Mars Farm

**Lesson 4: Explore engineering design process**

**Problem Statement:** Students must work together in teams to create a design a growing environment on Mars that will sustain three researchers for three years. This lesson exposes students to the engineering and design process via their first group activity.

**Learning Objectives:**

The student will list and discuss the elements of engineering design.

**Lesson Standards (NGSS, CCSS, CTE):**

The following 4 Engineering NGSS standards are introduced in this lesson:

MS-ETS1-1 Engineering Design

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.

MS-ETS1-2 Engineering Design

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

MS-ETS1-3 Engineering Design

Analyze data from tests to determine similarities and differences among several different 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 Engineering Design

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.

Materials

* NGSS engineering standards are either copied for student individual use, or displayed in the classroom for reference throughout the unit.
* Blank index cards for group team building exercise (20 cards per group, or more).

**Lesson Preparation**

* Prep science notebooks (graph paper on one side; lined on right side).
* Prepare list of terms on chart paper: constraint, risk, criteria, proposal, controlled environment
* Decide team structure (teacher determine groups; student choice; etc.)

**Time Required**: 45 minutes

Grouping of Students for Instruction

As sixth grade teachers, we decided to predetermine our groups to balance for mathematical ability (lots of ratio/proportion work), engineering and design background, reading level, ELL vs. highly capable, social skills, leadership skills, organization, etc.). The students all share the same “team” roles in this PBL; however, we know some may naturally gravitate toward particular tasks.

**Lesson Overview:**

* Teacher leads discussion on the work of engineers as problem solvers, and introduces the NGSS engineering standards.
* The students participate in a mini group project to practice group problem solving practices.

**Lesson Components:**

* Students share with class any parents or friends of their family that have engineering as a career. Discussion will take between 5-15 minutes.
* Students are introduced to the concept of plan iterations. This is a new vocabulary term for many students, and the connections should be made between this concept and the terms “drafts” and “trials.”
* Patience with iteration development and failure is stressed, as well as iteration recording.

No iterations are thrown out, but keep, and dated for record keeping.

* Optional: The brief video *The Learning Pit* can be shown to further illustrate how people learn and solve problems.<https://vimeo.com> 117364809
* Students then move into groups to participate in the Card Tower Activity to experience problem solving as a group. Activity directions are found on web site located in the reference section below. Teacher circulates between groups, but resists giving advice or helping groups. This activity will take between 10-20 minutes.
* Discussion of experiences during the card activity are discussed as a class wrap up.

**Assessment:**

* The students will work together as a group to build a tower of cards. The teacher can monitor the group dynamics, and note which groups may need more time to discuss the norms of successful group work.
* An optional exit slip, asking students to define what kinds of things engineers do, may be appropriate for the class.

Accommodations:

* Teachers are advised to monitor students who are easily frustrated during the card activity.
* Teacher will be reading and rereading assignment.
* Classrooms have microphones for hearing impaired.
* Teachers could also enlarge any documents under document camera.

Extensions:

* Often times students request additional trials of the card tower activity.
* A video of students building a successful tower can be seen at the link listed below.

Note: It is recommended that students watch the video only *after* they have constructed

their own tower.

References/Resources:

Education is Elementary [www.eie.org](http://www.eie.org)

(Additional engineering classroom tasks, if teacher is interested in extension activities.)

Card Tower Activity [www.educationworld.com](http://www.educationworld.com)

The Learning Pit Video <https://vimeo.com> <117364809>

Video of student-built card tower [https://www.youtube.com/watch?v=JsqKfjMKy1](https://www.youtube.com/watch?v=JsqKfjMKy1U)