JOURNEY TO THE RED PLANET
Interdisciplinary/Science Project | Grade 5 | 13-16 hours
JOURNEY TO THE RED PLANET: PROJECT OVERVIEW

FINAL PRODUCT
Students develop and present a unique engineering design for humans to safely explore Mars.

AREA OF STUDY
Interdisciplinary/Science

TIMEFRAME
13-16 hours

AGE GROUP
Grade 5

KEY STANDARDS ASSESSED
3-5-ETS1-1 >> Defining and Delimiting an Engineering Problem
3-5-ETS1-2 >> Developing Possible Solutions, LS1.A Structure and Function
4-LS1.1 >> Structure and Function
ELA-LITERACY.W.5.2 >> Text Types and Purposes
ELA-LITERACY.SL.5.4 >> Presentation of Knowledge and Ideas
CCSS.ELA-LITERACY.RI.5.9 >> Integration of Knowledge and Ideas

RUBRICS
Project Rubric >> BIE Presentation Rubric >>

PLANNING TOOLS AND TEMPLATES
Project Design Companion >> student-facing planning sheet >>

WHY JOURNEY TO THE RED PLANET?
This interdisciplinary project is designed to connect students with the history of space travel and the science of Mars exploration. Students will understand the physical characteristics of Mars, the dangers of space travel, and the challenges of exploring the planet. The final product will be a design for an invention that could enable humans to explore, live, or work on Mars.

WHAT MAKES THIS PROJECT GOLD-STANDARD PBL?

SUSTAINED INQUIRY
Many aspects of the project involve asking and answering questions through research, in addition to considering creative solutions. Students investigate questions such as: How would humans get to Mars? What conditions would they face once they are there? Why explore space at all? What would help humans overcome the challenges of spending weeks or months in space? Students are also asked to think creatively and problem-solve when designing solutions, both practical and imagined.

STUDENT VOICE AND CHOICE
Though the lessons in this project provide opportunity for collaboration and group discussion, the final products are largely the design of the individual. Each student chooses an authentic problem facing humans for Martian exploration and creates a potential solution.

CRITIQUE & REVISION
Critique and revision occur formally in two phases of the project: when students share their prototypes and when they draft their presentations. This feedback drives revisions to both. Informally, feedback occurs at each stage through teacher conferencing and student discussions.

REFLECTION
Reflection is embedded in each stepping stone. It is particularly essential after students receive feedback on their prototypes and presentation drafts but before they begin the revision process. Students will reflect on the key content and skills, their contributions to the group, and their group's effectiveness working as a team.

PUBLIC PRODUCT
The final product presents many product/presentation possibilities for public display. Engineering proposals can include sketches, prototypes, or formal speeches, which all can be presented to mock inventors/investors (Shark Tank, NASA engineers, SpaceX inventors, etc.). The possibility exists to arrange an encounter with an aerospace engineer through “Skype in the Classroom”.

AUTHENTICITY
Students use an adapted version of the engineering design process to devise and share a solution for a real problem humans would face exploring Mars. The students make suggestions to the inventors at NASA for items that solve the issue of sustaining human life on Mars.

CHALLENGING PROBLEM OR QUESTION
The driving question, “How can humans safely explore Mars?” asks students to consider how the most basic yet essential needs of humans could be met in the harsh conditions of Mars. It is also asks students to consider the challenges of the weeks- to months-long journey to the Red Planet. Students are asked to consider how engineers and scientists have overcome past challenges of space exploration to gain insight and inspiration for new inventions.

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KEY KNOWLEDGE, UNDERSTANDING, AND SUCCESS SKILLS
Students are asked to synthesize information from multiple content sources to create an engineering proposal. Critical thinking and communication skills are essential in this project during both the writing of informative text and the presentation of ideas. Scientific standards span the topics of Earth/Space Science, Life Science, and Engineering, Technology, and Application of Sciences.

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REACH FOR THE STARS

Very little captures the imagination like space. Whether we look up at the moon and stars to marvel at their beauty or are inspired to ask, “How do I get there?” few of us can resist the draw of space. The desire to explore, to see what lies around the bend, past the horizon, or beyond the atmosphere unites us all. This project provides students the opportunity to learn the history of space exploration and to imagine how humans can survive some of the harshest conditions we as a species have ever faced. The resources below will help inspire an interest in outer space by exploring how far we have already come in our journey to the Red Planet.

WHY MARS?

“We have made remarkable progress in the last hundred years, but if we want to continue beyond the next hundred years, our future is in space.” — Stephen Hawking

Exploration leads to knowledge, and knowledge new technology, new jobs, and a new, deeper understanding of our place in the universe. So why not Mars? Explore the resources below to learn where we stand in our quest to reach the Red Planet.
THE PROJECT PATH AND KEY MILESTONES

The Project Path illustrates the learning process in a project-based, competency-based setting.

