5E Integrated STEM Lesson Plan – Template

Lesson Title: Family Stem Project

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Topic: To execute a mini-simulation of a robotic mission with a goal to command a human-robot through a set course to retrieve a piece of lunar ice.

Targeted Grade Level: preschool, K-2, 3-5

Time Needed: 2-3 days

Subject Integration: Science, Engineering, Technology, and Math

Justification: The NASA BEST activities are designed to teach students with the integrated STEM method in mind. This specific lesson targets the scientific research necessary for a return trip to the moon and eventually Mars. Science is foundational as students will develop a knowledge of past and current space exploration. Engineering and technology are embedded within the lesson as students simulate communication through coding and technology. In addition, the Engineering Design Process is modeled in order to design and create some type of lunar robot that will be able to do a task. This task is measured out not only with an understanding of integrating technology, but in combination with mathematical understanding of measurement.

Standards:

NGSS Performance Expectations

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)
- 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. (3-5-ETS1-2)
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (3-5-ETS1-3)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:

Asking Questions and Defining Problems *Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.* • *Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)* ***Planning and Carrying Out Investigations*** *Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.* • *Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3)* ***Constructing Explanations and Designing Solutions*** *Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.* • *Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)*	***ETS1.A: Defining and Delimiting Engineering Problems*** • *Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)* ***ETS1.B: Developing Possible Solutions*** • *Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)* • *At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)* • *Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)* ***ETS1.C: Optimizing the Design Solution*** • *Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)*	***Influence of Science, Engineering, and Technology on Society and the Natural World*** • *People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)* • *Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)*
Common Core State Standards:		

Math: ● MP.2 Reason abstractly and quantitatively ● MP.4 Model with mathematics ● MP.5 Use appropriate tools strategically. ● 3-5.MD Measurement & Data ● CCSS.MATH.CONTENT.4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement sca. ELA: ● W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
Other Standards ***K*-8 TN Computer Science Standards:** ● AIT.2 Develop a plan to use technology to find a solution and create projects. ● AIT.6 Collect, organize, analyze, and interpret data to identify solutions and/or make informed decisions.

Measurable Student Learning Objectives:

- The students will be able to arrange a strategic path on a map.
- The students will be able to organize directional commands.
- The students will identify patterns in the robot's route and collect the data needed for each command to calibrate the distance the robot travels each time.
- The students will be able to create and improve upon a command sequence.
- The students will be able to record time and solve division problems based on distance.

Nature of STEM:

The nature of technology is demonstrated in the lesson by using tools, materials, and skills to make things and carry out tasks. In addition, creative thinking and economic and cultural influences shape technological developments.

The nature of science is addressed through empirical evidence. There is a great deal of social and cultural evidence in this lesson as the worldview on space and technology continues to change. Culturally, space exploration is available more than ever to all demographics. The embedded phenomena videos will allow background information to be collected and then connected with.

The nature of engineering is present with engaging, hands-on activities. Students will need to plan an idea, create it, test it,and then make adjustments. Students will also be allowed to discuss their findings.

Engaging Context/Phenomena:

The engaging phenomena comes in a series of videos that have suggested age ranges. Not all videos need to be watched, but it is recommended that they be made available to learners (both children and adults) at a later point to continue building background and engaging learners in on-going scientific research. The videos are recommended for those on the team above kindergarten age.

- (all ages) Artemis is the ongoing project to Moon. https://youtu.be/_T8cn2J13-4
- (all ages) What Apollo 13 astronauts saw: https://youtu.be/Ilifg26TZrI
- (all ages) Mars in a Minute: How do you Get to Mars? https://youtu.be/-nAhag_iFx0
- (all ages) Inside the Control Room when Curiosity landed on Mars: https://youtu.be/Ti_yre6dsa4
- (all ages) Testing with a Martian Dune Buggy https://youtu.be/AVqsV4rQ4bE
- (K-3 interest level) Ada Twist, Scientist / Stories from Space https://youtu.be/Q7TLqqct42M
- (3rd - adult) Engineering challenges of getting to Mars: https://youtu.be/pzqdoXwLBT8

For the younger learners (preschool and younger),

- Book suggestions: • *Goodnight Moon* • *Kitten's First Full Moon* • *Mooncake*
- Video suggestion: PBS Kids https://pbskids.org/video/super-why/2301079549
- Picture suggestion: NASA Kids https://images-assets.nasa.gov/image/PIA00405/PIA00405~orig.jpg

Data Integration:

This lesson is filled with collecting information, discussing it, and making adjustments to structures based on the findings. A snapshot of the data recording charts are included in the plans, as well as, attached to this plan.

