ENGINEERING A MARS HABITAT

Overview

Book: *The Martian* by Andy Weir

Grades 6-12

In this engineering PBL, students will design and build an "air-tight" habitat, similar to the one Mark Watney built for his long-distance journey to the Schiaparelli crater.

Standards

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.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-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.

HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Objectives

Students will brainstorm ideas for an air-tight habitat.

Students will construct a prototype.

Students will analyze similarities of the successful prototypes and use them to create an optimal design.

Materials Required

A variety of materials students can use to construct their habs (tissue paper, computer paper, straws, cardboard, paper plates, plastic cut from dry cleaner bags, aluminum foil, construction paper, etc.)
Masking tape
Duct tape
Scissors
Base for each group (see preparation)
Air pump (the kind used to inflate air mattresses works well)
Drawing paper
Colored pencils or crayons

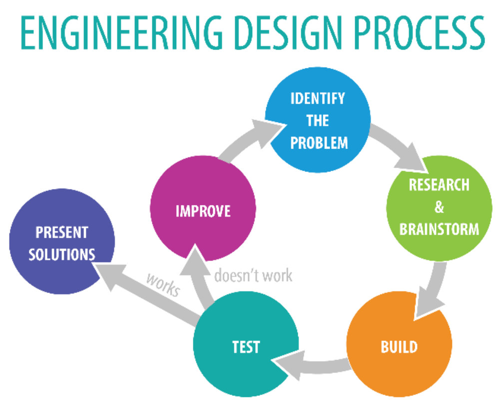
Preparation

Prior to starting this activity, prepare the pieces of cardboard each group will use for the base of their habitats. Cut the piece of cardboard into a circle or square at least 14 inches wide. At the center of each piece of cardboard, cut a hole just large enough for your air pump to fit through. It is important not to make the hole too large, as you will use the pump to check that habitats are air-tight. You do not want air to escape from your opening. The easiest way to do this is to trace on your cardboard around the opening of your air pump, then cut a hole a little smaller than what you traced.

This PBL can be divided into 3 class sessions: research/brainstorm, design and build, test and refine.

Procedure

1. Divide students into small groups.
2. Pose this problem to the students:
   The trip to Schiaparelli crater will require you to live in your rover for about a month and a half. You had previously spent a fraction of this time in the rover during your trip to acquire the Pathfinder Lander and the Sojourner rover, and the cramped quarters nearly drove you insane. To prevent you from going crazy on your much longer journey, build a small habitat to attach to your rover that will increase the livable during your long journey. The habitat must be air tight.
3. Talk to students about the Engineering Design Process.



4. Have students identify the various problems that will be faced building the habitat.
5. Instruct students that the habitat must be at least 7 inches high.
6. Allow research and brainstorming time for students to come up with multiple ideas.
7. Formatively assess the groups by asking students to share ideas from the brainstorming phase.
8. Give students time to construct the habitats.
9. Test prototypes using the air pump.
10. Ask the questions:
   a) Was your habitat able to hold air without leaking?
   b) What material worked best?

c) What did the most successful habitat designs have in common?
d) Describe some of the difficulties you encountered during this activity.
e) In this activity, you were given specific constraints on the types of materials you could use to construct your habitat, what size your final design needed to be, and how much time you had to build.
f) What constraints did Mark Watney face as he constructed the habitat he attached to his rover?

11. Review the similarities and differences in the ones that were successfully air tight.
12. Tell students to draw or construct a revised prototype that incorporates several of the successful traits of the other designs.

Extensions

W.7-12.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W.6-8.7	Conduct short research projects to answer a question, drawing on several sources and generating additional related focused questions for further research and investigation.
w.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

1. Have students write a journal for the trip to Schiaparelli crater using the habitats that they constructed. What happened each day? What was your state of mind? How well did the habitat work?
2. Research the type of vehicles that have actually been to Mars or other planets. Which ones were successful? Which ones failed? Write a paragraph explaining your research.
3. Research underwater habitats that must be water tight. What additional factors must be considered underwater? Create a diagram or blueprint of a successful underwater habitat.

Rubric

RUBRIC	Exceeds (3)	Meets (2)	Partially Meets (1)	Does Not Meet (0)
Brainstorming	Students can share 4-5 ideas that were discussed	Students can share 2-3 ideas that were discussed	Students came up with only 1 idea	Students skipped the brainstorming step
Habitat	Habitat was well designed, at least 7 inches tall and completely air tight	Habitat was at least 7 inches tall and mostly air tight	Habitat was 7 inches tall but not air tight	Habitat was not 7 inches tall and was not air tight
Optimal design	Design included 4 or more similarities of other successful prototypes	Design included 2-3 similarities of other successful prototypes	Design included 1 similarity of the other successful prototypes	Design did not include any similarity to the other successful prototypes
Total N/9				