Activity Title: mini Principles of Remote Exploration!

This activity is based on ***Principles of Remote Exploration****, an extensive, technology-based sample-analysis mission simulation for middle school students.* ***learners.gsfc.nasa.gov/PREP/***

Activity Objective(s): Teams will execute a mini-simulation of a robotic mission, to get the flavor of Mission Planning, including mapping, communication, calibration and simple programming. The ultimate goal is to get the human-robot from one end of the course to the other, and the robot should pick something up (A "lunar rock") at the end of the course.

Graphic courtesy NASA.

Grade Levels: 3 - 5

Process Skills: communication, measuring, graphing, logical thinking

Lesson Duration:

Two 60 min sessions

Materials and Tools (per group of three students):

- Rulers
- Graph paper, if available

Club Worksheets: (Make copies for each student to put in binder)

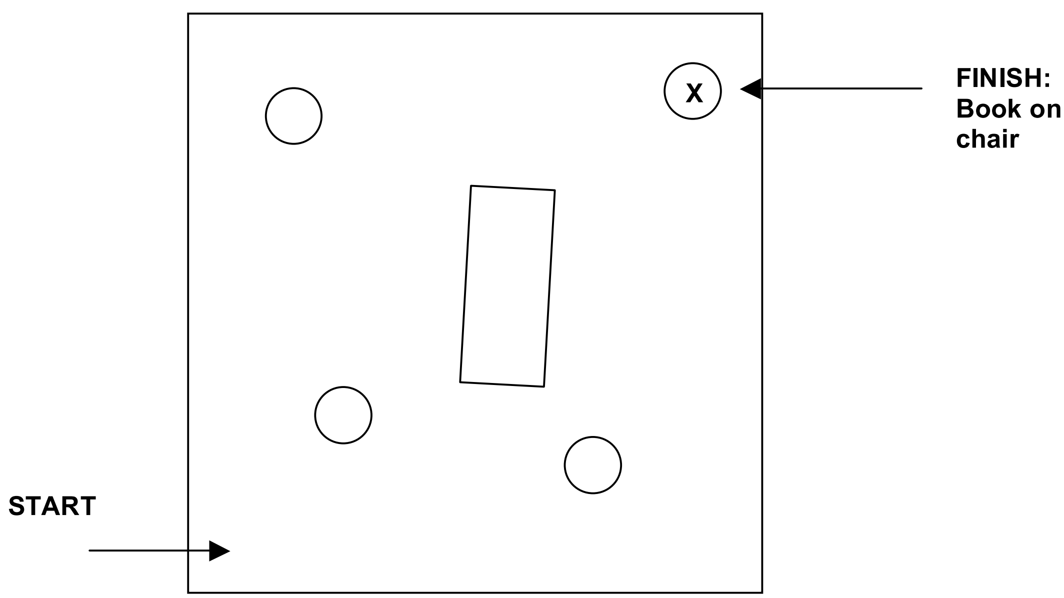
1. Mapping
2. Communications
3. Calibration
4. Mission Plan
5. Summary
6. Fun With Engineering at Home, Parts A and B

Club Facilitator or Teacher Notes by Stage:
(Based on those running 60-minute Clubs)

Session 1
SET-UP

Block off a small obstacle course or Landing Site. Use 3 chairs, 1 table, and 1 wastebasket as obstacles within the Landing Site. Use the following diagram to arrange your space as close to this image as possible (See the map on Student Page 2 that they will be using). Each chair will need to be labeled #1, #2, and #3 so they are easy to identify by your students on their maps.

(Table is rectangle, chairs/wastebasket are circles):



Stage 1.1: Set the Stage (Approx 10 minutes)

- Explain to the students that many of NASA's missions are conducted by robots. Although some robots have the ability to make decisions based on data they receive from sensors, the original programs given to the robots are written by humans. Humans tell robots what to do and how to execute their missions. Today, the teams will conduct a mini, robotic Discovery Mission.

The Discovery Mission Challenge

Your team has been chosen to operate a robotic Discover Mission on the surface of the Moon. You will be given a specific starting location, and your robot must mover from there to the location of the "lunar ice" without bumping into any "lunar boulders" or other obstacles. To successfully complete the Discovery Mission Challenge, your robot must pick up a piece of "lunar ice."

