Bay Area Scientists in Schools Presentation Plan

Lesson Name Robots that Run, Climb, Flap and Swim
Presenter(s) EE Outreach @ Berkeley

Grade Level K—5 targeting standards in 3rd Grade

Standards Connections:

California Science Content Standards: (1998)
(3rd Grade) LS-3.a. Structures of living things help them survive.
(3rd Grade) LS-3.b. There are diverse life forms in different environments.

Next Generation Science Standards: **K-2 Engineering Design** (2013)
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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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)	**Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Teaser:

Where are all the robots? TV, movies and the internet would have us believe that robots that look like people should be here, now, doing everyday tasks like our laundry. But we don't see that in reality: in fact the "robots" most people think of don't exist because of the huge challenges of getting robots to do even simple tasks. In this module we have students modify vibrating "bug" toy robots to follow walls like real insects to foster a discussion about what robots are and what they can do. The robots provide a conceptual bridge highlighting connections between disparate science disciplines.

Objective: *As a result of your lesson, what will students learn? What will they be able to do?*

The students will develop a precise definition of robotics: "programming matter to do work". They'll understand some of the basic tasks of robotic navigation, and how morphology (shape of animals) helps them perform particular tasks. They'll also learn how studying the natural world is connected to topics like robotics engineering.

Vocabulary / Definitions: *3 – 6 important (new) words*

robot, bio-inspiration, mechanical adaptation

Materials:

What will you bring with you?

Mini-robots, wires for modifying the robots, presentation material.

What should students have ready (pencils, paper, scissors)?

Heavy books or small boxes to build obstacles for the robots to navigate.

Classroom Set-up:

Students should be in small groups of 1-3 with their desks pushed together. This provides a large surface for the mini-robots to run around and fosters a little collaboration/competition between teams striving to accomplish the wall-following task.

A laptop projector is very useful.

Classroom Visit

1. **Personal Introduction:** ___5___ **Minutes**
   Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?
   We'll introduce ourselves as engineers from Berkeley, talk about what we do as scientists and also talk a little bit about where we come from to help establish a more personal connection.

   Topic Introduction: ____10____ **Minutes**
   What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge…
   This module starts with a discussion of how students understand robots, and what is right and wrong about those ideas. In particular, we invite students to define robots themselves by coming up with examples ("Is a hammer a robot?" "Is Google a robot?"). This discussion is often pretty far reaching, because people are pretty excited about robotics, so plenty of time has been budgeted.

2. **Learning Experience(s):** ___30-40__ **Minutes**
   What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring… Describe in order, including instructions to kids.
   After this, mini-robots are introduced and a series of tasks for the mini-robots is set out. For instance, tie wire around a robots head to make it follow a wall on its left side, even around corners. Each student is given a mini-robot and a length of wire to experiment with while we circulate in the room and have one-on-one design discussions. There are many tasks available if students finish quickly.

3. **Wrap-up: Sharing Experiences** ____10___ **Minutes**
   Putting the pieces together – how will students share learning, experience, build vocabulary?
   Another class discussion at the end of class allows students to share what design principles they learned, what was challenging about the task. This is compared to state-of-the-art research, using videos if time.

4. **Connections & Close:** ____5____ **Minutes**
   Remind students to notice how form relates to function, both in the design of artificial objects as well as the number and shape of limbs and size of animals seen in nature.

Total 50 – 60 Minutes

Follow-up – After Presentation

Students pick an example of form relating to function. Examples abound around the house (pets, kitchen utensils) and outside (bugs; birds; construction equipment). They then write a note explaining that form and function of their object or animal. The project can be expanded to include researching animal adaptions. Particularly, classifying adaptations as *mechanical* (arising passively from form) or *behavioral* (arising from active decision-making).

List or attach examples of activities, websites, connections for additional learning.
Our website (http://www.eecs.berkeley.edu/~eegsa/or) has the robotics material we've produced. We purchase our robots from http://www.hexbug.com/nano/. Several TED talks (e.g. http://www.ted.com/talks/robert_full_on_animal_movement.html) discuss related themes.