**Mars Farm**

**Grade level(s)**: 6-8 Subject(s): Science

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**Problem Statement:**

As part of a long term strategy to sustain the human race, NASA is exploring the feasibility of sustainable living on another planet. It is planning to send a team of three researchers to Mars for three years to study Martian living as a proof of concept.

The orbits of Mars and Earth position the two planets closest to each other once every two years. This is the optimal time to send a spacecraft. The journey will take just less than a year, about 300 days. The spacecraft, called Mars One, has already been designed and is currently being built. It has provisions to sustain three passengers for the journey plus one year after they arrive. The vessel will continue to function as a shelter, housing the three researchers and providing power, air, and water for a three-year period.

The harsh conditions on the planet will require the researchers to supply their own food within a controlled environment for the remaining two years. NASA needs to find out how large of a controlled environment is needed. They have hired your team to analyze the requirements and submit a report in the form of a proposal.

An analysis of the Martian soil sent back to earth by the Mars Rover indicates it is compatible with Earth soil and will provide the nutrients required to grow any plants that would normally grow on Earth. Your proposal should account for nutritional needs at 3,000 calories per day. In addition to energy needs, your team should also consider taste variety in your proposal. A separate team is developing special nutrition bars to provide additional energy requirements to keep the researchers healthy.

Your completed proposal should include the following elements:

* A selection of plants that provide the needed calories while minimizing water use, take up the least amount of space, and can grow fast enough to provide a sustainable yield before rations run out.
* A scaled drawing and/or model of the agricultural layout that allows researchers to access each crop for proper care and harvesting.

**Conceptual Storyline:**

With the current focus on the potential colonization of Mars, students demonstrate a natural curiosity about the realities of such a venture with regard to the basic needs of human beings. Furthermore, the sixth grade concepts of ratio and proportion (specifically scaling up and down) tend to confuse the students as these concepts are formally introduced in sixth grade per the CCSS math flow. By creating a problem based unit where both concepts weave together, the children can ground their mathematical thinking in potential real world/futuristic scenarios. We will launch the unit with a discussion on the current status of Mars exploration with an emphasis on the need to modify potential Mars colonization to suit the needs of human beings...specifically the need for a “farm” to meet the needs of researchers. After a few team building exercises, the children are asked to become an expert on one crop to begin thinking about the pros and cons of particular food sources and then they utilize a spreadsheet to create various versions of a Mars Farm while following the constraints and criteria of the project. Finally, after multiple iterations, the children apply the concepts of ratio and proportion to scale up and down while moving from a 2D paper model to a model that necessitates the use of a different scale. Groups present their iterations to the class and discuss which model provides enough calories for the researchers while using the least amount of water and area.

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

NGSS practices addressed in unit

Asking Questions and Defining Problems

* defining system boundaries
* defining components of the process
* identifying embedded systems
* identifying societal/personal needs relative to the problem
* define criteria and constraints

Developing and Using Models

* define and label essential variables of model
* describe relationships of components
* connect model to casual phenomena

Planning and Carrying Out Investigations

* identify the phenomenon investigated
* evaluate the accuracy of the data presented
* refine the investigation to produce more accurate data

Analyzing and Interpreting Data

* analyze models using appropriate tools
* interpret patterns in data

Using Mathematical and Computational Thinking

* use mathematical representations to describe relationships
* analyze representations to support claims

Constructing Explanations and Designing Solutions

* articulate an explanation
* cite evidence to support explanation
* describe connected reasoning
* evaluate potential solutions

Engaging in Argument from Evidence

* evaluate claims and reasoning
* identify additional evidence
* evaluate the logic of given reasoning

Obtaining, Evaluating and Communicating Information

* communicate information in at least 2 different formats
* use clear and effective communication skills
* connect DCI and CCC

#### [CCSS.Math.Practice.MP1](http://www.corestandards.org/Math/Practice/MP1/)

#### Make sense of problems and persevere in solving them.

#### [CCSS.Math.Practice.MP4](http://www.corestandards.org/Math/Practice/MP4/)

#### Model with mathematics.

#### [CCSS.Math.Practice.MP5](http://www.corestandards.org/Math/Practice/MP5/)

#### Use appropriate tools strategically.

#### [CSS.Math.Practice.MP6](http://www.corestandards.org/Math/Practice/MP6/)

#### Attend to precision.

#### [CCSS.Math.Content.6.RP.A.1](http://www.corestandards.org/Math/Content/6/RP/A/1/)

#### Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.Math. Content 7. GA.1 Solve problems involving scale drawings of figures.

[CCSS.ELA-Literacy.RI.6.1](http://www.corestandards.org/ELA-Literacy/RI/6/1/)

Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

[CCSS.ELA-Literacy.RST.6-8.2](http://www.corestandards.org/ELA-Literacy/RST/6-8/2/)

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

[CCSS.ELA-Literacy.RST.6-8.6](http://www.corestandards.org/ELA-Literacy/RST/6-8/6/)

Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

PERFORMANCE EXPECTATIONS FOR UNIT

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.

**21st Century Skills:**

Students must communicate while also using data to support their claim.

Furthermore, students will work in small groups where they must collaborate to create, iterate and finalize designs. Students must also analyze, using a rubric, whether or not their final designs best fit the criteria while working within the constraints.

**Locally and/or Personally Relevant for Students:**

Given the current information regarding the potential of sending astronauts to Mars and the children’s discussions about The Martian (book and movie), we decided to capitalize on their interest and curiosity about events that could happen in their futures. Furthermore, our children need more experience with the engineering and design process. Finally, we wanted to create an interdisciplinary unit where life science (botany), nutrition, geometry (area), reading informational text and technology (Excel spreadsheets and research) skills joined together to represent the connectedness of numerous disciplines.

**Connections to career and educational pathways:**

Prior to the implementation of the lessons listed below, our students will spend time analyzing the requirements NASA currently lists in the quest to create a pool of astronauts for potential travel to Mars. Furthermore, because of the expertise of our higher education and industry volunteers, the teachers involved in the unit have more insight into the engineering and design process; thus, we plan to share our new learning with our students.

**Table of Content/Overview of Unit**

Lesson 1: Introduction to problem statement.

Lesson 2: Current status of Mars exploration

Lesson 3: Teambuilding exercise

Lesson 4: Explore engineering design process

Lesson 5: Explore constraints and criteria

Lesson 6: Introduce Excel tool

Lesson 7: Baseline Food Plan

Lesson 08: Scaling Up the Plan

Lesson 09: Iterate the Plan

Lesson 10: 2D Design Phase

Lesson 11-12: Construction of 3D Model (optional)

Lesson 13: Presentation Preparation

Lesson 14: Presentation of Proposal