A NASA mission has several parts, and you will be responsible for carrying out each component of the mission. Before your robot begins to traverse the lunar surface, you will have to complete the following activities:

- Map the "landing site" – your team will make a scale map that you will use to determine the path that your robot should take. You will mark out a route for the robot on this map, and then you will translate this path into a program for the robot.
- Learn to communicate with your rover – you will develop a simple language to pass commands to your robot. You will practice these commands until you and the robot are comfortable with them. These will be the commands that you will give the robot to traverse the path you have drawn on the map.
- Calibrate your robot – you must determine how your robots motions translate into standard units. For example, ONE robot step will equal how many centimeters? You will use this information to tell the robot how to traverse the route you have planned on the map.
- Program the robot – you will use the commands that you developed and the calibration to make a command set that will tell the robot how to traverse the path you have drawn on the map.

Next session, your robot will get the opportunity to execute the program you have written at the "landing site." Your mission will be complete when your robot picks up a piece of "lunar ice."

- Break the students into three-person teams. Each member of the team should choose a role for today's robotic mission:
    1. **Robot (BOT)**: One of the students in the team should volunteer to be the robot. The BOT will be the person who actually walks through the course, following the instructions of her/his team. The team should give their robot a name.
    2. **Communicator (COM)**: One of the team members will be the person who communicates with the robot once it has "landed." This person will read commands to the robot.

3. **Calibrator (CAL)**: One team member will count the number of steps in relation to given obstacles and the dimensions of the landing site.

Stage 1.2: Pre-Mission Activities (About 30 minutes)

Logistics Note: Mapping, Communication and Calibration can be done at the same time, so that while one group is mapping the "landing site," the other groups can be developing their command language and calibrating their robot.

Mapping

The students should take the map of the "landing site" and a pencil to the designed course and answer the related questions found on the worksheet. This will allow them to establish measurements using the steps they take for the site layout.

Communication

The teams develop a "language" (a set of commands) that they will use with their rover. These commands should be one word, plus a number (the amount of steps to take). A few suggested commands are:

FORWARD N	(where N is the number of steps)
RIGHT N	(where N is the number of steps AFTER the right turn)
LEFT N	(where N is the number of steps AFTER the left turn)

They may come up with other one-word commands. They should make a list of their commands. If a command is not in their list, they may not use it once the robot has "landed."

COM should practice giving commands to BOT once the list is established. BOT should practice listening carefully to each command as it is given.

An example of a command sequence is delivered as follows:

a. COM touches BOT's shoulder
b. COM: HELLO Robot Smith
c. BOT: HELLO
d. COM: Forward 5
e. COM: Right 3
f. steps d & e are repeated until BOT reaches ending location
g. COM: CORRECT. GOODBYE.
h. BOT: GOODBYE

The command-response pattern is important to be sure the BOT understands the command. The greetings at the beginning and the end of the sequence serve to tell the BOT when to start listening and when to stop.

Calibration

Once the command set is developed, the BOT practices executing the commands. Teams will work to identify the number of steps needed to navigate by obstacles within the course.

Programming

Once Mapping, Communication and Calibration are complete, the teams chart the course for their BOT. First, they draw their chosen course on the map. Then, they use their calibration data to determine what command sequence they must use to get the BOT through the course.

Stage 1.3: Closure for Session 1 (5 minutes)

The Summary Sheets will be handed out next week, at the end of the Discovery Mission. Bring the students into a brief discussion to assess their progress at this point. Ideally, they will have a completed program for their BOT and will be ready to drop the BOT at the starting point to begin their mission next session. If they are not this far along, they can use the first part of the next session to finish programming their BOT. Send them home with "Fun with Engineering at Home, Part A."

Session 2

SET-UP

The landing site (obstacle course) must be reconstructed exactly as it was in Session 1.

Stage 2.1: Mission Readiness review (10 minutes)

Assemble the students in their teams. Ask each team to share their calibration results. They should show the graph they have made of the BOT's movements.

Discussion Questions

Does each BOT have the same calibration factor? (That is, ONE BOT step equals how many centimeters?) Why or Why not?

If suddenly you were asked to work with a new BOT, would you have to change any of your calculations? If so, what would change? Why?

Stage 2.2: Mission Execution (5 minutes per team)

- Missions should begin as soon as a team is ready to go.
- The BOT is placed at the starting point. COM delivers the first set of commands, using the command protocol. Map keeps track of the BOT's progress. If the BOT successfully executes the commands, the next set is delivered. If BOT makes a mistake, they go back to the previous stopping point, and get a second chance. If they still cannot execute properly, they get sent back to Mission Control for a tune-up, and the next team gets to go.
- Students **IMPROVE** by examining their maps and making corrections to their command sequence.

Stage 2.3: Challenge Closure

- Hand out the Summary Sheets (please collect one per team and save in a folder for NASA).

Stage 2.4: Previewing Next Week (Approx 5 minutes)

- The Moon is a very harsh environment. There is no atmosphere to protect astronauts and their equipment from solar radiation and the extreme temperature swings between night and day. Next week, we will begin to find ways to protect astronauts from those extreme temperature changes.