Differentiation of Instruction:

This lesson offers many opportunities for differentiating due to the very nature of it being a family project. Adjustments can be made on both ability, comprehension, or language. Additionally, the "Elaborate" stage offers an extension of the lesson that allows for deeper critical thinking, skills,and questioning.

Real-life Connection:

In July of 1969, Apollo 11 landed on the Moon. Any school-aged child born after that understands that while fascinating, it is a previous historical event that we can't typically make a connection with. Students today have the opportunity, through Artemis, to garner a greater understanding of the dynamics of space exploration. The use of digital technology also allows for learners to gain background knowledge in real time.

Possible Misconceptions:

- Because it is referred to as a family project, the term 'teacher' is used infrequently. Instead, it is substituted with the term 'team leader'. In the classroom, that wording can easily be adjusted.
- *"Robots are just in movies. They look like metal people."* Robotics is a type of technology that is used in everyday life. Robots could take on the form or movement of a human, but not all the time.
- *"Robots just know what to do somehow."* Robotics is a field where a type of language or code is used to give basic to complex commands. These commands come as a result of human programming.
- *"I can't be an astronaut."* Being an astronaut is available for anyone to pursue.

Lesson Procedure:

<table>
<tr><th>5E Model</th><th>• 5E Objectives</th></tr>
<tr><td><u>Engage</u></td><td>Procedure:

The <u>first part</u> of the lesson is designed to engage all members of the project and is steered by the team leader.
The team leader will choose 1-2 of the following engaging phenomena videos to spark curiosity, recall background, and set the stage for discussion. Before the videos begin, ask members to be thinking about what they notice and what they wonder for the discussion afterwards.
When the videos are completed, the team leader needs to facilitate a discussion but not be the sole speaker. It is advised that the team leader or members of the team write down some of the discussion on a large sheet of paper as a visual reference for thoughts and ideas.

(all ages) Artemis is the ongoing project to Moon. https://youtu.be/_T8cn2J13-4
(all ages) What Apollo 13 astronauts saw: https://youtu.be/Ilifg26TZrI
(all ages) Mars in a Minute: How do you Get to Mars? https://youtu.be/-nAhag_iFx0
(all ages) Inside the Control Room when Curiosity landed on Mars: https://youtu.be/Ti_yre6dsa4
(all ages) Testing with a Martian Dune Buggy https://youtu.be/AVqsV4rQ4bE
(K-3 interest level) Ada Twist, Scientist / Stories from Space https://youtu.be/Q7TLqqct42M
(3-adult) Engineering challenges of getting to Mars: https://youtu.be/pzqdoXwLBT8

The <u>second part</u> to engaging the team members is making some type of “robot”.
The robot can be worn or hand held and should be guided by the interest level of the learner.
The team leader should encourage them to use what they already know about robotics as well as adding new information and details from the phenomena videos.

Modifications</td></tr>
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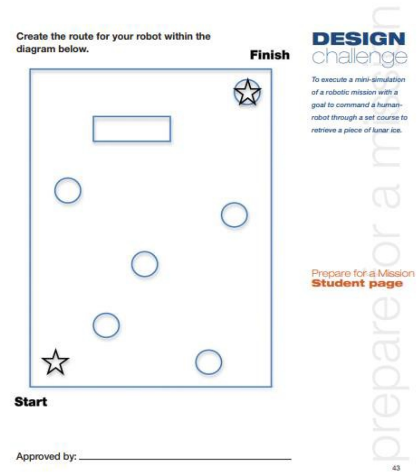
	● The engaging phenomena has been broken down by suggested age groups within K-adult. For the younger learners (preschool and younger), ○ Book suggestions: • *Goodnight Moon* • *Kitten's First Full Moon* • *Mooncake* ○ Video suggestion: PBS Kids https://pbskids.org/video/super-why/2301079549 ○ Picture suggestion: NASA Kids https://images-assets.nasa.gov/image/PIA00405/PIA00405~orig.jpg **Standards Addressed** ● People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ● Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2) ● ELA: W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. **Formative/Summative Assessments** ● The team leader or members of the team should record what they notice and wonder about the videos. An idea is to display those on a large piece of paper or board in order to refer back to them during the lesson. **Resources** ● writing tools, large paper ● Rulers, meter sticks, or tape measure ● Paper to sketch design ● Blindfolds ● "Prize" as lunar ice sample ● "lunar boulders" to navigate around ● Experiment and Record pages ● Optional: boxes and decorations to create a worn or handheld robot rover.
Explore	**Procedure:**

