

Bristol Public Schools  
Exploration and Establishment of Human Settlement on Mars  
STEM Module, Summer/Fall 2013  
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**Unit Title: I can see Mars among the stars...Should we live there?**

**Introduction**

In 8<sup>th</sup> grade science we discuss space science with a focus on our Solar System. Recent attention has been put on exploring space and the possibilities of establishing a permanent human settlement on Mars. In this project we will facilitate our students' exploration and understanding of science, technology, and engineering concepts involved in this endeavor.

**Standards Addressed**

**Connecticut State Science Frameworks/District Curriculum Standards addressed:**

- 8.3 The solar system is composed of planets and other objects that orbit the sun.
  - 8.3.a. Gravity is the force that governs the motions of objects in the solar system.
    - C28. Explain the effect of gravity on the orbital movements of planets in the solar system.
    - C29. *Explain how the relative motion and relative position of the sun, Earth and moon affect the seasons, phases of the moon and eclipses. – This activity will extend the application of this knowledge beyond Earth to Mars, evaluating the impacts on settling on Mars.*
- 7.3 Landforms are the result of the interaction of constructive and destructive forces over time.
  - This activity will extend the application of this learning beyond Earth to include landforms on Mars and the impacts of these landforms on a Mars settlement.*
- 6.3 Variations in the amount of the sun's energy hitting the earth's surface affects daily and seasonal weather patterns.
  - This activity will extend the application of this learning beyond Earth to include energy and weather patterns on Mars and the impacts of Martian weather on a Mars settlement.*

**Science and Engineering Practices addressed:**

Asking Questions and Defining Problems

Science: Science-type questions will be asked and problems defined as students explore the temperatures, climate, weather, and Earth-Mars distance relationship data. Students will gather actual data from internet sources to answer the science questions and further implement science and engineering practices.

Engineering: Engineering-type questions will be asked and problems defined as students explore the possibility of establishing a permanent settlement on Mars. Students will research the obstacles that engineers must overcome to build and sustain a permanent settlement on Mars.

#### Developing and Using Models

Science: Students will be using models in order to gather data about Mars. Simulations and models on Google Earth (Mars View) and NASA supported websites will show conditions on Mars and relationships between Earth and Mars. Students will be interacting with these models to gain a better understanding of Mars and allow for a prediction about conditions on Mars and the possibility of establishing a permanent settlement on Mars.

Engineering: As part of the “one pager” research summary, students will incorporate a sketch or drawing of possible engineering solutions to the research topic.

#### Planning and Carrying Out Investigations

Science: Students will plan what data is important to answering the research question and how to best organize this data within the given parameters. Students will plan how to research the data sets presented in “Step 3: Researching Science Data” section of the activity.

Engineering: Students will use the data gathered in “Step 3: Researching Science Data” to formulate the parameters for their engineering solutions to the research topic or obstacles to settling on Mars. These parameters will guide the sketch of the model (on the one pager) for testing the engineering design.

#### Analyzing and Interpreting Data

Science: Students will analyze and interpret weather, climate, and temperature data in order to gain an understanding of the conditions on Mars.

Engineering: Students will consider the types of data necessary for analyzing the successes and flaws in the suggested engineering designs for solving the problems impeding the establishment of a permanent settlement on Mars. This data will be considered during the steps for revising the hypothesis.

#### Using Mathematics and Computational Thinking

Science: Students will use mathematical and computational thinking to predict the behavior of interactions between Mars and the Earth and between Mars and its moons. These predictions will allow students to assess appropriate times and conditions for travel to and settling on Mars.

Engineering: Students will consider the types of data necessary for analyzing the successes and flaws in the suggested engineering designs for solving the problems impeding the establishment of a permanent settlement on Mars. This data will be considered during the steps for revising the hypothesis. The data discussed will be related to computational thinking in order to solve the engineering problem.

### Constructing Explanations and Designing Solutions

Science: Students will use the background knowledge gained from research and data analysis to formulate a hypothesis for establishing a permanent settlement on Mars. Students will then use evidence to support the hypothesis.

Engineering: Students will propose solutions to engineering problems using the information gained from the scientific background knowledge built throughout the activities and the scientific models used in the activities.

### Engaging in Argument from Evidence

Science: Students will be choosing a side of the issue (for or against) of establishing a permanent settlement on Mars. Students will defend their position based on the data analysis, reasoning, and information gained from reading a variety of source materials. Students will support their claims using evidence from a variety of reliable sources.

