

Rover Races

Modified from https://www.nasa.gov/pdf/392975main_Rover_Races_Activity.pdf

Overview

Participants work in teams to model the process for communicating with a rover on Mars, to understand the effects of time-delay and to build communications and programming skills.

Activity Time

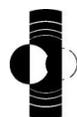
15 minutes, although participants may opt to repeat the game multiple times.

What's the Point?

- 🔍 Teams of scientists and engineers use robotic vehicles to explore other worlds.
- 🔍 There is a time delay in sending and receiving signals from planetary missions.
- 🔍 Rover missions require careful planning and programming on Earth.

Materials

- Large open space to play the game
- 12 sheets of construction paper per team, varying colors
- Tape
- 1 pen per team of participants
- 30 index cards per team
- 1 copy of the map for each team
- (Optional) 3 rocks per team—for activity extension
- (Recommended) *Mars in a Minute: How Do Rovers Drive on Mars?*
<https://www.jpl.nasa.gov/edu/learn/video/mars-in-a-minute-how-do-rovers-drive-on-mars/>
- (Recommended) Projector and computer to show video to participants
- (Optional) Exploring the Solar System: Mars Rover Content Training Video from the Explore Science: Earth & Space 2018 Toolkit <https://vimeo.com/245835422>. *Please note that in this revised activity, no blindfolds are used, and teams are competing against each other to be first.*



Preparation

Before the event

- (Optional) Review Mars Rover Content Training Video at <https://vimeo.com/245835422>. *Please note that in this revised activity, no blindfolds are used, and teams are competing against each other to be first.*
- Scatter the sheets of construction paper with the colors arranged randomly in the area where the races are to be held. (If desired, tape the sheets to the floor).
 - Modification for a limited space: create a grid with tape and place one sheet of construction paper within each space. Teams will take turns competing rather than compete simultaneously.
- Determine a starting point for each human rover and an end point, and place one of the construction sheets at the end point. Make sure that the end points are not obvious.
- Create a map of the starting and end points for the different rovers. (See the attached example, which you can use or modify.)
- (Recommended) Set up projector and computer to show the video *Mars in a Minute: How Do Rovers Drive on Mars?*
- (Recommended) If more than 3 teams are playing, consider asking another adult to assist in facilitating the game.

Activity

1. Share ideas and knowledge.

- Ask the participants what they know about robotic spacecraft on other planets.
 - Do they know the names of any rovers on Mars?
 - What are some of the reasons that it's difficult to operate a rover on Mars?
- Share that one of the challenges is the great distance to other worlds. It might take an hour to receive a signal from a rover on Mars and send a response. So driving rovers on Mars is not like driving a remote-controlled car. Mission teams instead need to send a carefully planned series of directions—commands—to the rover.
- (Recommended) Show participants the video *Mars in a Minute: How Do Rovers Drive on Mars?*

As much as possible, encourage the participants to offer information and to respond to others' questions, rather than answering them yourself. Use phrases like "What do the rest of you think?" "Do you agree with ____?" "Do you have any additional ideas?"

2. Explain the game.

Let the participants know that they will be working in teams to get a human "rover" from its starting position to its goal.

- One person on each team will be the rover, which follows directions, such as "Take 3 steps forward," "Turn right," or "Turn left." [*Possible modification: for participants over 11 years, consider allowing specific numbers of degrees, such as "Turn 45 degrees right" or "Turn 90 degrees left."*]
- One person on each team will be the "programmer." Only the programmer will know what the goal is for their rover.

- The remaining team members will act as radio signals (“relays”), taking turns to deliver a command to their rover.
- Some of the colors of construction paper are “hazards”--places to avoid, where a rover might get stuck. If your rover accidentally steps on a “hazard”, you will receive an instruction from the facilitator to stand still for 20 seconds. Only your team’s programmer will know which colors are hazards.
- The first team whose rover reaches its end point wins the race.

3. Play the game.

- Arrange the participants in teams. [Each team should have at least 3 people. The number of teams should be limited by the space and the number of facilitators.]
- Each team selects their “programmer.” Hold a brief private conversation with all of the programmers; provide them with a copy of the map, identifying the construction sheet that is their team’s goal and which of the colored sheets of construction are hazards. *Stress that they cannot share their end point or the hazards with their teammates.*
- Each team should determine which participant is their “rover.” Show the rovers to their starting positions.
- The programmer writes a series of instructions, one on each card, to direct their rover to its end point. For instance, the cards may include:
 - 3 steps forward
 - Turn left
 - 2 steps forward
 - Turn right
 - Pick up rock
 - Turn left
 - 4 steps forward

- *Modification for limited space:* each team takes their turn at the challenge, using the grid created. The facilitator times how long it takes each team for the rover to successfully reach its end point.
- *Modification for limited time:* The programmer writes a single instruction (such as “take 3 steps”) at a time, then waits to write the next step after the first has been completed.
- *Modification for young participants:* Participants can draw their instructions (such as a stick figure picking up a rock), or select from instruction cards created in advance.
- *Modification for ESL participants:* Participants use arrows and other symbols as their instructions.
- *Optional modification for older participants (ages 12 and up):* Quantify the size of the steps: for instance, specify that each step should be 1 meter.