Project Milestones help clarify the path from Launch to Present, as learners move through an iterative process of building new knowledge and skills, and applying their new knowledge and skills to develop, critique, and refine their products in collaboration with peers.

The Project Path and the Project Milestones provide a concrete but flexible structure for project design and implementation.

The Project Milestones are color coded in this Project Path and throughout the document.

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**LAUNCH**

1. Student explores the project and develops a set of need to know questions (NTKs).

**BUILD KNOWLEDGE**

2. Student explores the history of space travel and the inventions that have made this exploration possible for humans.

3. Student explores the challenges of space travel, the environment of Mars, and the effect of both on humans.

4. Student teams ideate and develop a proposed solution to their selected problem.

5. Student teams revise their solution and presentation based on the feedback they receive.

**DEVELOP AND CRITIQUE**

6. Student teams share their solutions with an audience.

**PRESENT**

5. Student teams revise their solution and presentation based on the feedback they receive.
### MILESTONE #1: Student explores the project and develops a set of need to know questions (NTKs).

- **Entry Event:** Student explores videos about what life is like for an astronaut on the International Space Station (ISS).
- **Preview the Project:** Student explores the question: "How can humans safely travel to Mars?"
- **Explore the Driving Question:** Student traces the history of space exploration from the Space Race to the present and considers the value of the space program.
- **History of Space Travel:** Students are introduced to the expectations for the final product.
- **Tools of the Trade:** Student explores the inventions that have been developed to support current space exploration.
- **Humans in Space:** Student explores the physical environment of Mars and compares it to that of the moon and Earth.
- **The Red Planet:** Student explores the challenges of human space travel.
- **Give and Receive Feedback:** Student teams provide and receive feedback to develop their final product appropriate to the intended audience.
- **Revise Solution:** Student teams revise design solution and presentation based on feedback from peers and content experts.
- **Prepare:** Student teams translate design solution and presentation.

### MILESTONE #2: Student explores the history of space travel and the inventions that have made space exploration possible for humans.

- **Entry Event:** Student discovers the challenges of human space travel.
- **Preview the Project:** Students are introduced to the expectations for the final product.
- **Explore the Driving Question:** Students are introduced to the expectations for the final product.
- **History of Space Travel:** Students trace the history of space exploration from the Space Race to the present and consider the value of the space program.
- **Tools of the Trade:** Students explore the inventions that have been developed to support current space exploration.
- **Humans in Space:** Students explore the physical environment of Mars and compare it to that of the moon and Earth.
- **The Red Planet:** Students explore the challenges of human space travel.
- **Give and Receive Feedback:** Student teams provide and receive feedback to develop their final product appropriate to the intended audience.
- **Revise Solution:** Student teams revise design solution and presentation based on feedback from peers and content experts.
- **Prepare:** Student teams translate design solution and presentation.

### MILESTONE #3: Student explores the challenges of space travel on humans and the conditions of the environment of Mars.

- **Entry Event:** Student explores the physical environment of Mars and compares it to that of the moon and Earth.
- **Preview the Project:** Students are introduced to the expectations for the final product.
- **Explore the Driving Question:** Students explore the question: "How can humans safely travel to Mars?"
- **History of Space Travel:** Students explore the inventions that have been developed to support current space exploration.
- **Tools of the Trade:** Students explore the inventions that have been developed to support current space exploration.
- **Humans in Space:** Students explore the physical environment of Mars and compare it to that of the moon and Earth.
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- **Revise Solution:** Student teams revise design solution and presentation based on feedback from peers and content experts.
- **Prepare:** Student teams translate design solution and presentation.

### MILESTONE #4: Student teams ideate and develop a proposed solution to their selected problem.

- **Entry Event:** Student teams ideate and develop a proposed solution to their selected problem.
- **Preview the Project:** Students are introduced to the expectations for the final product.
- **Explore the Driving Question:** Students ideate and develop a proposed solution to their selected problem.
- **History of Space Travel:** Students ideate and develop a proposed solution to their selected problem.
- **Tools of the Trade:** Students ideate and develop a proposed solution to their selected problem.
- **Humans in Space:** Students ideate and develop a proposed solution to their selected problem.
- **The Red Planet:** Students ideate and develop a proposed solution to their selected problem.
- **Give and Receive Feedback:** Student teams ideate and develop a proposed solution to their selected problem.
- **Revise Solution:** Student teams ideate and develop a proposed solution to their selected problem.
- **Prepare:** Student teams ideate and develop a proposed solution to their selected problem.