	• The remainder of the challenge is modified from *NASA'S BEST Students, An Educator's Guide to the Engineering Design Process, pages 39-51.* 　○ (Please note: *This lesson plan has combined the K-2 and 3-5 Educator's Guide together. Notations are made on the "Family STEM Project packet when an activity is specific to a grade level. Otherwise, the NASA challenge project is the same K-5. Due to the dynamic of the audience of this lesson plan, the teacher is referred to as the team leader and the class is referred to as team members. Families are encouraged to work together as a team, but also allow each team member and opportunity to experience the challenge.) • The team leader will introduce the challenge of the "Family STEM Project" packet. Team leaders can be as creative as they want when introducing the following mission: 　○ *"Your team has been chosen to operate a robotic Discovery Mission on the surface of the Moon. You will be given a specific starting location, and your robot must move through a lunar landscape to the location of the "lunar ice" without bumping into any "lunar boulders' or other obstacles. To successfully complete the Discovery Mission, your robot must pick up a piece of "lunar ice"."* ***Step 1 - Mapping***. • Using the mapping page (seen below), each team member should create or "program" their own route for a human robot to take in order to get the lunar ice. • They can draw them as arrows or lines. • It is important that maps include at least one right turn and one left turn. • Team members need should get their map signed off by team leader before moving on.

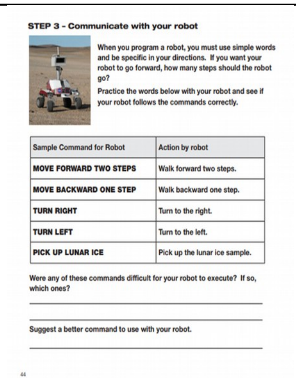


Step 2 - Designate your robot.

- Team members will pair up. (If team members constructed robots to wear or hold, they will begin using them now.)
- Everyone will take turns as the "robot" and as the "programmer".

Step 3 - Communicate with your robot

- Team leaders should explain that the programmers job is to use simple words and give specific directions.
- Partners will practice giving the command while the other is acting it out. Switch.
- Fill in or discuss the following questions:
    - Were any of these commands difficult for your robot to execute? If so, which ones?
    - Suggest a better command to use with your robot.



STEP 3 - Communicate with your robot

When you program a robot, you must use simple words and be specific in your directions. If you want your robot to go forward, how many steps should the robot go?

Practice the words below with your robot and see if your robot follows the commands correctly.

Sample Command for Robot	Action by robot
MOVE FORWARD TWO STEPS	Walk forward two steps.
MOVE BACKWARD ONE STEP	Walk backward one step.
TURN RIGHT	Turn to the right.
TURN LEFT	Turn to the left.
PICK UP LUNAR ICE	Pick up the lunar ice sample.

Were any of these commands difficult for your robot to execute? If so, which ones?

Suggest a better command to use with your robot.

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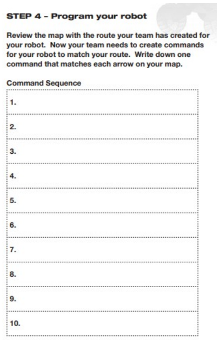
Step 4 - Program your robot

- Double check the final route you or your team decided on.
- On the list below, create commands for the human robot to follow.
- Write down one command that matches each arrow or line on your map.



STEP 4 – Program your robot

Review the map with the route your team has created for your robot. Now your team needs to create commands for your robot to match your route. Write down one command that matches each arrow on your map.

