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BASIS Lesson Plan

Lesson Name: Fill the Feeder!

Grade Level Connection(s)

NGSS Standards: Grades K-2 Engineering

**Note to volunteers: The BASIS Program Manager will discuss how to adapt this lesson for grades K, 1, and 2 in your coaching session (for example, vocabulary or criteria will change). This lesson plan is a general guideline, base roughly on 1st grade.*

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

This hands-on lesson introduces students to engineering through a fun, team-based challenge. Students will discover how engineering is used in the world around them, in everything from pencils to highways; then, they will complete an engineering challenge with a team of classmates, based on the storybook "Those Darn Squirrels" by Adam Rubin.

Lesson Objectives

- Students will work together to conduct a collaborative engineering challenge.
- Students will ask questions, make observations, and gather information about a situation they wish to change for the fictional Old Man Fookwire, which can be solved by developing a new tool
- Students will develop a sketch of possible solutions to a problem that can be solved with engineering.
- Students will understand the values of teamwork, design, optimization/improvement, and "failure" in the engineering process.

Vocabulary Words

- **Engineering:** Finding solutions to problems using math and science.
- **Technology:** The product/outcome of the engineering process; a tool/device that is used to solve a problem.

- **Criteria:** How we measure success; how we know our engineering solution is successful.
- **Constraints:** Limitations or restrictions: in engineering, usually time, money, materials, space, human resources

Materials

Scientist volunteers will bring:

- "Those Darn Squirrels" by Adam Rubin
- Small bowl or cup
- String/tape to mark off circle with diameter of 2-4 feet
- Paper bags with building supplies (one bag per group): 3 corks, 1 toilet paper roll, 6 feet of string, 2 Dixie cups, 1 plastic spoon, 1 ping pong ball, 1 bottle cap, 8 popsicle sticks, 2 rubber bands, 2 index cards, 3 paperclips, 2 straws (materials can be changed, but must be identical for each group), 1 roll of masking tape
- *If you have other materials available for the students to use those can be added to the lesson. Lots of items that often go into the recycling or garbage can turn into wonderful materials for and engineering challenge like this.*

Teachers should provide:

- Lab notebooks (or paper for students to write on), pencils

Classroom Set-Up

- Students should begin on the carpet if possible; if not, students should begin facing the front
- Students will then break into groups of 3-4
- We will need an area of the classroom approx. 6x6 feet for students to test their designs

Classroom Visit

1. Introduction (10-15 minutes)

Role Model Introduction:
Being a role model is an important part of being a BASIS volunteer! Begin your lesson by explaining who you are and what you do as a scientist. Feel free to tell your "story" as if giving an elevator pitch to kids: Why did you become an engineer? What problems are you trying to find solutions to?

What do you do in your job? Why should students relate to you? Feel free to bring in photos, specimens, and other props. Let your personality shine through!

Topic Introduction:

1. Introduce engineering
    - Write **engineering** on the board
    - Activate students' prior knowledge with a group discussion: What do you know about engineering? What do engineers do? What kinds of projects do they work on? What kinds of things do they build? (This also helps you to adjust the lesson according to the class's background).
    - Engineering is a way of finding solutions to problems using science and math.
    - Problems may be big (how to we get cars across the SF Bay?) or small (how can we remember things we learn?)
2. Introduce technology
    - Engineers address these challenges by creating **technology** (write on board). What kinds of things do we already know about technology?
    - Technology can be electronic, but it definitely doesn't have to be!
    - It also can be complicated (a bridge) or simple (paper and pencil)
    - What kinds of technology can students see in this classroom? What problem do they solve? (eg shoes help us walk without hurting our feet; a computer helps us record and learn things, communicate, and play games; the walls help us display things and keep sounds from going from one room to another; etc.)

Teaching Tip: Guide Discussion in grades K-2

- Write new vocabulary words and brainstorm lists on the board
- Refer back to the board to engage visual learners and English Language Learners
- Be aware of examples you use that may not be accessible to all students: for example, some students may not have ridden a roller coaster, been on an airplane, played with a smartphone, or even been outside of their hometown!
- Guide students to figure things out together by turning statements into questions
    - Instead of saying: "A baseball cap is a kind of technology, because it solves the problem of how to keep the sun out of our eyes."
    - Try: "Can you think of an example of technology from this classroom? What about that baseball cap hanging up by the door? What problem does it solve? How does it solve that problem?" etc.

3. Introduce engineering challenge
    - Today, we're going to be engineers by working together to create technology that will help solve a problem.
    - The problem we're going to help with is actually a problem that a man named Old Man Fookwire is having; Old Man Fookwire is a man from this book!

- Skim the book with students, highlighting important plot items and pointing out relevant illustrations. Invite students to describe what they see, in addition to offering your guidance through the story. Main points to hit:
    - Old Man Fookwire loves to paint birds
    - Old Man Fookwire needs a bird feeder to attract the birds
    - Squirrels keep eating the food, which means the birds will stop coming
    - Old Man Fookwire needs a way to keep the birds out
    - He tries to engineer solutions, but the squirrels find a way around it
    - Finally, he figures out an elaborate technology to keep them out – but now he has to figure out how to get the food in, without falling into his own trap!
- We engineers need to work together to figure out a way to help Old Man Fookwire to put the birdfeed in the birdfeeder without touching the lasers around the feeder!

2. Learning Experience (35-40 minutes)

- Students will work in teams to design a device that delivers a ping-pong ball into a cup in the center of a circle, which **models** the birdfeeder and birdfeed.
- Next Generation Science Standards **engineering process** (write on board for grades 1-2)**:**
    1. Define the problem: identify situations that people want to change as problems that can be solved through engineering
    2. Develop solutions
    3. Optimize: compare solutions, test them, and evaluate them (alternate word: improve)
        - Emphasize that engineers often have to test and re-design many times before they find a solution that works! Give examples: are we still driving cars like the ones our grandparents drove? No, every year engineers improve upon car designs. Will we be driving the same cars in the future? No, engineers will continue building on each other's solutions.