### MILESTONE #5: Student teams revise their solution based on the feedback they receive.

- **Entry Event:** Student teams ideate and develop a proposed solution to their selected problem.
- **Preview the Project:** Students are introduced to the expectations for the final product.
- **Explore the Driving Question:** Students ideate and develop a proposed solution to their selected problem.
- **History of Space Travel:** Students ideate and develop a proposed solution to their selected problem.
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- **Revise Solution:** Student teams ideate and develop a proposed solution to their selected problem.
- **Prepare:** Student teams ideate and develop a proposed solution to their selected problem.

### MILESTONE #6: Student teams share their solutions with an audience.

- **Entry Event:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Preview the Project:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Explore the Driving Question:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **History of Space Travel:** Students and teacher reflect on their original NTKs and their current sense of understanding.
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- **Give and Receive Feedback:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Revise Solution:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Prepare:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Present:** Students and teacher reflect on their original NTKs and their current sense of understanding.
- **Reflect:** Students and teacher reflect on their original NTKs and their current sense of understanding.
Begin with the end in mind! It’s time to tee up a few significant decisions you’ll need to make about the final project. As you make decisions, reflect on what you believe will work best with your students and your community, as well as time constraints, budgets, and your own skills and comfort level.

WHAT TO DO:
1. Review the three decision points below.
2. After weighing your options, make your decision and document them in your Project Design Planning Companion >>.

DECISION POINTS:

Low Complexity
Student presents the design solution to classmates/teacher.

Medium Complexity
Student-driven poster fair with pictures or sketches for display to an audience of classmates, parents, and guests.

High Complexity
Student teams create a prototype of the design solution.

Who will the audience be, and how will you ensure an audience?
- Student teams present to other student teams in the classroom.
- Student teams present to a mock group of investors or inventors.
- “Skype in the Classroom” presentation with an aerospace engineer or NASA staff.

How much decision-making power will students have regarding the topic, audience, and final product?
- Teacher provides the topics, but student teams choose how to create their solution.
- Student teams choose their own problems to address through their solution.
- Student teams give input on audience choice and mode of sharing their solutions.

CUSTOMIZING THE PRODUCT OR PERFORMANCE

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CUSTOMIZING THE PRODUCT OR PERFORMANCE
Welcome to Launching Inquiry. This milestone is the entryway into Journey to the Red Planet. Students begin their exploration of the driving question, “How can humans safely explore Mars?” by watching how astronauts deal with everyday situations while in space.

Because Martian travel and human exploration are not yet possible, students will have to base their work on a combination of what they know and learn about space travel as it currently exists and the conditions of Mars to make their solution decisions. Lessons here should help them organize and prioritize their questions and ideas along the way so they can stay focused and make choices that will move them forward in the project.

The key is to honor all questions as students orient to the project.

Note: The recommended resources will be helpful as you design lessons for this milestone.

**ENTRY EVENT**

Student explores the project and develops a set of need to know questions (NTKs).

**PREVIEW THE PRODUCT**

Student is introduced to the expectations for the final product.

**EXPLORE THE DRIVING QUESTION**

Student explores the question, “How can humans safely travel to Mars?”

**RECOMMENDED RESOURCES**

**TEXTS AND DATA**

- NASA: Living in Space >>
- An Astronaut Reveals What Life in Space Is Really Like >>
- The Barriers of Bringing Humans to Mars >>

**AUDIO AND VISUALS**

- An Astronaut’s Guide to Life in Space >>
- Tour of the International Space Station >>

**TOOLS AND FORMS**

- Know/Want-to-Know Chart >>
- Inquiry Chart >>
As you design your launch, consider this three-part structure to help guide your efforts: Entry Event, Project Preview, and Driving Question Exploration. The launch may be only one lesson, but these three key segments each involve careful decision-making, planning, and materials development. Let’s take a closer look.

**ENTRY EVENT**  
Captivating experiences create buzz, guide context, access prior knowledge, and tap student interests, curiosities, and values.

**PREVIEW THE PROJECT**  
Student is introduced to the expectations for the final product.

**EXPLORE THE CHALLENGE QUESTION**  
Student accesses and assesses prior knowledge, and asks their own questions. Student uses their questions to frame inquiry into issues central to the project.

**MATCH, LIT**  
Student participates in an engaging shared experience that generates excitement about the Journey to the Red Planet project.

**PROJECT, LINKED**  
The connection between the provocation or entry event and the final project is totally clear; basic project expectations are communicated upfront.

**INQUIRY, LAUNCHED**  
Opportunities for students to generate their own need to know questions (NTKs) tap into their innate curiosity as they begin to connect with the challenge question, “How can humans safely explore Mars?”

**MIGHT LOOK LIKE...**

1) Exploring videos on space travel, life on the ISS, or how engineers are working to solve the challenges of space exploration.
2) A hands-on problem-solving experience and reflection related to space exploration, such as building a model rocket.
3) A guest speaker or visit to a science museum.