- The race starts! The programmer gives the first message to a “relay” to bring to the rover. Once the rover has completed the instruction, another “relay” can give the next message.
- If a rover steps on a “hazard” the facilitator stops all action and orders that rover to halt for the next 20 seconds, and invites the other rovers to continue. (If more than 3 teams are playing, you may need additional facilitators to assist with this.)
- If a rover is badly off-course, the programmer can write a command to “stop” and send it to the rover via a relay, then write new commands for the rover based on the rover’s new position.

- The team with the first rover to reach its end point wins; the remaining teams may continue toward their end point. Encourage the team that finished first to cheer on the remaining teams!
- If desired, repeat the game, changing the roles for the rovers, programmers, and relays.

4. Conclude. Draw on the participants' observations and reflections:

- Was it difficult to send the rover to the correct locations? How could you improve the "programming"?
- What are some of the problems that might come up during a rover's mission?
- Programming requires very explicit (specific) language. How is communicating with a robot, or a computer, different from communicating with a human?

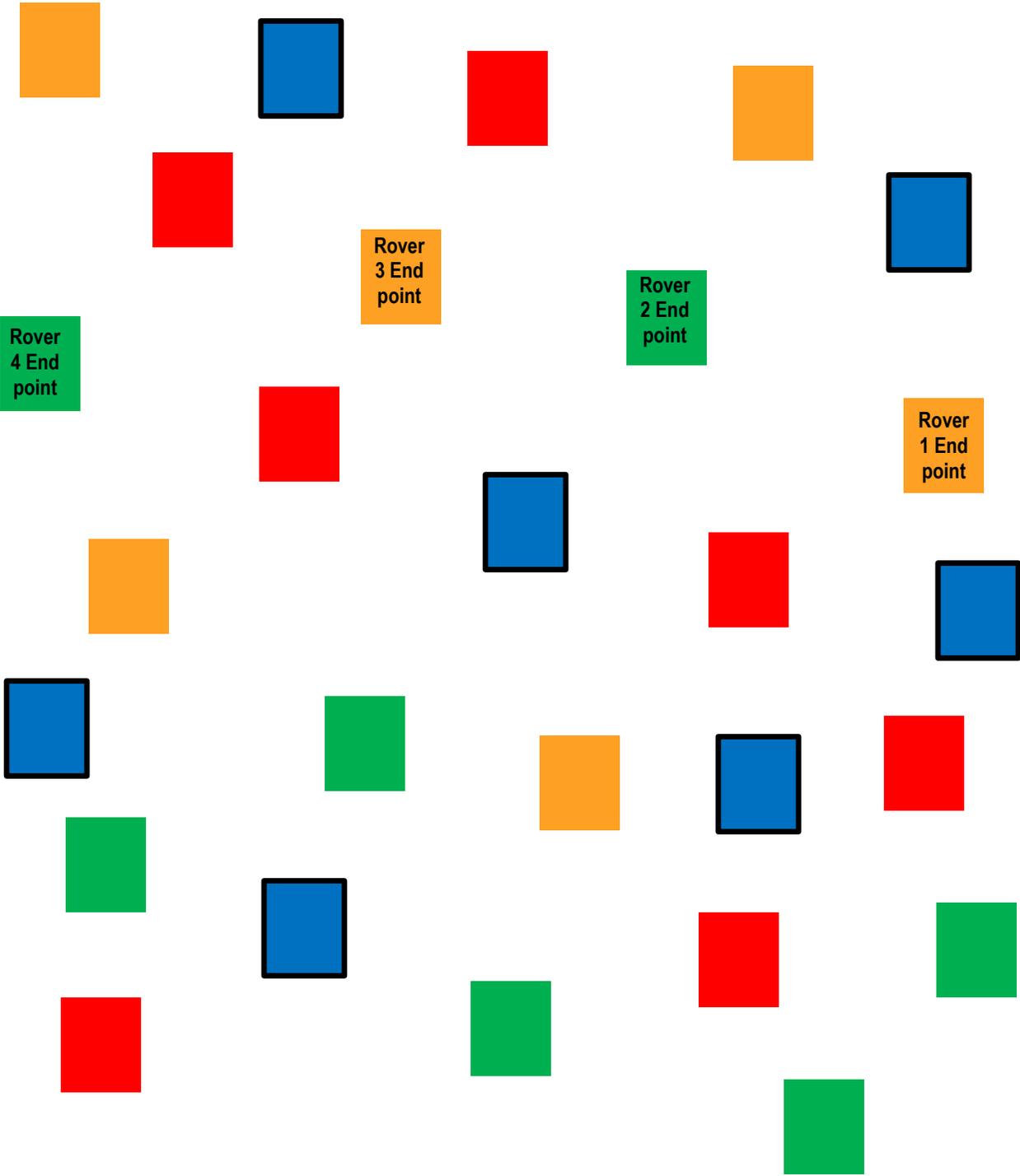
Extensions

Play the game again with a modification: invite the rovers to compete to see which can collect the most rock samples.

- Explain that the rovers will be collecting rocks to cache for return to Earth; the rover will need to first travel to and pick up a rock. Each rock sample would need to be cached at the end point before the second rock sample is collected.
- Before starting the game, scatter rock samples on some of the sheets of construction paper.
- Set a specific time limit (such as 5 minutes): the team whose rover collects the most rocks and returns them to its cache (end point) within the allotted time wins.

Rover Map (example)

All **Blue** Sheets are Hazards—Program your rovers to avoid Blue!!



Rover 1
Starting point

Rover 2
Starting point

Rover 3
Starting point

Rover 4
Starting point