1. Mapping

Goal: To produce a map of the "landing site"

The map, which you will create, will represent the landing site in the room. Follow the steps below to create your landing site map.

Step 1: Identify the table on your map. Color the table on your map green.

Step 2: Identify the chairs on your map. Color the chairs red on your map.

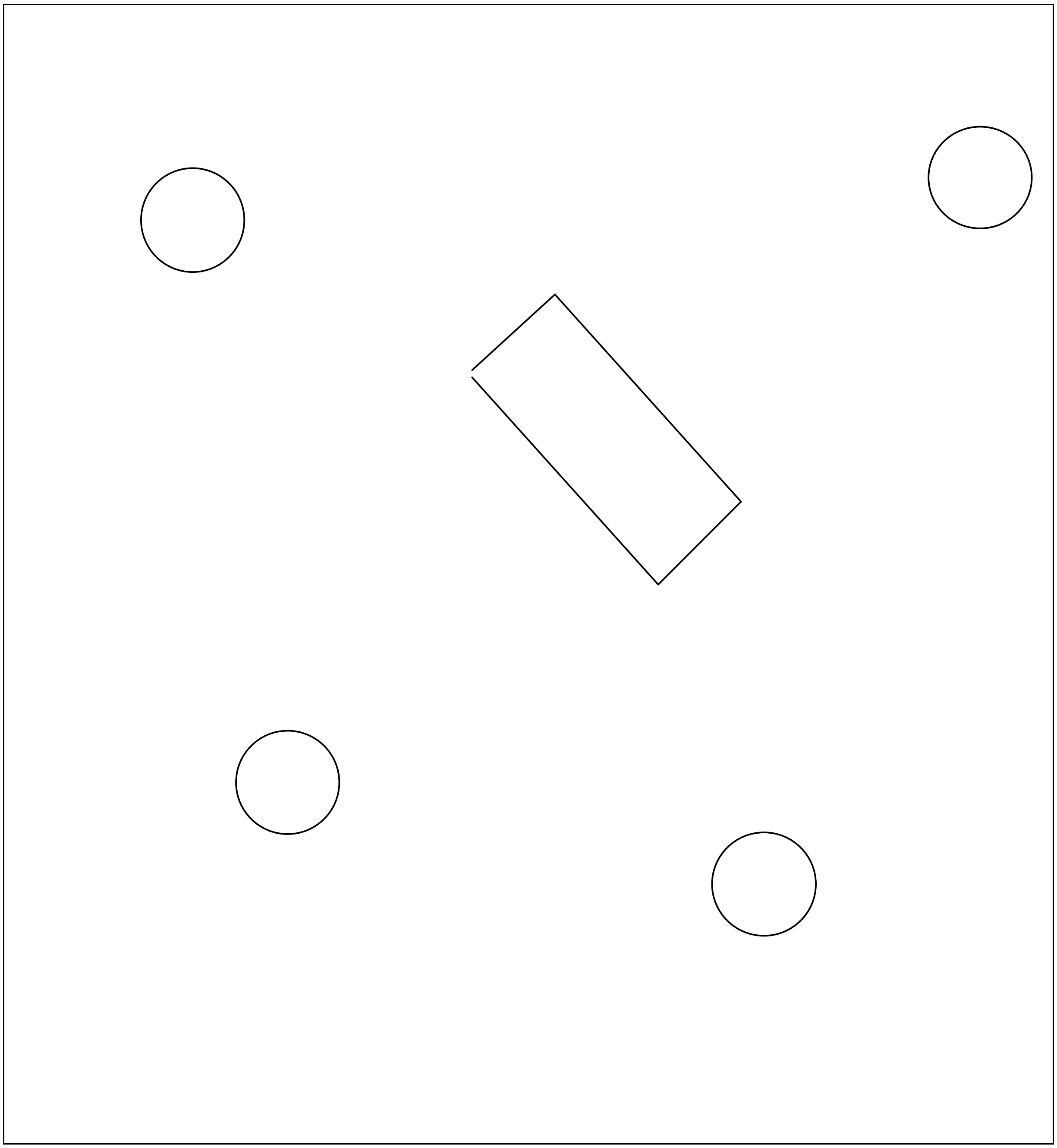
Step 3: Identify the wastebasket on your map. Color the wastebasket yellow.

Step 4: Using a pencil, draw small arrows on your map that shows the route you will take to navigate the landing site. You must include one right turn and one left turn.

What areas within the landing site may be more difficult for your robot to navigate?

What steps will you take to ensure that your robot navigates the course accurately based on this map?

