

POWERHOUSE SCIENCE CENTER

3615 Auburn Blvd., Sacramento 95821 (916) 674-5000

Topics

Engineering

Grades

3-5

Duration

60 minutes

Vocabulary

engineering, prototype, constraints, criteria, hypothesis

Next Generation

Science Standards

Practices

Planning & Carrying Out Investigations

Constructing Explanations & Designing Solutions

Core Ideas

ETS1.A: Defining & Delimiting Engineering Problems

ETS1.B: Developing Possible Solutions

ETS1.C: Optimizing the Design Solutions

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World.

Design Lab

Overview

The Design Lab program introduces students to some of the basic concepts of engineering. Students work in small groups to attempt three different challenges; building and testing models of earthquake resistant buildings, work under constraints to design the tallest tower prototype, and create a bridge that meets load bearing criteria. Each group of students will record the results and patterns they observe at each challenge in a data log. After students have the opportunity to try each challenge they will participate in a debrief to discuss their observations.

Objectives

- To provide a hands on experience where students engage with engineering.
- Highlight the presence/effect of engineering on the world around us.
- Understand failure is not a bad thing, especially in the field of science.
- Engage students with challenges that require them to think outside the box, use teamwork and fail.

Teacher Preparation

- If time allows during normal lessons, introduce students to some of the vocabulary to be used in the lab and the definition of engineering.
- Arrive 15 minutes before start time to allow time for check in.
- Have students in divided into groups of 2-3 to make station assignments more streamlined.

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Performance Expectation

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Vocabulary

Engineering: the branch of science and technology concerned with the design, building, and use of engines, machines, and structures.

Prototype: a first, typical or preliminary model of something, especially a machine, from which other forms are developed or copied.

Model: a three-dimensional representation of a person or thing or of a proposed structure, typically on a smaller scale than the original.

Design Lab

Extended Learning Activity

Point A to Point B

An engineer is a problem solver. Many of the problems engineers face require them to think outside the box, or have criteria/constraints (materials, time or cost) to consider. By participating in this challenge students generate and compare multiple possible solutions to a problem like engineers.

In the classroom or in an open space located on your school campus designate two spots; Point A and Point B roughly 8 yards away from one another. Place students into groups of 2-4 and present this challenge to them: **Move an object from Point A to Point B.** Explain the following constraints to the groups:

- 1) All team members must be touching the object while it is being moved.
- 2) The object cannot touch the ground between the two points.

Give teams time to generate possible solutions for moving their object. When ready each team takes turns moving their object across the space from point to point. If a team fails they must rethink their plan and try again.

Remind the teams that: in science failure is not considered a bad thing, it is as an opportunity to define the problem and do things differently the next time. Allow each team to try a few possible solutions to complete the challenge. After each team has succeeded in moving their object debrief together about the activity:

- Why did you think this was easy/hard?
- Did you notice anything that worked for more than one team?
- Why do you think failing helped?

Alternative Procedure:

- Randomly assign extra constraints on each team (i.e. you cannot use your right arms, one of your team member's eyes must be closed, and, you must walk backwards...).

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Vocabulary Continued:

Constraints: a limitation or restriction.

Criteria: a principle or standard by which something may be judged or decided.

Hypothesis: a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.

Interesting Fact:

The snowboard was invented by an engineer. Sernan Poppen created a winter toy for his daughter, by bolting two snow skis together and attaching a rope to the front.

Did you know?

The word engineer comes from a Latin word meaning 'cleverness'.

Quote

“Failure is central to engineering. Every single calculation that an engineer makes is a failure calculation. Successful engineering is all about understanding how things break or fail”.

-Henry Petroski

Design Lab

Extended Learning Activity

Alternative Procedure (Cont.):

- Limit how many times each team can attempt the challenge. If you are limited on time, the number of attempts can be crucial. It also allows the teams to really take their time to define problems with failed attempts as well as generate and test possible solutions.
- Increase the difficulty of the challenge by changing the types of objects that have to be moved. Size, weight, and, shape of materials are factors engineers must consider. If the weather permits using water can be fun and challenging alteration.

Resources:

<https://www.engineeringforkids.com/>

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Design Lab

Extended Learning Activity

Tower Take Two

The design process does not always generate the same answer. Even with constraints in relation to materials, time, and cost; engineers still get to decide how those materials, time, and budget will influence their design.

In the Design Lab students had the challenge of building a paper tower using limited materials, in this activity students will take on a similar challenge, and put what they learned in the Design Lab into practice.

You will issue the same challenge to teams of students in your class: Build the tallest “free standing” tower, using 2 pieces of paper and 1ft of tape. Then ask students to think about what worked or did not work during the challenge in the Design Lab. Once your class has brainstormed, issue 1 or more of the following additional constraints to the challenge:

- Give the students a time limit (10min, 7 min, and 5min)
- Assign each team a specific amount of Monopoly money that they can use to “buy” more tape or paper.
- Tape out a square on each teams building area that the towers base must fit inside.

Once time is up or teams have finished building, debrief together about the activity:

- Why did you think this was easy/hard?
- Did you notice anything that worked for more than one team?
- Why do you think failing helped?

Alternative Procedure:

- Allow teams to build in three different “phases”. Between each phase allow the teams to shop for more material. With more than one opportunity to purchase material, better building supplies can be offered, prices can change, and materials could run out.

Interesting Fact:

The first engineer known by name was the Egyptian pyramid builder Imhotep. Around 2700 B.C. he built the first pyramids in Egypt.

Quotes

“The fewer moving part, the better.”

- *Christian Cantrell*

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Design Lab

Extended Learning Activity

Alternative Procedure (Cont.):

- Switch out the starting materials. Instead of paper and tape have students use clay and Popsicle sticks, or raw spaghetti and marshmallows. **When switching to new starting materials it is a good idea to try building with them beforehand so you can offer assistance to students that are struggling.*
- The goal for the challenge can also be changed. Instead of having teams working to build the tallest tower, try having them build a tower that can hold a book, a tower that a toy car can roll under, a tower that's base touches the table at 3 different place.

Resources:

<http://edu.stemjobs.com/best-online-engineering-resources-for-kids/>

Quotes

“The trick to having good ideas is not to sit around in glorious isolation and try to think big thoughts. The trick is to get more parts on the table.”

— *Steven Johnson*