Oil Pipeline Disaster Engineering Design

Overview

Apply science and mathematics to a real world engineering design solution. Students experience key lessons including the application of an engineering design process and real world engineering challenges.

Objectives

Students will plan an investigation to provide evidence that the change in an objects' motion depends on the sum of the forces on the object and the mass of the object.

Students will graphically represent solutions.

Students will use 21st century skills of communication, collaboration, critical thinking and creativity.

Students will apply determine volumes.

Activities

1. Engage students in review discussion of: what is an engineering design process; why use an engineering design process; why do engineering designers use ideation and create multiple solutions; what are constraints; why is it important to define the problem completely?

Engineering Design

3rd-14th grade with grade appropriate modifications

Materials

Mailing tubes

Golf balls

Scissors

Tape, paper, string

Set-Up/Preparation

Assign groups of 4.

Build materials: available in a location removed from groups. For each group of 4 – scissors, one cardstock 8.5" x 11 sheet, 1 yard tape, 1 yard string.

Test materials: available in a separate location removed from groups. For each group one mailing tube with a golf ball in the bottom.

2. Engage students in a discussion on the BP Oil Spill. Show timeline video. Engage students in discussion on number of iterations and engineering design constraints and challenges

3. Review brainstorming.

4. Tell students that they will now apply what they have learned and consider engineering design constraints with the following BP Oil Spill Simulation with a focus on the need for ideation. We will simulate the time pressure engineering designer felt with limited materials and the remote constraints that the actual challenge presented: "Your challenge is to unblock the pipeline blockage. You have significant constraints, 18 minutes for the challenge and limited supplies."

5. Review brainstorming: 1. Defer judgement, 2. Encourage wild ideas, 3. Build on the ideas of others, 4. Stay focuses on the ideas of others, 5. One conversation at a time, 6. Be visual, 7. Go for quantity

6. Share constraints: 1. Limited to using the supplied materials; 2. Scissors can only be used for manufacturing, 3. Everyone in the group will help manufacture but only one person will extract the ball, 4. Groups are not allowed to handle materials until it is time to test, 5. Groups must manufacture the design shown on the concept drawing, 6. The time limit for manufacturing is 3 minutes., 8. The tube cannot be touched. Ask if there are any questions.

7. Start challenge with the following time limits:

    a. 3 minutes: silent individual brainstorming – draw sketches.
    b. Divide into teams

Modifications

Vary the design challenge to include unplanned for modifications, including stricter time limitations, allow students to only communicate graphically, require students to work with only one non-dominant hand.

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c. 15 minutes: teams collect ideas, brainstorm select best concept, finalize sketch of solution.
d. 1 minute: assign responsibilities for manufacturing and testing
e. 3 minutes: manufacture final concept
f. Group timed extraction

8. Test solutions collectively. Discuss lessons learned.

9. Discuss mathematical considerations

Notes:

REFERENCES

BP Oil Spill timeline https://www.youtube.com/watch?v=QiF-X-Ez9Bs

IDEO Brainstorming https://openideo.com/blog/seven-tips-on-better-brainstorming

SAMPLE STANDARDS

NGSS MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

NGSS ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

NGSS ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristic of each that van be combined into a new solution to better meet the criteria for success.

NGSS ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

NGSS MS-PS2-2. Plan an investigation to provide evidence that the change in an objects;' motion depends on the sum of the forces on the object and the mass of the object.

CCSS.MATH.CONTENT.5MD.C.5A Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

MN Academic Mathematic Standard 5.3.2 determine the area of triangle and quadrilaterals; determine the surface area and volume of rectangular prisms in various contexts.

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