CRS WWW.CRSCIENCE.ORG
COMMUNITY RESOURCES FOR SCIENCE

BASIS Lesson Plan

Lesson Name: Special Delivery: Design A Package Protector!
A Lesson Developed for The Port of Oakland

Grade Level Connections:
Next Generation Science Standards: Grades K-2, Engineering
FOSS Next Generation Edition: N/A

**Note to volunteers: This lesson plan is a general guideline, based on 1st grade, but can be adapted for grades K, 1, or 2 through changing vocabulary, criteria, and constraints.*
**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 focused on cargo transportation. Students will learn that there are many ways to transport an object from one point to another – on land, over the sea, through the air. Then students will be introduced to the engineering design process and will work collaboratively in pairs to design and build a package that can safely and quickly transport cargo across the classroom. Real-world connections to the criteria and constraints that must be made for transporting materials via container ships and airplanes will be emphasized throughout the lesson.

Lesson Objectives

- Students will understand that cargo is transported from place to place in many different ways, but we always want that cargo to be transported quickly and safely.
- Students will work together to conduct a collaborative engineering challenge.
- Students will understand the values of teamwork, design, optimization/improvement, and failure in the engineering process.

Vocabulary Words

- **Transportation:** A way of moving people and things
- **Cargo:** Things being transported
- **Engineering:** Finding solutions to problems using science and math

- **Criteria:** How we measure success; how we know our solution is successful
- **Constraints:** Limitations or restrictions (e.g. time, money, materials, space)

Materials

Volunteers will bring:

- Boba straw with small aluminum container attached (5)
- Long string (5)
- Tape (6 rolls)
- Engineer Design Process Signs, laminated (5)

- Chip ("cargo") (at least 16)
- Golf ball ("cargo") (16)

Ziploc bags (16) filled with

- Construction paper (2 sheets)
- Tissue paper (2 sheets)
- Egg carton pieces (2)
- Cotton balls (4)
- Tape (small pieces given as needed)
- Glue stick (1)

Teachers should provide:

- Lab notebooks (or paper for students to write on)
- Pencils
- Scissors

Classroom Set-Up

Students should be seated at the central classroom carpet for the introduction to the lesson and we will need some white board space and markers. After the introduction, students will go back to their seats and will work in pairs on their engineering design and package construction, so please have the students paired beforehand. At the end of the lesson, students will return to the carpeted area for a wrap-up discussion. It would be helpful if students wear nametags during the lesson.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they do as a Port employee/scientist/engineer/science-enthusiast. 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 in your job? Why should students relate to you? Feel free to bring in photos, specimens, and other props. You may also wish to weave your own projects in as examples throughout the lesson or return to it with Q& A at the end.

Teaching Tip: Say, Write, Show

- Bring in photos and props to illustrate the topic intro
- Write new vocabulary words, key terms, and brainstorm lists on the board
- Refer back to the board to engage visual learners and English Language Learners

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: *how cargo is transported from place to place.* It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **Cargo must be transported from place to place safely and quickly.**

Your topic introduction should follow the outline below. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitate student-guided conversation.

- Have two volunteers stand at two opposite sides of the classroom. One volunteer will be holding a package and the other volunteer will not.
- "[Name of volunteer with package] wants to send a package to [Name of volunteer without package]. How could they do this?" [Gather suggestions from the students]
- "Now, let's pretend that [Name of volunteer without package] is on the other side of the school, the tow, the world from [Name of volunteer with package]. How could we get the package to her/him?!?!" [Have students think, pair, share. Then gather responses on board.]
- All of the ways that you've mentioned are called **transportation** [Define, write on board]. Transportation is a way of moving people or things from one place to another.