Teaching Tip: Differentiate for grades K, 1, and 2

- Ask the teacher about students' background in engineering, and adjust constraints and criteria accordingly.
    - A kindergarten class with no experience may need to explore the challenge free-form, without criteria or constraints ("using imagination")
    - A 2nd grade class with lots of experience may need a follow-up challenge: if they succeed at the first challenge, can they reverse their roles? This time, they are the squirrels: how can they design a way to get the birdfeed OUT?
- Ask the teacher about their students' experience with teamwork. In some classrooms teamwork may still be a challenge, so the teacher may recommend using pairs.
- Read the room. Kindergartners may want you to go read the story more in-depth, which can give them a solid foundation for understanding the challenge; 2nd graders may want you to fly through the important bits so they can get started!

Set up: Prepare a circle with string or tape on the floor (or use a hula hoop). For younger students, a 2-foot diameter is good; for older students, you can increase the diameter to 3-4 feet. Place the cup or bowl in the center. This is the "target": the birdfeeder!

Step 1: What's the problem?

- Reiterate to students that Old Man Fookwire needs their help. He has create a circle of lasers around his bird feeders to try to keep the squirrels away, but now he needs to put the seeds (a ping pong ball in this activity) in the feeder (a cup in this activity). To stay safe, no part of Old Man Fookwire's body (or the students' bodies) can cross the invisible wall of lasers that extends upwards from the circle. .
    - Check to ensure students understand what the ping pong ball, cup, and string/tape circle represent
- Introduce the word **criteria** (write on board, define):
    - The device must drop the ball into the cup in the center of the circle
    - (Criteria can be modified to change the difficulty of the challenge)
- Introduce the word **constraints** (write on board, define):
    - The students can only use the materials provided
    - No part of any student's body can cross over the vertical line created by the circle on the floor. Imagine that the circle is the base of a wall of lasers. (For younger students, you may want to put up a low physical barrier to emphasize the point, like folders lined up)
    - (Constraints can be modified to change the difficulty of the challenge)
- Next, let each group look at the circle and cup so they understand how far their device will need to reach.
- Challenge students to ask questions that will clarify the criteria and constraints (what materials can we use, does the ball have to stay in the cup, can we reach in and drop the ball into the cup, how much time do we have, etc.)
    - Check to be sure everyone understands the criteria and constraints.
- Let the students see the materials as a class by holding them up in front of the class.
- Reiterate to students that there is no failure in this challenge, only steps and improvements. For older students, you may wish to present the acronym FAIL: Future Advantage In Learning.

Step 2: Develop solutions

- Separate students into their groups.
- Give students 5-10 minutes to brainstorm several possible solutions independently, drawing designs and recording descriptions in their notebooks. This is important, as it allows students to come up with ideas without being affected by other students' thoughts and evaluations.
- After students have brainstormed independently, have them gather together with the rest of their group. Everyone in the group should share the ideas they had, and together, the group should decide on a design they want to build. (They may choose to select one student's brainstorm ideas, or combine ideas to come up with a new design). They should have a drawing of their plan before they begin building.

- Once a group has decided on a design, have them raise their hand to request materials.
- Give students time to construct their technology.
- When each group is ready, they can bring their technology to the "birdfeeder" and test their solution.

Step 3: Optimize

- After groups test their design, they should return to their desks/table to improve their design: either to find a solution that works, or to find a solution that works even better.
    - Re-emphasize that engineers often have to test and re-design many times before they find a solution that works!
    - Groups should start by looking at their first design and talking together about what worked and what didn't. What will they do differently the second time?
    - Volunteers should walk around the room guiding students to identify what about their technology keeps it from being optimal, and how they can find solutions to the specific problems they're having.
- Groups can continue to test and improve their solutions.
- If all groups are successful, you can increase the challenge by making the circle bigger or changing one of the other constraints.
- If groups are struggling, consider making it less challenging by altering constraints.
- If one or more groups are especially successful, you may wish to switch the challenge around: this time, students are the squirrels! How will they design a technology that gets the birdfeed *out* of the birdfeeder without touching the laser wall?

3. Wrap Up: Review and Discuss the Learning Experience (5-7 minutes)

Round out the experience by giving students time to share and discuss their solutions. For younger students, show-and-tell on the carpet may work best; for older students, a gallery walk or show-and-tell from their desks often works fine.

Prompts may include: Why have they included the various components of their design? What did they learn the first time that helped them to be successful the second time? Why did they try their first design? What worked? What problems did they have? What did they change the second time? Did that solve the problem?

Encourage students to respond to one another's solutions, and identify patterns. Did more than one group try something similar? Did different groups experience similar challenges?

4. Connections & Close (2-3 minutes)

Connections to the real world around students:
Engineering is everywhere! What other problems would students like to solve in the future? What else would they like to create? Do they have any questions?

Close:
Wrap up by leaving a few minutes for students to ask questions about engineering, about being an engineer, and about becoming an engineer. Then, thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  - K-2. Engineering Design
- Connections by disciplinary core ideas:
  - K-2-ETS1 Engineering Design
- Connections by scientific & engineering practices
  - 1. Asking questions and defining problems
  - 3. Planning and carrying out investigations
  - 6. Constructing explanations and designing solutions
- Connections by crosscutting concepts
  - 2. Cause and effect: mechanism and explanation
  - 6. Structure and function
- Connections by performance expectation:
  - K-2-EETS1-1. 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.