Bay Area Scientists in Schools Presentation Plan

Lesson Name: Materials and Structures
Presenter(s): SECO
Grade Level: 2nd Grade
Standards Connection(s): Motion can be changed with force; Objects fall to earth unless held up.

California Science Standards: Students know objects fall to the ground unless something holds them up
Next Generation Science Standards:
2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
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 and Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Planning and Carrying Out Investigations -Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1) Analyzing and Interpreting Data -Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2) (K-2-ETS1-3) Developing and Using Models -Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)	PS1.A: Structure and Properties of Matter -Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1) -Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3) 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)	Patterns -Patterns in the natural and human designed world can be observed. (2-PS1-1) Cause and Effect -Events have causes that generate observable patterns. (2-PS1-4) -Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2) Influence of Engineering, Technology, and Science 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. (2-PS1-2) Structure and Function -The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Common Core State Standards Connections:
ELA/Literacy –
RI.2.8 Describe how reasons support specific points the author makes in a text. (2-PS1-2)
W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1),(2-PS1-2)
W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1),(2-PS1-2)
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. (2-PS1-2), (K-2-ETS1-3)
MP.4 Model with mathematics. (2-PS1-1),(2-PS1-2), (K-2-ETS1-3)
MP.5 Use appropriate tools strategically. (2-PS1-2), (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. (2-PS1-1),(2-PS1-2), (K-2-ETS1-3)

Teaser:
Our world is full of things that are engineered—cars, buildings, even everyday things like tables and chairs! A large amount of effort and planning goes into figuring out how to make many of the items we use every day. In this lesson, students will learn about the relationship between materials and structures: that is, the substances an item is made up of vs. how those substances are arranged. Each student group will figure out how to build a paper structure capable of supporting a medium-sized book, demonstrating the power of a strong structural arrangement (even when using a relatively weak material).

Objective:
Students will learn that the strength of a structure is not just determined by the strength of its materials, but also by the way its materials are shaped. Students will learn that engineers can conserve resources by arranging materials in carefully designed and creative ways.

Vocabulary/Definitions:
3 – 6 important (new) words
Design
Structure
Material
Properties
Function
Trade-off

Materials:
What will you bring with you?
Paper, Tape, Styrofoam cup(s), Cardboard box, Egg carton

What should students have ready (pencils, paper, scissors)?
Each group needs a heavy book (textbook) with which to test their structure.

Classroom Set-up:
Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed
Groups of 3-4, ideally, we'll have one volunteer per student group

Classroom Visit

1. Personal Introduction: 5 **Minutes**

We're NAMES… We study Mechanical Engineering., Chemistry, etc. Does anyone know what engineers do? (*Each volunteer describes what they do, why it is interesting, and what they studied in school*)

Topic Introduction: **5 Minutes**

How many of you have ever built something? What are some things that you've built? Engineers have a special word for things that they build: **structures.**

When you build structures, what do you use to build? Blocks? Legos? What else? The things that we use to build structures are called **"materials."**

When you build, are your [forts/walls/whatever] easy to knock over or hard? [followup: why was it easy/hard? Can you remember how it looked?] Do you ever need to hold something up? What? How do you make sure you can support your [doll/action figure/baby brother]? Do you just make a solid brick of [legos/blocks]? Different materials have different properties that make them good or bad for building certain structures. Take, for example, Styrofoam [show cup]: what are some properties of Styrofoam? (Shapeable, holds heat, weak) What if you tried to build a chair made out of this piece of styrofoam? Do you think that would work?

Do you think this Styrofoam cup could hold up this heavy book? (Show of hands: yes vs. no) Why do you think yes? Why do you think no? Sometimes, materials can surprise you! A set of Styrofoam cups can hold up this heavy book! [Demonstrate using 4 styrofoam cups and a textbook].

[Hold up/pass around piece of cardboard cut from egg carton] Does anyone know what structure this is from? What material is it made from? How strong do you think this piece of thin, flimsy paper is? What could we do with it? [Show egg carton] Well, you can stack these up very high and they will still protect the eggs inside from getting crushed!