Team Name: ______________________________



2. Commands

Goal: To develop commands to navigate within the landing site.

COM should practice giving commands to BOT. Teams should now think about all the movements the robot is going to have to make to navigate through the landing site that was just mapped.

An example command sequence could be delivered as follows:

a. COM touches BOT's shoulder
b. COM: HELLO Roboman
c. BOT: HELLO
d. COM: Forward, 5
e. BOT repeats the sequence and performs action
f. COM: Right, 3
g. BOT: repeats the sequence and performs action
h. COM: CORRECT. GOODBYE.
i. BOT: GOODBYE

Create a list of commands that you will use in the chart below. Keep in mind all of the directions that your robot may need to navigate in order to reach the ending location successfully. You will only be able to use the commands that you add to this list.

COMMAND	ACTION

Practice delivering a command sequence so that it becomes easy for your BOT to repeat the commands and execute them. Remember, your BOT may feel under pressure in the "landing site," so you want to help BOT feel prepared.

3. Calibration

Goal: Calibrate the rover's movements.

Your team will need to be in the landing site to complete robot calibration. You will be identifying the number of steps your robot needs to take in order to navigate around each of the obstacles below.

Object	**# of Steps (Front of Object)**	**# of Steps (Side of Object)**
Chair #1		
Chair #2		
Chair #3		
Wastebasket		
Table		

How many steps across is the entire landing site? ______________________

How many steps in length is the entire landing site? ____________________

Now add these numbers to your map next to each location. For example, if it took your robot 3 steps across the front of the table then you would place a 3 along the front edge of the table on your map. Do this for each object for the front and side measurements. Be sure to also label the length and width of the landing site in the number of steps on your map.

Using this information and your map, your team will now work together to develop a command list to navigate your robot through the landing site. You will need to develop a plan that includes both a left and right turn and one that uses commands only from the list that was created. Identify how many steps will need to be taken in each direction.

4. Mission Plan

Goal: Chart your BOT's traverse through the "landing site." Develop a plan that results in a Command Sequence using your command language.

- Use the map you made of the "landing site" to determine the best path for the BOT to take to get from the Starting point to the Finish, where the "lunar rock" awaits.
- Now develop a Command Sequence, using your command language, that will result in your BOT getting from the Starting point, to the Finish.

GOOD LUCK!

Command Sequence	
1.	15.
2.	16.
3.	17.
4.	18.
5.	19.
6.	20.
7.	21.
8.	22.
9.	23.
10.	24.
11.	25.
12.	26.
13.	27.
14.	28.

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5. Summary

What was the most challenging part of completing this Discovery Mission?

What step in today's process was the most important to this activity?

Explain why your team felt that this was the most important step.

What would you do differently the next time?

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Team Name:____

Fun with Engineering at Home – Part A

Activity 8: *mini Principles of Remote Exploration!*

Pre-Mission Activities

Today we conducted a simulated, robotic Discovery Mission. We practiced many of the very same activities that NASA scientists and engineers do when planning and executing a mission, such as Mapping, Calibration, Communication and Programming.

Home Challenge: During this week, why not try to do a Discovery Mission at home? You could rearrange some chairs and maybe a table to set up the Landing Site. You could help you family members understand why making a good map is important, and why you must calibrate your BOT. You could even blindfold the BOT to make it more challenging! If you have a big family or are doing this with lots of friends, you could break into teams and race to the end. Maybe the "lunar rock" could be something fun, like a treat!

These are the steps:

- <u>Mapping</u>: make the map of the Landing Site (you'll need a ruler)
- <u>Communication</u>: develop a command language and practice with the BOT
- <u>Calibration</u>: calibrate your BOT's steps (you'll need a ruler)
- <u>Programming</u>: plan a route through the Landing Site and program it using your command language.
- <u>Mission Execution</u>: BOT traverses the Landing Site, following the commands.

HAVE FUN!!

Team Name:____

Fun with Engineering at Home – Part B

Activity 8: *mini Principles of Remote Exploration!*

The Discovery Mission

Today we conducted a simulated, robotic Discovery Mission. Now consider what challenges would face living humans instead of mechanical robots: aside from air and water there are extreme temperature variations on the Moon because the Moon lacks an atmosphere.

Home Challenge: During this week consider the ways in which we deal with this problem on Earth. Research on the web and/or talk with family and friends. List three ways we protect ourselves from extreme cold on Earth. List three ways we protect ourselves from extreme heat.

Protect against Cold:

- ____
- ____
- ____

Protect against Heat:

- ____
- ____
- ____

On the Moon: Which of the ways that you described above as working on Earth will work on the on the Moon, and why?