ACTIVITY TITLE: Mission: Explore with Rovers

Activity code: ncATRV02

DURATION	120 minutes
AGE RANGE	15–16 years
TOPICS	Engineering, Robotics, Scientific Inquiry, Design Thinking, Creativity, Space Exploration

Description of the project

In this interactive design challenge, students will become space engineers tasked with designing a planetary rover capable ofsurviving theextremeconditionsofalienworlds. Workingincollaborativeteams,theywill:

- Analyzesimulatedplanetaryenvironments.
- Designandbuildabasicroverprototypeadaptedto specificterrainandconditions.
- Integrateartisticandculturalelementsintotherover'sidentityandvisualdesign.
- Presenttheirsolutionusingstorytelling, technical reasoning, andcreativemedia.
- Highlight the contribution of a female, gender-diverse STEAM role model or underrepresented groups in space and scienceandexplaintheirrelevancetothe mission to foster equitable and inclusive STEAM identities.

Bytheendofthe activity,studentswill:

- Constructandpresentaworkingroverprototypewithaculturalandinclusivedesignidentity.
- Reflect ondesign decisionsusingscientific, environmental, andartisticreasoning.
- Collaborativelyexploreinnovation, inclusion, andspaceexplorationcareers.

Objectives: What will I learn?

- **Apply core engineering and design principles** by collaboratively building a rover prototype adapted to an alien environment, in order to understand how real-world constraints shape technological solutions in space exploration.
- **Analyze planetary data and environmental variables** using fictional terrain cards and teamwork discussions, to design a rover capable of operating in diverse extraterrestrial conditions.

- Integrate artistic expression and cultural symbolism into their rover's visual identity and mission poster, to explore how scientific tools can also reflect human culture and diversity.
- **Rotate team roles** (engineer, designer, analyst, presenter) to experience equitable participation and decision-making, promoting collaborative leadership and inclusion in STEAM activities.
- **Research and honor female or gender-diverse STEAM professionals** by incorporating tributes into their project visuals, to recognize underrepresented contributions and inspire inclusive STEAM role models.

Materials: What do I need?

1. **Provided by Teacher:**
   - Cardboard, small wheels (toy parts or bottle caps)
   - scissors, glue, tape, straws
   - Colored markers, printed *Planet Condition Cards*, rulers
   - Team logo/poster templates
   - Worksheet for Cultural and Traditional Symbol Research
2. **Provided by Students:**
   - Notebooks, pencils
   - Smartphones or tablets (for photos/videos if allowed),
   - Internet access
3. **Downloadable Resources:**
   - Rover Sketch Sheet (blank template)
   - Planet Environment Cards (e.g., Mars, Europa, Titan) -information about the gravity, terrain, temperature, and atmospheric challenges of the planets.
   - Poster Sample Sheet
   - Worksheet for Cultural and Traditional Symbol Research
   - Profiles of Women in Engineering

Previous preparation

Print and organize materials:

- Print Rover Sketch Sheet, Planet Environment Cards, Poster Sample Sheet, Worksheet for Cultural and Traditional Symbol Research and Profiles of Women in Engineering

Build context and connect prior knowledge:

- Begin with a brief discussion:
  - What do students already know about space, exploration rovers, or harsh environments like Mars or Europa?

- Has anyone ever had to fix something that didn't work as expected, like a bike or a toy?
- Show the NASA Mars Rover video or clips from ESA's ExoMars to build excitement and inspire design ideas.

Prepare student teams:

- Form mixed-ability groups of 4 students.
- Assign rotating roles to ensure equity and shared leadership:
  - Engineer (leads building)
  - Designer (leads visual identity)
  - Analyst (interprets terrain and data)
  - Presenter (shares results and reasoning)
- Encourage role swapping mid-task so all students experience different STEAM functions.

RESEARCH

Have a look at these resources

Why This Matters – Context and Relevance

For decades, rovers have helped humanity explore environments we may never walk on. These robotic explorers—equipped with cameras, drills, sensors, and solar panels—act as our mechanical eyes and hands on alien worlds. Designing them requires more than engineering: storytelling, teamwork, coding, cultural thinking, and empathy all come together.