Engineering: Students will be choosing a side of the issue (for or against) of establishing a permanent settlement on Mars. Students will defend their position based on the data analysis, reasoning, and information gained from reading a variety of source materials. Students will support their claims using examples of potential engineering solutions to overcome obstacles or hazards to settling on Mars.

### Obtaining, Evaluating, and Communicating Information

Science: During the activity, students will present their preliminary ideas orally and visually. These ideas will focus on one area of establishing a settlement on Mars. In the final paper, students will persuasively communicate (in writing) their ideas about establishing a settlement on Mars.

Engineering: During the activity, students will present their preliminary ideas orally and visually, including possible engineering solutions to the area investigated by the group. In the final paper, students will persuasively communicate (in writing) their ideas about establishing a settlement on Mars, with the inclusion of engineering solutions to problems.

### Common Core State Literacy Standards addressed:

Reading:

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

*This will be accomplished when reading and summarizing information about exploring and settling on Mars. When writing the final position paper, students will support their position with specific evidence from the readings.*

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.

*Students will summarize the central ideas or conclusions of text when completing the tables, OWL chart, and one pager activities.*

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

*Students will be following multistep procedures throughout this unit.*

*Students will be gathering information from data, which will involve measurements and technical tasks.*

RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6 – 8 texts and topics.

*Students will be required to determine the meaning of symbols, key terms, and content vocabulary throughout the reading and research activities.*

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

*Students will be gathering data and information that is expressed in a variety of ways. Students will be gathering information from reading text and interpreting data tables, charts, and graphs. Students will be summarizing and presenting information from their reading and research in a one pager that incorporates a written summary and visual representations of information.*

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

*Students will gather information presented as data from experiments and from reading. Students will also be asked to use video, Google Earth, and other visual sources to compare and contrast information.*

RST.6-8.10 By the end of grade 8, read and comprehend science/technical texts in the grades 6 – 8 text complexity band independently and proficiently.

*Throughout the research portions of this unit, students will be reading texts that progress toward meeting this standard.*

Writing:

WHST.6-8.1 Write arguments focused on discipline-specific content.

*Students will write a position paper at the end of the unit that requires them to choose a side of the issue, present their side, and support their side with evidence from readings and analyses of data.*

WHST.6-8.2 Write informative/explanatory texts, including the narration of historic events, scientific procedures/experiments, or technical processes.

*Student summaries of readings and data will be informative and explanatory.*

WHST.6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

*Students will produce a final position paper that is clear, coherent, organized, and appropriate.*

WHST.6-8.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

*Students will receive feedback from peers and well as give feedback to peers as they plan and develop their written responses. The teacher will also be facilitating the writing process with guidance and support.*

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

*As students complete the unit, they are researching the answer to a question that was provided to them. Students are seeking answers to self-generated questions that pertain to the overarching research question, therefore allowing multiple avenues of exploration.*

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

*Students will complete independent research on their chosen area of focus under the overarching research question. Students will be assessing the validity of sites and information presented. Students will have access to Noodle Tools to facilitate the quotation, paraphrasing, and interpretation of information as well as the proper citation of sources.*

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.

*Students will use the articles presented and found via research in order to support their final position.*

**Common Core State Math Standards addressed:**

8.EE.3 Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.

*This relates to the representation of distances in space.*

8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.

*This relates to various data gathered throughout the unit.*

8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate

patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

*This relates to various data gathered throughout the unit.*

8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

*This relates to various data gathered throughout the unit.*

8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables.

*This relates to various data gathered throughout the unit.*

### **Disciplinary Core Ideas**

Physical Science:

PS2.A Forces and Motion

*Students will apply their knowledge of forces and motion to the task of traveling to and creating a settlement on Mars.*

PS2.B Types of Interactions

*Students will apply their knowledge of underlying forces, including gravity, and collisions between objects, to travel to and settle on Mars.*

PS2.C Stability and Instability of Physical Systems

*In exploring the possibilities of establishing a permanent settlement on Mars, students will be evaluating systems that need to be put into place to aid human survival in a hostile environment. Students will be designing and evaluating the stability and instability of certain systems and the impacts on human existence.*

PS3.A Definitions of Energy

*Students will draw on prior knowledge to define energy and then identify sources of energy in relationship to the topic area being researched.*

PS3.B Conservation of Energy and Energy Transfer

*The source of energy and flow of energy through systems will be applied to the idea of creating a permanent settlement on Mars.*

PS3.C Relationship Between Energy and Forces

*Students will draw on their background knowledge of energy and the use of energy through ecosystems and energy as related to forces.*