**DESIRED OUTCOMES**

1) Exploring videos on space travel, life on the ISS, or how engineers are working to solve the challenges of space exploration.
2) A hands-on problem-solving experience and reflection related to space exploration, such as building a model rocket.
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**EXAMPLES OF INITIAL STUDENT NEED TO KNOWS**

**QUESTIONS ABOUT EXPLORING SPACE**

- What is space like?
- Can life exist in space?
- Why should we explore space?
- What technologies exist to help humans overcome the challenges of space travel?
- What is the Space Race? What caused it?

**QUESTIONS ABOUT TRAVELING TO MARS**

- Can life exist on Mars?
- What do scientists know about Mars? How did they learn about Mars?
- What is the environment like on Mars? How does it compare to the environment on Earth?
- What challenges of space travel must be overcome to send humans to Mars?
- How would humans stay physically and mentally healthy during a trip to Mars?
Imagine what it would be like to travel to Mars. Humans have never set foot there, but we have our eyes turned to the skies, and our next target for exploration is the Red Planet. Before we get there, though, we have a lot of challenges to overcome. Space and Mars aren’t exactly friendly environments for human life. As you watch these videos about life on the International Space Station, think about what you see and why life in space isn’t easy for the people who live there.

Choose videos that you think will grab your students’ interest and inspire their imaginations. You may even have time to search for a video that the students suggest. If possible, find a guest speaker who can talk to students about the challenges of space travel, how scientists are exploring Mars, or how engineers solve problems related to space travel.

Use images of space exploration to create a Photo Drop. The Student Planning Sheet will help orient students to the project. Adapt it to fit your specific expectations and plans.

We will create a unique engineering design solution to one of the problems or challenges of space travel human explorers of Mars face. Once our designs are complete, we’re going to share them with an expert in engineering design.

As you explore the expectations and the Student Planning Sheet, complete a Jot Thoughts activity with a small group of your peers.

Now that you’ve had a glimpse of life on the ISS, think about our driving question, “How can humans safely explore Mars?”

Drawing from the discussions you’ve just had, let’s organzize our shared knowledge: What do we already know about Mars and how humans will travel there? What do we need to know or learn in order to create a unique engineering design solution to one of the problems Mars explorers will face?

Based on what you saw today, what would life be like during the journey as explorers travel to Mars? What problems or challenges do you think explorers would face? Can you identify some potential solutions?

The need to know process is essential to the project. It helps students activate their prior knowledge and identify their own questions for exploration. You can use a variety of tools (e.g., anchor chart, table), but the goals are to:

• Collect student questions (not answer them) that will become the driving force of the project as students seek to find answers.
• Establish a living document that you will refer back to regularly: What has been answered? What is proving less or more important? What new questions are emerging?
• Ensure that your list includes both clarifying and higher-order-thinking questions. Prompt and model as needed.

Check out this BIE resource on need to know for more information!
Welcome to the History of Space Exploration. In this milestone, learners develop and practice research skills that are essential to understanding the history of space exploration and, eventually, to developing a solution to the problem or challenge they identified. To support learners, you will design and facilitate different mini-lessons for various student groupings based on observed student needs.

Knowing the timeline of both the major events and the technologies of space travel will help students generate ideas and ask meaningful questions that will drive their own work later in the project. If they know where we’ve been, then they can better predict where we can go. The tools and forms will help keep these ideas organized.

Note: The recommended resources will be helpful as you design lessons for this milestone.

**MILESTONE #2: THE HISTORY OF SPACE EXPLORATION**

**BUILD KNOWLEDGE**

2. **Student explores the history of space travel and the inventions that have made this exploration possible for humans.**

**STEPPING STONES**

**HISTORY OF SPACE TRAVEL**

Student traces the history of space exploration from the Space Race to the present and considers the value of the space program.

**TOOLS OF THE TRADE**

Student explores the inventions that have been developed to support current space exploration.

3. **Student explores the challenges of space travel, the environment of Mars, and the effect of both on humans.**

**RECOMMENDED RESOURCES**

**TEXTS AND DATA**

- National Geographic Kids Resources on Space >>
- Space Travel >>
- JFK: “We Choose to Go to the Moon” >>
- PBS Aerospace Engineer >>
- Top 10 NASA Inventions >>

**AUDIO AND VISUALS**

- History of Space Exploration >>
- Sample Timelines >>

**TOOLS AND FORMS**

- Web-Based Timeline Creator >>
- BIE Learning Log >>
- Conferencing Tools >>
STEPPING STONES TO THE HISTORY OF SPACE EXPLORATION

1. HISTORY OF SPACE TRAVEL

This stepping stone grounds the students in the advances made in space travel. They will uncover a lot of information, and lessons in culling and curating information are key. To support students as they summarize the information they find in their resources, use this rules-based summarization >> activity. For summarizing videos or other auditory texts, model using Mini Summaries >>.

