineers do exactly what they did – look to nature for inspiration. When humans copy nature, we call that BIOMIMICRY (bio means "life" and mimicry means "copy."
- The class will watch the BIOMIMICRY video (duration = 9:21) www.youtube.com/watch?v=2d1VrCvdzbY
- Ask students to recall from the video problems that needed solving and the ways nature solved those problems.
  - Add new data (information from the video) onto the Structures Chart.
    - Notify students that they will be engineers who are charged with the challenge of solving a problem they experience in their lives and find inspiration from nature in solving that problem.

1. ASK

Present problem or need

- Inform engineers that partners will select a PROBLEM: similar to those experienced by a plant or animal.

Present Focus Question: "How can you solve a problem by mimicking a plant or an animal?" *(Printed on self-stick labels)*

- Display the Focus Question and have students stick/glue the Focus Question into their Engineering Notebooks.
  How can you solve a problem by mimicking a plant or an animal?

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed*:
  - Teams consist of two members
  - The completed design must solve the agreed-upon problem by mimicking a plant or animal structure and function.
  - Design must be approved by the teacher.
- **Restrictions** (Constraints) *limitations that keep something from being the best it could be; may be problems that arise or issues that come up*:
  - Use only the materials supplied by teacher
  - The team design must incorporate an aspect of each team member's design

2. BRAINSTORM

- Observe materials, discuss properties of materials and imagine how they might be utilized.

3. CREATE - A - DESIGN

- Each member must draw a design individually (2-3 minutes), without team member input, into his/her engineering notebook.
  - Title the page "My design"
  - Students should label parts of their design (SL.K.5) (K.MD.A.2)
- Team members share designs with one another (3-5 minutes), compromise, and collaborate in order to create into a "team design" incorporating an aspect of each member's own design. (SEP-1)
  - Title the next page in the engineering notebook, "Team design"
  - Team members should each draw and label parts of this collaborative design (SL.K.5) (K.MD.A.2)

4. DEVELOP - A - PROTOTYPE

- Build !!! (SEP-2)
- Test design
  - Team member will each test their design to see if it successfully solves their unique problem.

5. EVALUATE

- Teacher facilitates discussion about student successes and challenges (SL.K.1). Students may observe other teams solving similar problems in a different way and consider modifying their own designs.
- After observation of other designs and input from colleagues (SL.K.1), students **redesign** and **rebuild**.
- Have students answer the Focus Question in their engineering notebooks using both text and diagrams.
  - For scaffolding, sentence frames work well.
  - For example, "We solved our problem of _____ by mimicking the _____." (W.K.2)