Through this challenge, students simulate how real engineers address terrain, resources, and mission challenges. They learn how diverse disciplines, from engineering and coding to storytelling and culture, merge in modern space exploration; students step into the shoes of NASA and ESA teams.

Real World Examples:

- NASA's Perseverance Rover launched in 2020, collecting Martian soil and searching for signs of ancient life. It had to survive dust storms, communicate through satellites, and navigate rocks and cliffs.
- ESA's upcoming Rosalind Franklin Rover, named after a pioneering female scientist, will search for life on Mars with a two-meter drill, designed by international, multicultural teams.
- NASA engineers failed their first test of the Mars helicopter "Ingenuity", then redesigned its blades and flight plan through trial, error, and creativity.
- Every planetary mission today is built on decades of collaborative engineering, computer modeling, and creative thinking. NASA's Jet Propulsion Laboratory integrates over 20 engineering disciplines in each rover mission.
- Space exploration drives innovation. Over 2,000 technologies developed by NASA have led to everyday products, like infrared thermometers, scratch-resistant lenses, and water purifiers.

- Equity in STEM is still a challenge. Women and marginalized groups remain underrepresented in engineering and space science careers worldwide.
- Hands-on design builds lasting learning. Studies show students retain 70–80% more when they build and create using real-world contexts.

Updated Prompt Questions:

- Have you ever designed or fixed something that needed to work in a tough environment? What did you learn from it?
- Why do you think it's important for humans to explore planets and moons we may never live on?
- How do rovers survive challenges that humans can't (dust, cold, cliffs, radiation)?
- How do engineers make decisions when they can't test something in real life, like landing on Mars?
- What kinds of people and skills are needed on a space mission team?
- If your rover could send back one message to Earth, what would it say?
- What would your rover need to be different if it were exploring Earth's oceans or Arctic instead of Mars?

CREATE

Some things you need before beginning

Before designing the planetary rover, let's explore some fascinating facts and ideas about space design, teamwork, and innovation. These concepts will help students think like a space engineer, and a creative STEAM problem-solver.

- Rovers are robotic vehicles designed to move across the surface of planets or moons. Their designs must consider terrain, gravity, temperature, and communication delays with Earth.
- The shape, balance, and wheel type of a rover affects how well it performs on rocky, icy, or sandy terrain—this links directly to concepts like force distribution and center of mass in physics.
- No rover is built alone. Each one involves artists, engineers, coders, and scientists working together for years. NASA's Perseverance rover took over 10 years to plan and build, with over 2,000 people involved.
- Space engineering is a STEAM challenge**.** Rovers must combine design, electronics, materials science, storytelling, and even symbolism (many include flags, names, or cultural references).
- Extreme design matters. Rovers operate in temperatures from –180°C to +400°C and must work without humans nearby. One small design mistake could ruin an entire mission.

- Testing is everything. Engineers must simulate terrain, dust, storms, gravity, and more—because you can't fix a rover once it's on Mars or Europa.
- Real rovers tell stories**.** From "Sojourner" to "Curiosity" and "Zhurong," these machines are symbols of their country's identity, goals, and vision for the future.

Now, follow these steps

Step. 1: Understand Your Planet

- Each team receives one Planet Card (e.g., Mars, Europa, Titan, Mercury, Venus).
- Read about the gravity, terrain, temperature, and atmospheric challenges of the planet.
- Identify three main obstacles the rover must overcome.
- Teams use this data to start defining design constraints for movement, stability, and survival.

Step. 2: Cultural Symbol and Traditional Knowledge Research

- Each team research about a traditional symbol or ancestral design element from a culture of their choice (e.g., Indigenous space lore, ancient navigational myths, Polynesian navigation tattoos, Aztec star glyphs)
- Research the meaning, use, and history of this symbol using books or online resources.
- Teams will incorporate later the symbol into their rover logo, flag, or visual design.
- A short description must be also included on the team´s poster explaining the cultural origin and how this ancestral knowledge connects to exploration.