You may want to pre-select reliable sources for students to choose from to conduct research. To support students as they curating information are key. One-Sentence Summaries >> or Scene It >> are useful.

ACTIVITY IDEAS

Presentation of information in a timeline with both visuals and brief explanations allows students to organize a progression of events but can also provide opportunities to practice presenting among peers. Exemplar timelines are provided in the resources. When determining how to represent the pros and cons of the space program, these Comparing and Contrasting >> activities may help.

If you want to provide specific events for students to research, generate that list, taking into account student need to know stats and questions. Remember the power of Conferencing >>, as well.

Ideas for Activities

- Trace the history of space exploration from the start of the Space Race to the present and consider the value of the space program.
  - Visual Timeline >>
  - Scene It >>
  - One-Sentence Summaries >>

Reflection and Synthesis Prompts

- How did you decide which information and graphics were important to be included in your timeline? Was there information that was particularly difficult to decide to include or leave out? If so, what strategies did you use to make your decision?
- If you could make your timeline interactive for the viewer, what strategies did you use to make your decision?
- What strategies did you use to make your decision?

Formative Assessment Ideas

- Write a postcard to a friend or family member as though you were a part of one of the events on your timeline.
- Choose one explorer, event, or invention to research and present to the class.
- Check out these Exit Ticket >> ideas from BIE.

Suggestions for Feedback and Support

- Word Scramble Prediction >> or Predict-O-Gram >> are useful to pre-teach terms that students may encounter.
- Zoning in on specific information in familiar texts or text types, a Text Feature Grid >> is a valuable scaffold.

Standards

- CCSS.ELA-LITERACY.RI.5.9 >>
- CCSS.ELA-LITERACY.W.5.2 >>
- CCSS.ELA-LITERACY.W.5.3b >>
- CCSS.ELA-LITERACY.W.5.5 >>

2. TOOLS OF THE TRADE

Virtually every human function and need are more difficult to meet in space than on Earth, from traveling safely to eating meals, creating a wide field for possible innovations. Not all innovations have to be huge leaps forward either; a small idea can have profound consequences for the quality of life of astronauts.

Asking students look at a wide range of useful inventions for space travel will inspire their own creative ideas. Not all inventions need to be mission-critical or life-saving, but all should improve conditions for humans. Losses in this stepping stone should ask students to document their ideas using the Engineering Design Process >>.

REFLECTION & SYNTHESIS

Many of the tools explored will offer inspiration for the students’ projects. They may choose to improve upon an existing design or to suggest something novel. Use the Reflection & Synthesis to get them thinking about their own ideas for the engineering process.

LEARN FROM THE EXPERTS

If at all possible, enlist the help of a NASA engineer or any aerospace engineer. Engineers in other disciplines are helpful for the engineering process in general. If you can’t find a suitable expert, there is a recommended online resource from PBS.
Welcome to the Challenges of the Journey. This milestone defines the problems that students could address with their solutions.

Guided by their need to know, learners dig deeply into the challenges of space travel and exploration of Mars. Students uncover why the Martian environment presents a unique set of problems for human survival.

To support learners, you will select learning assets (texts, videos, websites, and more) that give them the knowledge necessary to identify and solve a problem that Mars explorers will face.

Comparing and contrasting are important skills in this milestone, as students will analyze the similarities and differences between the conditions humans experience on Earth, in space, and on Mars.

Note: The recommended resources will be helpful as you design lessons for this milestone.

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**Milestone #3: The Challenges of the Journey**

**Step 2:** **Build Knowledge**

**Humans in Space**

Student discovers the challenges of human space travel.

**The Red Planet**

Student explores the inventions that have been developed to support current space exploration.

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**Recommended Resources**

**Texts and Data**
- Exploring the Planets: Earth >>
- Exploring the Planets: Mars >>
- Mars: Extreme Planet >>
- All About the Moon >>
- The Human Body in Space >>

**Audio and Visuals**
- Neil Degrasse Tyson: Why Go to Mars? >>
- Earth vs. Mars—How Do They Compare? >>

**Tools and Forms**
- Comparing and Contrasting >>
- Conferencing Tools >>
1. HUMANS IN SPACE

ACTIVITY IDEAS
Activities here allow students to research to build background and to learn more about their own questions. They also create the opportunity to share what they have learned. The Socratic Seminar is a great way for students to engage in conversations at any point in the research; it can be especially effective after students have developed sufficient background in the challenges that explorers will face in space and on Mars. You may choose to allow students to explore from a list of well-documented topics that you provide. However, the Wonder Poem is a way for students to launch research into a question that interests them personally.

SUGGESTIONS FOR FEEDBACK AND SUPPORT
• Conferencing can help students who struggle picking a topic and also determine which groups share common interests.