- At the Port, we transport people and things all the time, all over the world. We call all the things we transport **cargo** [Define, write on board]. Cargo is the word we use for the things that we transport. What are some examples of cargo? [Gather responses from students.]
- At the Port, we also have lots of engineers that work here. Has anyone heard of the word engineer before? Does anyone know what **engineering** is? [Define, write on board] Engineers use science and math to find solutions to problems.
- Some of our engineers work on airplanes, some of our engineers work on boats, and some of our engineers work on cargo and transportation.
- Today, you are all going to be engineers that find a solution to a problem. Let's find out what the problem is that you're going to solve!
- [As this discussion is happening, one volunteer should tape the end of a string to the whiteboard (or other classroom structure). Put the other end of the string through a straw that has an aluminum container attached and pull the string tight and tape or tie it to a lower support in the room.]
- We transport cargo from one place to another, over long distances. Some cargo is really heavy and some cargo is really light and can break easily. But sometimes we have to transport really light and really heavy packages at the same time! What do you think will happen if we transport this potato chip and this golf ball together? [The chip might break/get damaged!] Put the two objects in the transport system and see what happens [it might take a few tries to get the chip to break, but it will.]
- Your challenge today is to create a package that can quickly and safely transport one potato chip along with this golf ball from [starting place] to [ending place]. Let's imagine and plan some solutions!
- Add the first step of the engineering design process on the board "**ASK**". The first step that an engineer does is ask what the problem is and know what materials you will have:
    - Provide students with the **criteria** (you do NOT need to include this vocabulary term, especially for younger students):
        - You will need to create a package that (1) will fit inside of our aluminum transportation system and (2) will safely carry one potato chip and one golf ball. You want both objects to reach the finish line and you want the chip to be in one piece at the finish line!
    - Provide students with the **constraints** (you do NOT need to include this vocabulary term, especially for younger students):
        - You will have a bag that includes: construction paper, tissue paper, egg carton pieces, cotton balls, tape, and a glue stick
- Add "**IMAGINE**" and "**PLAN**" to the engineering design process on the board. In a moment you will imagine and plan your design with a partner. Make sure that you listen to your partner, share your own ideas, and work together to come up with a single plan for your package!

2. Learning Experience (35 minutes)

Students will go back to their desks and work with a partner for the engineering challenge. Remember that this activity is designed to address the topic of this lesson: **Cargo must be transported from place to place safely and quickly.**

- Have students return to their seats and provide each student with a piece of paper and pencil. Give them a few minutes to brainstorm and draw their design.
- Check in with each student pair to see what ideas they have. Make sure each has a plan before proceeding to the next step. Call all students back to attention. Add "**CREATE**" to the engineering design process on the board. In a moment, we will be passing out your materials and you will start to create your package. We will pass out a single strip of tape to each team, but if you need additional tape, just ask us.
- Conduct the challenge
    - Pass out materials to each pair of students.
    - Observe groups' progress and ask them to tell you what they are building, observing, concluding. Why did they decide on the design?
    - As students are doing this, set up four launching stations with strings taped or tied around the classroom. If space allows, these can all be around the carpet aligned with one another so that the student pairs can race one another. Each volunteer will help student pairs test their designs at the launching station, so only set up enough stations for the number of volunteers that are present in the classroom.
    - Let students know when there is one minute left for building their packages.
- Conduct the tests
    - Invite students to come up and test their designs at the launching stations, four pairs at a time if there are four launching stations. Students should form a circle around the launching area and stay there until all pairs have tested their design.
    - Emphasize that engineers "**IMPROVE**" (add to design process) and 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 be driving the same cars in the future? No, engineers will continue building on each other's solutions.
- Stage 2: Give groups 10 minute to optimize their design or address a greater challenge.
    - For younger students, have student pairs optimize their structure by working to improve it.
    - For older/more advanced classes, tighten the constraints: 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!
    - Observe groups' progress and ask guiding questions.

    - Let students know when there is one minute left for their re-design.
    - Re-test at the launching stations.
- Guide a group share
    - Have each group share with the class what they built. Focus on why each group made certain design decisions.
    - **Emphasize the importance of failure and how that helps engineers learn to make better solutions to problems!**

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

Have students rejoin you on the carpet for a wrap-up discussion.

- What are some things that you learned today about cargo and transportation? What was easy about the challenge? What was hard? If you had to do it again, would you do something differently?
- What if you had to use a boat to carry your cargo? How would this be different? How would this affect how far it would travel or how much it could carry?

4. Connections & Close (5 minutes)

Connections to the real world around students:

The problem of creating a package that can transport cargo from one place to another quickly and safely is very similar to real world problems that engineers work on too! Engineers have to figure out how we can transport lots of different cargo – different sizes, different shapes, different weights – all safely and quickly. From now on, pay attention to the shape and structure of packages that you see. Think about how engineers used good design.

Close:

Wrap up as a role model by leaving a few minutes for students to ask questions about the Port, science/engineering at the Port, and different careers that intersect with what students experienced in their classroom today. 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
  - Engineering: 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
  - 6. Constructing explanations and designing solutions
- Connections by crosscutting concepts
  - 2. Cause and effect: mechanism and explanation
  - 6. Structure and Function: Determine properties of things
- Connections by performance expectation
  - 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.

NC STATE Engineering

The Engineering Design Process

- The engineering design process is a series of steps that you repeat to develop or improve a product, process or system. You can start anywhere in the process, however, most engineers begin at **ASK** or **IMPROVE**.
- Failure is always a part of the process ... so is learning from failure!

Design process adapted from the Museum of Science Boston "Engineering is Elementary" program.

the engineering place