PS3.D Energy in Chemical Processes and Everyday Life

*Students will be exploring the necessity of energy in food and in fuel. Students will be addressing these needs as they explore necessities for and obstacles to establishing a permanent settlement on Mars.*

PS4.B Electromagnetic Radiation

*Students will gain a familiarity with solar and electromagnetic radiation as they explore safety concerns in traveling to and living on Mars.*

PS4.C Information Technologies and Instrumentation

*The use of instruments that transmit waves will be investigated as students research what information is gathered by rovers and probes, how information is gathered by rovers and probes, and how the information from the rovers and probes is transmitted to scientists on Earth.*

Life Science:

LS1.C Organization for Matter and Energy Flow in Organisms

*In researching the establishment of a permanent settlement (including food supply) on Mars, students will apply their understanding of matter and energy flow in organisms and ecosystems.*

LS2.A Interdependent Relationships in Ecosystems

*In researching the establishment of a permanent settlement (including food supply) on Mars, students will apply their understanding of interactions between biotic and abiotic factors in an ecosystem.*

LS4.A Biodiversity and Humans

*Students will build on their background knowledge of biodiversity in order to evaluate the need for biodiversity or impacts of a lack of biodiversity when establishing a permanent settlement on Mars.*

Earth and Space Science:

ESS1.A The Universe and Its Stars

*Students will learn about the universe and the place of the Solar System within the universe.*

ESS1.B Earth and the Solar System

*Students will draw on their knowledge of the Earth's place in the Solar System and the results of the predictable patterns to research Mars, the patterns on Mars, and the possibilities of traveling to and establishing a settlement on Mars.*

ESS1.C The History of Planet Earth

*Students will apply their understanding of reconstructing and dating events in Earth's history to exploring, reconstructing, and dating events in the history of Mars. This application of learning will aid students in formulating an opinion about establishing a permanent settlement on Mars.*

ESS2.A Earth Materials and Systems

*Students will apply their understanding of how systems interact on Earth to how systems interact on Mars and the implications to establishing a permanent settlement on Mars.*

ESS2.B Plate Tectonics and Large-Scale System Interactions

*Students will apply their understanding of plate tectonics, earthquakes, and volcanoes on Earth to the landforms and implications for settling on Mars.*

ESS2.C The Roles of Water in Earth's Surface Processes

*Students will apply their understanding of the role of water on shaping the Earth's surface to the shaping of the Martian surface and the impacts on establishing a permanent settlement on Mars.*

ESS2.D Weather and Climate

*Students will apply their understanding of weather and climate on Earth to the weather and climate on Mars. This information will be used when determining a position on establishing a permanent settlement on Mars.*

ESS3.B Natural Hazards

*Students will apply their understanding of how natural hazards on Earth impact individuals and societies to the impacts of natural hazards on individuals and settlements on Mars.*

ESS3.C Human Impacts on Earth Systems

*Students will apply their understanding of how humans impact Earth systems to how humans can positively and negatively impact systems on Mars.*

Engineering, Technology, and Applications:

ETS1.A Defining and Delimiting an Engineering Problem

*Students will practice designing and evaluating engineering solutions for a problem.*

ETS1.B Developing Possible Solutions

*Students will gain an understanding of the processes used when designing potential engineering solutions to problems.*

ETS2.A Interdependence of Science, Engineering, and Technology

*Students will gain an understanding of the connected processes and information requirements of science, engineering, and technology.*

ETS2.B Influence of Engineering, Technology, and Science on Society and the Natural World

*Students will gain an understanding of how science, engineering, and technology impact human lives and the interactions between the natural world (on Earth or on Mars) and humans.*

**Application of the "5 E" Learning Cycle**

*Engage: Part 1 of the unit will be the engage portion of the unit. Students will be engaged in gathering background and becoming familiar with the overarching question.*

*Explore: Part 2 Research (using Google Earth [Mars View] and the Internet) and Researching Science Data sections will allow the students to explore information relevant to the overarching research question.*

*Explain: Part 2 Step 4, Step 7, and Step 8 will allow students to summarize and explain their findings. These findings will be communicated orally, visually, and in writing.*



Elaborate: *Part 2 Step 6, Step 9, and Step 10 will allow students to further investigate the topic and then give and receive feedback, extending student understanding of the topic.*

Evaluate: *The position paper in Part 3 will allow students to evaluate claims, formulate and support ideas, and be evaluated by the teacher.*