REFLECTION AND SYNTHESIS PROMPTS
• What challenges interest you the most? Why?
• What did you learn that completely surprised you?
• How would you convince a peer that the challenge you chose is the most important one to solve first?

FORMATIVE ASSESSMENT IDEAS
• Create a Problem/Solution Matchup for a peer to try to solve.
• Mind-Map potential problems and their solutions.
• Check out these Exit Ticket ideas from BIE.

STANDARDS
• NGSS-3-ETS1-1 >>
• CCSS-ELA-LITERACY.RI.5.9 >>
• CCSS-ELA-LITERACY.W.5.2 >>

1. HUMANS IN SPACE

Explain the challenges of human space travel.

• Equity Charts
• Inverted Classroom
• Wonder Poem

2. THE RED PLANET

Explore the physical environment of Mars, and compare it to those of the moon and Earth.

• Draw to Remember Summaries
• Prior Learning Thinking Guide
• Double-entry Prediction Chart

FOCUS ON STUDENTS’ NTKS
As students are gathering information to move forward, readdress the NTKs throughout the milestone. This will allow you to check for gaps in student understanding before they begin identifying solutions to the challenges explorers will face.

REFLECTION & SYNTHESIS
The goal of this stepping stone is twofold: to gain knowledge of the problems humans face for this journey and to focus the students’ thinking toward generating their solutions. Reflection should connect their work to the goal of the overall project so they can dig into designing the solutions in the next milestones.

CREATING GROUPS
Think about groupings: Do you want each student to research each environment individually or in small groups? Or do you want to divide the room into experts on each section to then share with the class? Those BIE resources >> offer guidance to managing group work.

2. TOOLS OF THE TRADE

Though the problems that face humans in space and on the moon are well-known, the same cannot be said for those that explorers will face on Mars. Lessons here should guide students to connect their new learning about the Martian environment to what they already know about space travel and to eliminate misconceptions. Practice prediction strategies, that move the work forward in the most sensible way.

• Create cartoon or imaginary creature that they believe could withstand the natural conditions of the moon and Mars, and explain their specific adaptations.
• Create travel slogans for the moon and Mars that incorporate the specific environmental conditions.
• Create a tinfoil poster or brochure that compares and contrasts the environments of the Earth, the moon, and Mars.
• What new ideas or potential solutions have you generated?
• What new challenges of space exploration have you uncovered? What are the most important ones to solve, and why?

• What new questions have you discovered? How could you find answers to those questions?
• Connecting the environment on Mars to what you already know about the specific environmental conditions.
• What new needs or wants have you uncovered?
• Create a trifold poster or brochure that compares and contrasts the environments of the Earth, the moon, and Mars.

• I Wonder Poem
• Socratic Seminar
• Inquiry Charts
• Draw to Remember Summaries
• Double-Entry Prediction Chart
Welcome to Prototype Design and Presentation. In this milestone, students continue to engage resources that help them develop their proposed solution to the challenge they selected. Collaborative brainstorming is an essential piece to this work, so student teams will need to develop criteria to evaluate ideas and make decisions. Help students develop ways to ensure that everyone is heard and feels as though the group has acted fairly.

The SCAMPER method can be effective in taking an existing product and improving upon it by making changes, combining two items, or using an item in a new way. See the recommended resources for more info.

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Student teams ideate and develop a proposed solution to their selected problem.

IDEATE
Student teams brainstorm ideas for a design solution that presents a solution for a space travel problem.

PROTOTYPE DESIGN
Student teams consider audience and purpose while designing the product.

DRAFT AND PRACTICE
Student teams draft the presentation of their design solution.

Develop and Critique

Student teams share their solutions with an audience.

Student teams revise their solution and presentation based on the feedback they receive.

MILESTONE #4: PROTOTYPE DESIGN AND PRESENTATION

RECOMMENDED RESOURCES

TEXTS AND DATA
• Three Effective Techniques for Brainstorming Ideas >>
• NASA For Kids: Intro to Engineering >>

AUDIO AND VISUALS
• What Is a Prototype? >>

TOOLS AND FORMS
• Identifying an Engineering Challenge >>
• The SCAMPER method >>
• Ideate >>
• Evaluate the Possibilities >>
• Construct a Model or Prototype >>

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STEPPING STONES TO PROTOTYPE DESIGN AND PRESENTATION

1. IDEATE
Modeling is a useful way to walk students through the ideation process. Using a problem you’ve identified, model for students your brainstorming process to generate a brief list of potential solutions.

This stepping stone is an opportunity for students to let their creativity truly come into play. Some students will take it to naturally, while others may struggle to find “the right” answer. Some may prematurely decide on a solution without evaluating other possibilities. Here are some prompts that can be helpful to probe and spur student thinking during this stage:

- What problem are you trying to solve?
- What would you want to have if you were traveling to Mars?
- What other solutions have you considered?
- How did you decide that solution was the best one?
- How did you decide that problem was the most important to solve?

