Materials Rich Learning Experiences - Engineering and Design
Developer: Explora
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Approximate Length: 60-75 minutes

Main Idea:
Through the process of using common materials to design a simple toy car, a great deal of science and engineering concepts are available for investigation, experimentation, and discussion. This activity puts engineers in the position of being an engineer on a specific project. Having a common engineering objective will help frame and foster discussion about elements common to the process of engineering. It will also serve as a discussion point for how we can use real experiences to stimulate activity and interactions with visitors.

Relevant Objectives:

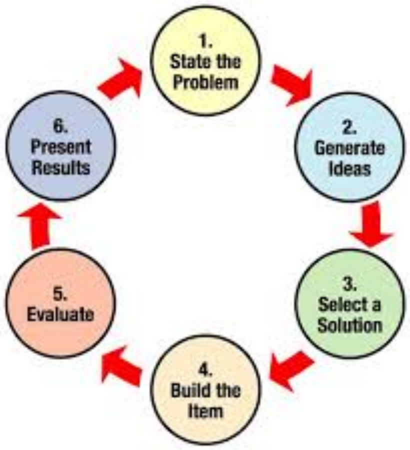
- Engineers develop communication strategies that support inquiry.
- Engineers and informal science education staff work together to design and facilitate materials-rich learning experiences that actively involve and affect all parties.
- Engineers understand the importance to learning of developing personal connections with audiences based on shared experiences.
- Engineers develop a broader understanding of how people learn and of the nature of informal learning environments.

How This Relates To Other Professional Development Elements:

This element focuses on the importance of physical materials and common experiences as a fertile ground for discussion of engineering with the public. It would be good to place this element early in the professional development process as it can inform the development of activities/challenges the engineers will be designing later and it will help frame their facilitation process.

Assumed Prior Knowledge and Experience:

We assume the engineers, at some point in their education or careers, utilized a design process similar to the following.



[Engineering Design Process | NASA]

Room Setup and Materials Preparation:

A runway in a room, or nearby space, at least 25 feet long will be needed. At two different locations in the room, set up a ramp (3ft long x 2 ft wide) for testing cars. Using short strips of masking tape on the floor, mark off a straight line at one-foot intervals past the end of the ramp.

Challenge 1
For each participant:
- cardboard (16"x8") - 16" side is cut across the corrugations
- 2 dowels (3/16" dia. 12" long)
- 8 plastic plates (minimum 4" diameter) - center holes can be pre-made or tools for making holes should be provided
- 1 brass fastener
- 8 pieces of plastic tubing (3/16" ID, ~½" long)

General materials:
- Masking tape
- Scissors
- Box cutters
- Rulers
- Meterstick or other longer straight edge

Place the following on a separate materials table:
Challenge 2
- Rubber bands (#32, 3" long, ⅛ inch wide)
- Large paper clips

Challenge 3
- Rubber bands of various sizes
- 8 plastic plates of a different diameter than those in part 1 (again, minimum 4" dia.)

Process:
Part 1: Introduction (2 minutes)

Tell participants that at the science center we are interested in providing the public with opportunities to have learning experiences through direct manipulation of the physical "stuff" of the world. Sharing experiences with the public will provide them with a basis for conversation related to engineering. Using cardboard, dowels, and plates (or lids or other heavier duty circles) allows for quick and inexpensive experimentation with design.

Part 2: Activity and discussion
Challenge 1 (20 minutes)

Engineers should use the available materials to make a car that will travel as straight and as far as possible. When ready they should roll their cars down the ramp. Allow the participants time to build, test, redesign, test again, etc for about 10 minutes.

They should be called back to their tables and asked to pause in the designing activity. Each person could answer the questions for the group "Did it go straight?, How far did it go?". Ask them to call out ideas regarding the process they just used to get their car to go straight and far. "What problems did you encounter in the process, and what did you do to eliminate the problem?" "Were the materials optimal for making a car go straight and far? What materials would be best? Are best and optimal the same thing? If not, how are they different?"

If engineers have not created a car that goes straight and far, allow them to finish that now.

Challenge 2 (20 minutes)
Add the following to the materials table:

- Rubber bands (#32, 3" long)
- Large paper clips

Call participants' attention to the additional materials and introduce the new challenge:

Get your car to move using a rubber band as a power source.

Tell the engineers they have 15 minutes to gather their additional materials, brainstorm plans for how to attach them to their existing cars, build and test.

Remove the ramps, as this time the cars must travel using only the energy from the rubber bands. As participants try out their cars, ask if they can improve the cars' performance. They can now spend some time redesigning and trying out their cars.

They should be called back to their tables again and asked to pause in the designing activity. Ask everyone to set aside their car for a brief sharing about their car's performance. Let each one show their car and report the distance traveled. Since everyone used the same materials, how can they explain the differences in performance? What factors are involved? Most comments will be related to one of two parts: technique and design.

Part of the design process is to figure out why something is not working well and test ways to improve it.

Challenge 3 (15 minutes)

Add the following to the materials table:

- Rubber bands of various sizes
- Both sizes of plates

In this challenge, participants will involve themselves in the process of finding the best solution for a problem, given the restraints. The problem remains: make a rubber band-powered car that travels the farthest distance in a straight line. There are now new materials with which to work - different sized rubber bands and another size of plate. They can also double the rubber bands in different combinations.

Tell the engineers they have 15 minutes to gather their additional materials, build and test. Which is the best rubber band or combination of rubber bands to use for the car? Which plates: small, large, combination, or orientation of plates give the results?

Once again, they should be called back to their tables and asked to pause in the designing activity. Have each person report on their car and its performance. What was the optimum rubber band or combination of rubber bands? What was the optimum configuration for the plates as the wheels? Is there a general agreement among the participants as to what is the optimum? Why is optimization important?

Rationale
By experiencing the preceding activity as adult learners, participants will become aware of the struggles and challenges that children may encounter while doing a similar activity. They will also experience the value of conversation based on shared experience with content-rich materials. These activities are designed to use an engineering approach for defining a problem, sorting out available information, and using available materials to solve a problem.

Materials and activity adapted from *Rubber Band Powered Cars* from *Design It! Engineering In After School Programs*, a series the Education Development Center, Inc. available through Kelvin® (www.kelvin.com - Stock #651663).