Command Sequence

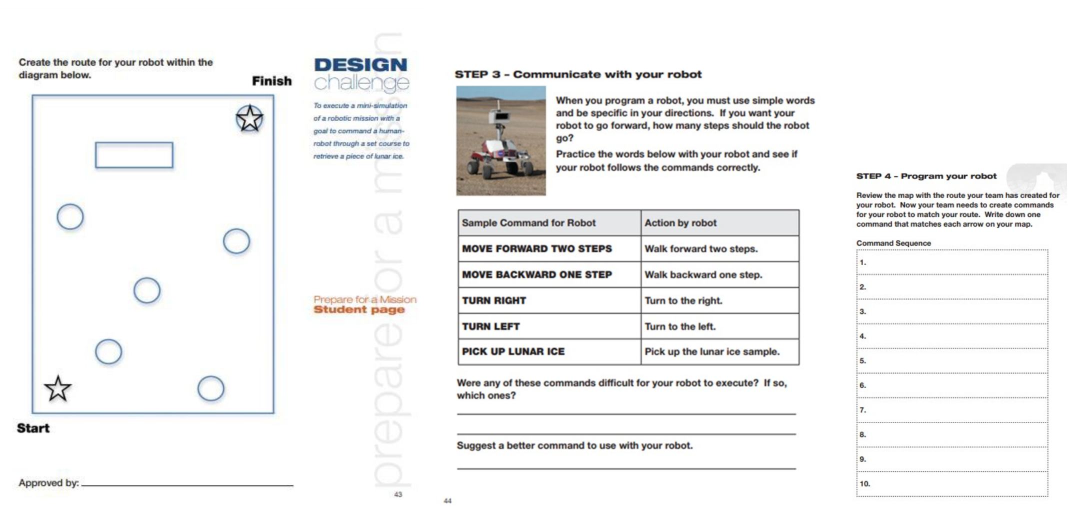
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Modifications

- Team leaders or other members can act as scribes for those needing help with the written portions.

Standards Addressed

	• Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) • 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. (3-5-ETS1-2) • Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (3-5-ETS1-3) **Formative/Summative Assessments** • Team Leaders need to “sign off” on members sequence maps. • Team Leaders can do an overall check for understanding with this stage on the step 4 Command Sequence. **Resources** • *NASA’S BEST Students, An Educator’s Guide to the Engineering Design Process, pages 39-51.*



Create the route for your robot within the diagram below.

Finish

Start

Approved by: ______________________

DESIGN challenge

To execute a mini-simulation of a robotic mission with a goal to command a human-robot through a set course to retrieve a piece of lunar ice.

Prepare for a Mission
Student page

prepare for a mission

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STEP 3 - Communicate with your robot

When you program a robot, you must use simple words and be specific in your directions. If you want your robot to go forward, how many steps should the robot go?

Practice the words below with your robot and see if your robot follows the commands correctly.

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MOVE BACKWARD ONE STEP	Walk backward one step.
TURN RIGHT	Turn to the right.
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PICK UP LUNAR ICE	Pick up the lunar ice sample.

Were any of these commands difficult for your robot to execute? If so, which ones?

____

____

Suggest a better command to use with your robot.

____

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STEP 4 - Program your robot

Review the map with the route your team has created for your robot. Now your team needs to create commands for your robot to match your route. Write down one command that matches each arrow on your map.

Command Sequence

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Explain

Procedure:

Step 1: Explain the Discovery Mission

- Now that a command sequence has been made, cut the list into strips of paper.
- Make sure the following jobs gets assigned:
  - reader of the commands (can be more than one person)
  - timer
  - time recorder.
- Based on ability, team members should use one of the two forms below to begin recording the data.

Discovery Mission Data Table

Team Name	Time (seconds)
1.	
2.	
3.	
4.	
5.	

Discovery Mission Data Table

Command and Movement	Time (seconds)
Movement #1	
Movement #2	
Movement #3	
Movement #4	
Movement #5	
Movement #6	
Movement #7	
Movement #8	

- Team leaders: allow for teams to make sense of what is happening by asking questions:
  - What did you notice?
  - What differences were there between teams?
  - What conclusion can you make about certain movements? How do you know?
  - What do you predict would happen if you continued another round?
  - What factors had an effect on the time?

Modifications

- The project leader can assist as the scribe or reader.
- Partner learners that can assist with writing/reading.