2. PROTOTYPE DESIGN
Brainstorm ideas for a design solution that presents a solution for a space travel problem.

- Problem/Solution Matchup
- Problem/Solution Brainstorming
- The Identifying an Engineering Challenge formative task is additional ideas for helping kids identify a problem and potential solution.

3. DRAFT AND PRACTICE
Consider audience and purpose while designing the product.

- Construct a Model or Prototype
- Audience Analysis
- Summarizing
- Outline and Draft Presentation
- Conduct a Shark Tank-style conference before you present.

SUGGESTIONS FOR FEEDBACK AND SUPPORT

- If students need help brainstorming, select one or more activities from the ideate >> formative task.
- Use this storyboard-based design process >> when students struggle to write down ideas.
- Conferenceing >> is important at this point, as students are preparing for their first round of feedback.

PROVEN IDEAS FOR ACTIVITIES

- Brainstorming Process to include rubrics >> in the formative task.
- The Work Time >> resource from BIE is a useful tool for structuring conferences.
- Construct a Model or Prototype >>. Given the time constraints and wide range of possible problems and solutions students will address, creating a visual representation of the solution is likely the most feasible way of prototyping. Other options are using foam blocks, paper, or cardboard. Whatever option you choose for prototyping, be sure that the emphasis is placed on utility, not on artistry.

The mode of presentation can vary based on the students, the time, and the resources available. You will need to decide on the timelines and details to be included in the presentation, and clearly present that to the students. Allow them time to practice in front of peers or be recorded so they can self-critique before presenting for feedback.

BIE has these resources to include subunits >> in process with the students.
Welcome to Feedback and Revision. In this milestone, students engage in feedback and revision cycles to improve their prototypes. They benefit not only from teacher-student conferencing but also peer conferencing. Students are positioned as developing experts as they give and receive feedback on their engineering design solution.

Keep in mind that there are two aspects that require feedback and revision: the prototype product and the presentation. Dividing the work and conducting mini-lessons specific to each aspect will allow students to focus their attention on each piece before they pull them together to practice their final presentation.

Note: Check out the recommended resources for prototyping suggestions.

Student teams ideate and develop a proposed solution to their selected problem.

Student teams share their solutions with an audience.

Student teams revise their solution and presentation based on the feedback they receive.

Student teams revise their design solution and presentation based on feedback from peers and content experts.

GIVE AND RECEIVE FEEDBACK

Student teams provide and receive feedback to develop their final product appropriate to intended audience.

REVISE SOLUTION

Student teams revisit their design solution and presentation based on feedback from peers and content experts.

MILESTONE #5: FEEDBACK AND REVISION

STEPPING STONES

RECOMMENDED RESOURCES

TEXTS AND DATA
- Helping Students Give and Receive Feedback >>
- Help a Child Edit and Revise >>

AUDIO AND VISUALS
- Austin's Butterfly >>

TOOLS AND FORMS
- Giving and Receiving Feedback >>
- BIE Critique Protocols >>
- Improve the Design >>
1. GIVE AND RECEIVE FEEDBACK

Feedback, though useful, can sometimes feel negative. Setting norms for feedback at the beginning of the process will help to reduce discomfort. Involving the students in creating these norms will deepen their engagement and ensure their concerns are heard.

One method for focusing feedback is to offer students sentence prompts such as, “One thing I noticed...” “I would like to know more about...” “Can you please clarify...” etc., that the students can use when giving feedback.

ACTIVITY IDEAS

Students will practice giving and receiving feedback in this stepping stone but will need to share their work in order to do so. The activity suggestions promote the sharing of products in small groups with opportunities to discuss and ask questions.

Modeling how to give feedback in these formats will give students a better idea of what is expected. A Flatbowl with student and teacher at the center is a great way to model giving feedback. A Flatbowl with students at the center can be used to give feedback on giving feedback! In either case, ask students on the outside to record and share their noticings.

Ideas for Activities

- Gallery Walk >> to share ideas
- Town Hall Circle >> with feedback protocols
- Give and Receive Feedback >>

Reflection and Synthesis Prompts

- What are the major adjustments you made to your prototype? To your presentation? How did these changes affect your overall product?
- How did your group decide which changes to make and who would make them? Why is it important to talk changes through with the whole group?
- Create a T-chart with proposed changes on one side and the overall effect of the change on the other.
- Choose 3 points of feedback you gave and why you think it helped the work you were evaluating.
- The Critique Protocols >> from BIE assist students in giving and receiving feedback.

Suggestions for Feedback and Support

- Incorporating Feedback for Revision >>
- Edit >>

Students will be able to...

1. GIVE AND RECEIVE FEEDBACK

Standards

CCSS.ELA-LIT.5.1 >>

Provide and receive feedback to develop their final product appropriate to the intended audience.

