SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Lesson Plan

Coding Tool	Offline Coding
Cross Curricular	Math - Probability

Big Ideas

Space exploration has generated valuable knowledge but at enormous cost.

Specific Expectations

D1.2 assess some of the costs, hazards, and benefits of space exploration.

D2.1 use appropriate terminology related to the study of the universe,

D2.4 gather and record data, using an inquiry or research process, on the properties of specific celestial objects within the solar system.

D3.2 describe observational and theoretical evidence relating to the formation of the solar System.

Description

To learn about the Moon and the challenges and cost of exploring it, students play a rover that explores the surface to find a suitable location for a lunar base. They do this by giving commands to their rover and then analyzing and solving the incoming data and errors due to natural events (which happen randomly based on the roll of a dice). This lesson is set up so that students generate the "code" to guide a rover safely on the Moon as it's conclusion.

Materials

For each student team of 2:

- Two tokens to represent rovers
- Lunar map
- Instruction sheet
- Lunar fact sheet (cut in half – one half to each team member)

Computational Thinking Skills

- Algorithm design

Introduction

The Moon has likely fascinated humans since we first started looking at the night sky in wonder. This fascination peaked in the 1960s and 1970s when we first visited the Moon. In the last 50 years we have not returned however. This is about to change, with much interest again by countries and private corporations to set foot on the Moon.

Today you will take on the role of mission controller for a rover mission to the Moon. Your job will be to guide a rover successfully to a location where there is water. Water is crucial to establish a lunar base because it would be very expensive to have to bring it in from Earth. Along the way you will learn about the Moon, and the challenges a rover can face on its surface.

Your goal is to put together a set of instructions that will successfully guide the next robot – which will build a habitat on the Moon.

Brief Discussion

- What kinds of things do you think could happen to a rover on the Moon? (Get stuck, needs to move around rocks or steep crater rims, etc…)
- Do you think this kind of mission will be expensive? (yes, we'll learn more about that today)

Once we see what kinds of things happen to a rover as it explores the teacher will periodically make more funding available to upgrade the rover – class will decide together what the most urgent improvement is.

Action

Setup

- Students should work in teams of two. Each team receives a lunar map (attached below), the instruction sheet, and the lunar facts. Each team member should only have half the lunar facts as they will share them with each other.
- DO NOT read all the facts yet, nor should you study the rover map coordinates, EXCEPT for the starting locations.
- Place a token that will represent your rover on the start locations.
- You will take turns as "mission control" for your rover and move it on the map to explore the surface and hopefully find water in the end.

Actions

- When it is your turn, you will do the following (summarized on your instruction sheet):

- Move rover in any chosen direction (one square per round).
- Ask your partner to check if the rover gets stuck, is obstructed by something, or found water (by looking at the coordinates on the instruction sheet to see if it says anything for the square you are attempting to move onto).
  - If stuck, you lose a turn. Mark the sandy spot on the map
  - If obstructed, you can't move this turn but may move again next turn. Mark the obstruction on the map.
  - If you find water you're done!
- If you CAN move, then roll dice to see if natural event occurs or you are instructed to do an analysis with your instruments. Follow instruction according to the roll of the dice.
- Then the other person takes their turn.

Your goal is to find a path that leads to water. Record your rover movement instructions that work successfully so that we'll have a sequence of commands to use for another rover to follow!

Once the students are clear they can start with the activity.

Rover Improvements
At teacher's choosing announce that NASA (or whoever) has made additional funding available to improve the rover. Ask the class what things have happened that is affecting their mission (e.g. radiation blast – which could be from a solar flare). The whole class decides together what should have the highest priority to address. You can then announce that from now on when they roll that outcome the rover is no longer affected by it (BUT, the program has just gotten a lot more expensive!).

Consolidation/Extension

- Now that we have one set of instructions that works from the beginning to the end, we can give them to a construction robot that will follow them from the landing area to where the water has been found!

- Discuss the outcomes:
  - What did they learn from the facts they read?
  - Why haven't we been back to the Moon in so long? (Very expensive, not clear what the purpose would have been, dangerous, etc)

- Coding elements:
    - The **program** is the sequence of commands that you've developed.
    - We have **variables** in our program such as direction = (west, south, east, north), surface = (sand, obstruction), water = (yes, no).
    - A yes/no variable is called a **boolean**. Water is a Boolean variable that we check after each move. **If true then** the program is done.
    - When we roll the dice we get a random number. This is often used in programming. We can assign a variable a **random value**. Something like natural_event = random(1,12) – a random number between 1 and 12. OR to actually more accurately in our case: random1 = random(1,5), random2 = random(1,6) and then natural_event = random1 + random2.
        - Why is the second statement different? (It gives a different result. It will give us a higher probability of getting some numbers, such as 5, than others, such as 2, because there are more ways to make a 5 than a 2…)
    - **If then else** statement example: IF surface = sand THEN stuck=true ELSE stuck=false. Later in the code we will say IF stuck THEN turn = false (meaning you will miss a turn)

Coding Extension

You could actually write a computer program that does the same Lunar surface exploration simulation.

Additional Resources

Examples of lunar base ideas:

- https://www.nature.com/articles/d41586-018-07107-4
- https://www.bbc.com/future/article/20190201-how-easy-will-it-be-to-build-a-moon-base
- https://en.wikipedia.org/wiki/Colonization_of_the_Moon

Evidence for water on the Moon:

- https://www.space.com/41554-water-ice-moon-surface-confirmed.html
- https://en.wikipedia.org/wiki/Lunar_water