Standards Addressed

- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)
- 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. (3-5-ETS1-2)
- Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (3-5-ETS1-3)

Formative/Summative Assessments

- Team leaders should use the guiding questions as assessment.
- Team leaders should assess data collection sheets.

Resources

- *NASA'S BEST Students, An Educator's Guide to the Engineering Design Process, pages 39-51.*

Discovery Mission Data Table

Team Name	Time (seconds)
1.	
2.	
3.	
4.	
5.	

Discovery Mission Data Table

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Movement #1	
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Elaborate

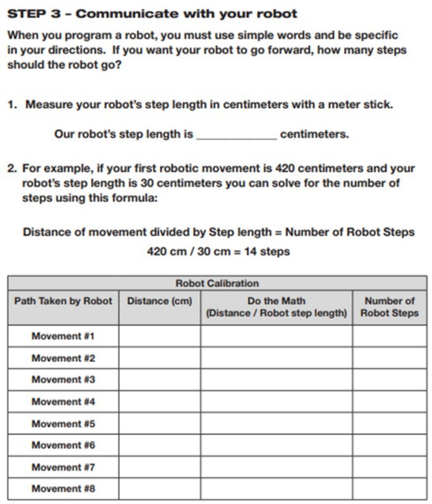
Procedure:

Step 1: Team leader will lead teams in extended learning. Explain that communicating with technology to move requires understanding distance and measurement.

Step 2: Pass out meter sticks. Measure the human robot's step length in centimeters. Record.

Step 3: Solve the distance of movement divided by the step length. This will equal the number of human robot steps. (Example: 420 cm / 30 cm = 14 steps)

Step 4: Using this equation, team members may begin filling out "Robot Calibration" chart.



STEP 3 – Communicate with your robot

When you program a robot, you must use simple words and be specific in your directions. If you want your robot to go forward, how many steps should the robot go?

1. Measure your robot's step length in centimeters with a meter stick.

   Our robot's step length is ___________ centimeters.

2. For example, if your first robotic movement is 420 centimeters and your robot's step length is 30 centimeters you can solve for the number of steps using this formula:

   Distance of movement divided by Step length = Number of Robot Steps

   420 cm / 30 cm = 14 steps

Robot Calibration			
Path Taken by Robot	Distance (cm)	Do the Math (Distance / Robot step length)	Number of Robot Steps
Movement #1			
Movement #2			
Movement #3			
Movement #4			
Movement #5			
Movement #6			
Movement #7			
Movement #8			

Modifications

calculators may be used.

Standards Addressed

- MP.2 Reason abstractly and quantitatively
- MP.4 Model with mathematics
- MP.5 Use appropriate tools strategically.
- 3-5.MD Measurement & Data
- CCSS.MATH.CONTENT.4.MD.A.2 Use the four operations to solve word problems

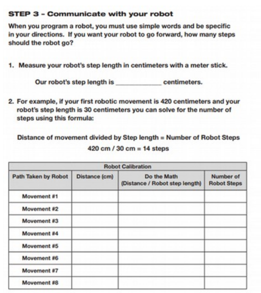
involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement sca.

Formative/Summative Assessments

Team leaders should assess mathematical calculations and data collection.

Resources

- *NASA'S BEST Students, An Educator's Guide to the Engineering Design Process, pages 39-51.*



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Movement #7			
Movement #8			

Evaluate

Procedure:

Team discussion:

- How would you describe mapping your robot path?
- Can you explain what challenges you found doing that? How did you solve those challenges?
- What was the relationship between the human robot and the speaker?
- What challenges were there in communicating with your robot? How did you solve those

	challenges? ● What happened if you skipped a step or any directions to your robot? ● What connections can you make between pretending to be a robot and programming a real robot? ● What improvements could you make for future projects? ● What advice would you give to NASA robotics for creating lunar rovers? **Modifications** ● members can draw or use visual models and prompts for complex language. **Standards Addressed** ● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2) ● At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) **Formative/Summative Assessments** ● Assessing for clarification on concepts should occur at this stage during the questioning/team discussion. **Resources** ● *NASA'S BEST Students, An Educator's Guide to the Engineering Design Process, pages 39-51.*

Teacher Background:

Teachers/team leaders should utilize the phenomena videos at the beginning of the lesson to build background and overall understanding.

Teachers/team leaders should review the engineering process.