Step. 3: Learn About and Honor a STEAM Role Model

- Each team will explore the life and impact of females or gender-diverse engineers whose work have helped shape the future of science and technology from the Profiles of Women in Engineering worksheet.
- Then, they will choose one person to highlight, answer the following questions and discuss:
  - What challenges did this person overcome?
  - What makes this person inspiring?
  - What STEAM field are they connected to?
  - How can your rover design or poster include a tribute to their work?
- A visual or verbal tribute must be included in the rover design or team poster. This may take the form of:
  - A quote on the rover body
  - A name honoring the innovator
  - Colors or symbols related to their work

Step. 4: Sketch Rover Design

- Use sketch template provided to draw the rover

- Each team creates a labeled drawing of their rover. In the drawing make sure that these important parts are highlighted:
  - Wheels adapted to the terrain (e.g., large for rocks, ridged for ice) for movement.
  - Sensors or tools for temperature/terrain detection
  - Energy source (like solar panels or batteries)
  - Name and symbol of the rover (from cultural and tribute research)
  - The rover's name (you could incorporate the tribute to the women you have read about before)
  - Clearly labeled parts and a legend
- Include labels to each part so others know what it is and add annotated diagrams that explain how the rover works.

Step.5: Build the Rover

- Gather the materials: use cardboard, plastic containers, recycled parts, bottle caps (for wheels), straws, tape, scissors, and markers. Axles (wooden sticks or skewers) can also be used, rubber bands…
- Start with the base: Cut out a strong rectangle or square from cardboard. This will be the body of the rover.
- Attach the wheels: Use sticks or pencils as axles. Carefully poke holes or use tape to attach wheels so they can spin.
- Add your key features:
  - *Sensors*: Draw or build fake sensors using bottle caps or buttons
  - *Energy source*: Add a cardboard solar panel or battery pack
  - *Cultural symbol*: Decorate your rover with a logo, flag, or design that reflects your tribute or chosen culture
  - *Name tag*: Clearly display your rover's name
- *Make sure it stands and rolls!* Test the rover on the surface. Does it move? Does it stay balanced? Adjust if needed.

Step. 6: Test and Collect Rover Data

- Simulate three Terrains: set up 3 test surfaces to represent different alien terrains:
  - Rocky (e.g., crumpled cardboard or gravel)
  - Sandy/Dusty (e.g., sandpaper, dry soil)

  - Smooth/Icy (e.g., plastic sheet or aluminum foil)
- Place each terrain on the floor or a ramp and test your rover on all of them.
- For each terrain, record the following:
  - Distance your rover traveled (in cm)
  - Time it took to travel that distance (in seconds)
  - Stability (Did it tip over? Get stuck?)
- Choose one of the following to represent your test results:
  - A bar graph comparing distance on each terrain
  - A line graph showing time vs. terrain
  - A color-coded chart to show which surface worked best
- Finally, answer:
  - Which terrain was the hardest and why?
  - What rover feature helped most?
  - If you had to redesign your rover, what would you change?

Step. 7: Team Poster and logo

- Create team visual identity: team name, colors, STEAM tribute, cultural symbol
- Design a Mission Poster that tells the story of the rover:
  - Your planet name and environmental summary
  - Your rover's name and logo
  - A drawing or photo of your prototype
  - Labels and notes explaining how your rover works
  - The tribute to your STEAM role model: name, photo, quote, and what inspired you
  - Any symbols, patterns, or designs that represent your culture or values

Step 8. Prepare the Pitch:

- Each team collaboratively prepares a short pitch (3–5 minutes) to present their mission.
- The pitch should include:
  - An introduction to the assigned planet and its key environmental challenges.
  - A brief overview of the rover's name, design features, and functionality
  - Explanation of why the rover works for the assigned planet (justify design choices: wheels, sensors, energy source, and describe how specific parts were adapted to terrain challenges)
  - The cultural symbol used and its significance (including traditional knowledge origin).
  - A tribute to a STEAM role model and how their story inspired the team's design.
- Each team member selects and practices one specific part to present:
  - Engineer: Technical solution or movement design
  - Designer: Visual identity and artistic/cultural choices
  - Analyst: Terrain strategy and performance findings

- Presenter: Overall mission goal and tribute narrative

- Encourage the use of **notes, sketches, or diagrams** to support the explanation.
- Rehearsal time should be provided to ensure clarity, timing, and role coordination.