Engineers have many ways to make a strong structure out of a weak material. How many of you have ever put things into a cardboard box? What kind of things can you put in there? How much weight can a cardboard box hold? Has anyone ever taken apart a piece of cardboard to see what is inside? [demonstrate by peeling apart a sheet of cardboard in front of them]. This wavy part is called "corrugation"—it's what allows us to make a strong piece of cardboard using only three thin pieces of paper. Imagine if we tried to make a strong piece of cardboard by just stacking many sheets of paper together—it would take a LOT more paper! That box would weigh so much that it would be hard to lift it, even without anything inside.

Who has seen a car tire? What is it made of? Has anyone seen the inside of the tire? What's inside? Why do cars and trucks use tires, instead of just a solid wheel of rubber? (material cost, better function – friction, shock-absorbing…) Why does a big truck have more than four tires? [Ask students] Discuss how only a few tires would not be enough to support a truck, but many tires works!

2. **Learning Experience(s):**
We've seen how structure can play a big part in the strength of an object. Now it's time to put it into practice! You guys are going to be engineers for a day. Using the materials we give you – paper, tape, and a book - you need to build a structure that can support the book at least two fists [demonstrate] above the table. You can use as much paper and tape as you want, but the structure can't be taped to the table. You'll have [X] minutes to work on your structure, and then we'll have you share your structure with the rest of the class.

[Give students 5-10 minutes to work on their structures in groups. Observe their progress and ask them to tell you what they are trying, observing, concluding. Why did they decide on the structure they did?

Let them know when there is one minute left. Stop and have students show what they did, explaining what they observed while they were building.]

In the real world, engineers have to work with a limited amount of time and money, so they might not be able to do exactly what they want. This means that we have to learn to work with smaller amounts of materials! Sometimes we also have other restrictions, like size, shape, or even appearance! Often, we have to make compromises that we call "trade-offs." [Give examples of trade-offs, like cutting out an extra feature to save space/money, spending more money on a higher-quality material, etc]

As engineers, your job is to now to build a structure that can support the same book two fists above the table using only [X] pieces of paper. You'll have [X] minutes to work on your structure, and then we'll have you share your structure with the rest of the class.

[Give students 5-10 minutes to work on their structures in groups. Observe their progress and ask them to tell you what they are trying, observing, concluding. Why did they decide on the structure they did?

Let them know when there is one minute left. Stop and have students show what they did, explaining what they observed while they were building.]

[Discuss that paper is a weak material, but when shaped in certain ways, it is very strong!]

3. Wrap-up: Sharing Experiences **___30____ Minutes**

What are some things that you learned today about materials and structures? Did you see anything that surprised you? What was difficult? What "hints" helped the most? What did you learn?

What if you wanted to use popsicle sticks to support a book? How would this be different? How are the properties of popsicle sticks different from the properties of paper? [Stronger material—maybe they will say that this is better. If so, point out that this is true, but they are more expensive, more complicated, would take longer, would need glue, etc]. What do engineers call these differences? [**trade-offs]**

Can you think of a case where you might need to use Popsicle sticks instead of paper to build a structure? [holding up a really big book, holding up a person, if you didn't have paper]

4. Connections & Close: 5____ **Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

From now on, pay attention to the structure of the things around you. How did engineers use good design? What are some of the trade-offs they might have made? Take a photo or draw a picture of something you observe that has an interesting structure or interesting material properties.

Total 50 – 60 Minutes

Follow-up – After Presentation

Students can write letters to the volunteers describing what they learned or talking about other experiments they've done with structures.

Berkeley Engineers and Mentors lesson plan archive: http://beam.berkeley.edu/resources/lesson-plans

PBS kids is also a great source of engineering activities, at http://pbskids.org/designsquad/parentseducators/workshop/welcome.html and http://pbskids.org/zoom/activities/sci/#engineering.