2. REVISE SOLUTION

The goal of this stepping stone is for students to apply feedback to both the presentation and the prototype. Because the students are working in small groups, it will be easier to devise a plan that breaks this work up among the group members.

Of course not all feedback has to be incorporated into the final product, so mini-lessons about how to decide what feedback to accept and what to reject will be helpful. A set of guiding questions can help students make these decisions.

If students choose to reject specific pieces of feedback, it would be valuable for them to record their thinking about this decision. Remember that revision and editing are different practices. Revision may take several cycles; editing is undertaken once revision is complete.

Ideas for Activities

- Incorporating Feedback for Revision >>
- Edit >>

Standards

CCSS.ELA-LIT.5.1 >>

Revise design solution and presentation based on feedback from peers and content experts.

Formative Assessment Ideas

- Complete an edited draft of the presentation.
- Create a T-chart with proposed changes on one side and the overall effect of the change on the other.
- Choose 3 points of feedback you gave and why you think it helped the work you were evaluating.

Suggestions for Feedback and Support

- It would be helpful for feedback to be recorded or written for students to keep with them while they work. Feedback forms may be helpful in this way.

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Feedback from experts is a valuable asset for students as they refine their work. Experts can come from a range of specialties—writing, engineering, public speaking, etc. However, feedback and questions from non-experts can be invaluable, too. Use what you have!

BIE offers resources on working with outside experts >>. Because of the interdisciplinary aspect of the project, you may consider two rounds of feedback for both the presentation and the prototype.

Working with Outside Experts

Feedback from experts is a valuable asset for students as they refine their work. Experts can come from a range of specialties—writing, engineering, public speaking, etc. However, feedback and questions from non-experts can be invaluable, too. Use what you have!

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The Present milestone gives every student the opportunity to present their prototype or idea to an audience, as well as to see their peers’ work.

Think about how students’ presentations will be assessed and the role they will play in their overall assessment. Also think about whether the presentations will be a formal or informal sharing of their inventions.

Because the process was a key element of the project, students can share that, as well, by displaying brainstormed ideas and early prototypes, and talking about how their decisions were made.

After the presentation, students pause and reflect on their learning experience over the course of the project.

Note: The recommended resources will be helpful as you design lessons for this milestone.

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**RECOMMENDED RESOURCES**

**TEXTS AND DATA**
- 7 Ways to Teach Public Speaking to Kids >>
- Share Solutions >>

**AUDIO AND VISUALS**
- 10 Public Speaking Tips >>

**MULTIMEDIA**
- Web 2.0 Tools for Schools >>
- Skype in the Classroom >>
1. PREPARE

Preparations will vary depending on how students share their prototypes with their audience, as well as what exactly they will be sharing. Regardless of how and what, rehearsing the presentation of the problems and solutions is important. Team members need to make decisions about who will say what and when. You’ll also need to make and rehearse last-minute event management arrangements. Think about who will greet the guests, how the room will be set up, and other logistical considerations.

2. PRESENT

You’ll want to capture feedback from guests and audience members for students to use as they reflect. Check out this BIE resource, Audience Feedback Form >>, for additional ideas on eliciting feedback from the audience.

3. REFLECT & SYNTHESIZE

The reflection process is both essential and more complex than you may first imagine. Reflecting on the project as a whole should take students on a journey of thinking about their new learning of content and skills, and the quality of their final products. By examining and making meaning of their product and their process, students secure their new learning, consider how they can transfer it to new contexts, and increase their metacognitive skills.

This BIE resource Post Project Reflection and Feedback from Students >> is a useful tool for teachers to reflect on the project as a whole.
ENGINEERING DESIGN

NGSS 3-5-ETS1-1 >>
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

NGSS 3-5-ETS1-2 >>
Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

HISTORY

C3-D2-Hs.1-3.5 >>
Create and use a chronological sequence of related events to compare developments that happened at the same time.

C3-D2-Hs.12-3.5 >>
Generate questions about multiple historical sources and their relationships to particular historical events and developments.

WRITING

CCSS.ELA-LITERACY.W.5.2 >>
Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

CCSS.ELA-LITERACY.W.5.4 >>
Produce clear and coherent writing in which the development and organization are appropriate to the task, purpose, and audience.

SPEAKING AND LISTENING

CCSS.ELA-LITERACY.SL.5.1 >>
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly.

READING INFORMATIONAL TEXTS

CCSS.ELA-LITERACY.RI.5.9 >>
Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

APPENDIX I: STANDARDS
acknowledgements

Helen Keller said it best, “Alone we can do so little; together we can do so much.”

This project was designed and developed as a collaboration between Buck Institute for Education and reDesign, LLC.

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Karen McCallion
Antonia Rudenstine

got more?

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