COMMUNICATE

Now it's time for each team to share their rover project and explain their creative and technical decisions to the class. Each team should present:

- Their physical rover prototype, tested and labeled
- A complete Mission Poster including:
    - Planet name and summary of terrain/environmental challenges
    - Rover name, design sketch or photo, labeled parts, and movement strategy
    - Cultural symbol or traditional element used and its origin or meaning
    - Tribute to a female or gender-diverse STEAM innovator
    - Logo, team name, and any slogans or visual identity elements

- After each team presents, peer teams provide constructive feedback using color-coded sticky notes or a feedback sheet. Use the following structure:
    - *Blue*: "What works well?"
    - *Yellow*: "What could be clearer or better explained?"
    - *Green*: "One idea to improve accessibility, sustainability, or design"

It is time to share!

Share your amazing work and inspire others!

#MissionRoverQuest

- LinkedIn: https://www.linkedin.com/company/steambrace-project/posts/?feedView=all
- Instagram: https://www.instagram.com/steambrace_eu/
- X: https://www.instagram.com/steambrace_eu/

KEEP ON LEARNING

How can I make a similar project by myself?

- What was the most difficult design challenge your team faced and how did you solve it?
- If you had more time or resources, what feature would you improve on your rover?

- What kind of rover would you design for Earth-based exploration (like the Sahara Desert, Arctic ice sheets, or the deep sea)?
- How would your design change if your rover needed to carry or rescue something?
- Could your rover be adapted to help with real-world challenges (like natural disaster response or space farming)?
- What new materials could you use to make your design more eco-friendly or biodegradable?
- How could traditional knowledge (e.g., indigenous navigation, ancient cartography) inspire your next rover's design?
- Can you recreate your rover in Tinkercad or Scratch and program basic movements or responses?
- How could you simulate sensors that detect heat, light, or obstacles in your model?
- Could you animate your rover's journey in a short digital story or game?
- Imagine a future Mars colony: what role would your rover play in helping people live there?
- How could your rover design be turned into a toy, a sculpture, or a teaching tool for younger students?
- What STEAM issues matter most to your community? Could a rover-like invention help address them?
- If you could design a STEAM-art project to raise awareness about space, climate, or accessibility, what would it look like?

Which are other connected projects?

1. Rover Coding Simulation – Scratch or Tinkercad

- Create a digital version of your rover using Scratch or Tinkercad Circuits.
- Program simple behaviors like obstacle avoidance, terrain detection, or data collection.
- Simulate solar charging or battery use by using variables and conditionals.
- Add visual elements: sensors lighting up, flags waving, or sound feedback for communication.

2. Eco-Upgrade Challenge – Sustainable Design Remix

- Redesign your rover using only biodegradable or recycled materials.
- Explore how material choices impact durability, cost, and environmental impact.
- Use cardboard, paper straws, cloth, or organic fibers.

- Reflect: Would this version survive a real mission?

3. Mission Documentary or Logbook – Space Reporting

- Become the mission's reporter or historian.
- Write a daily Mission Log describing rover challenges, team debates, and terrain discoveries.
- Or create a short documentary video; interview team members, film the rover's test journey, and explain design choices.

5. STEAM + Culture Mash-Up – Mythology Meets Mechanics

- Design a new rover inspired by a mythological story or ancestral worldview.
- What values or ideas would guide this rover's mission?
- How could symbols or traditional wisdom shape the rover's purpose or tools?
- Present it as a museum exhibit, complete with story and prototype.

LINKS FOR FURTHER INFORMATION

- **NASA's Mars Rover Simulator** – Control a virtual rover on a simulated Martian surface. https://mars.nasa.gov/
- **ESA's Rovers & Robotics Portal** – Explore how Europe is exploring the Moon and Mars. https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration
- **Girls Who Code – Planetary Missions** – Lessons and stories about girls building for space. https://girlswhocode.com/
- **DIY Science: Make Your Own Mars Rover** – Free downloadable projects for home or school. https://jpl.nasa.gov/edu/learn/project/make-a-cardboard-rover/

Disclaimer