Space Brain Hack

Educator Guide

The Space Brain Hack is one of the Canadian Space Agency's annual opportunities to involve youth in Canada's exciting Moon missions. Youth are invited to tackle the challenges that current professionals in the space sector are facing through a problem-solving and design-thinking exercise. This is your handbook for helping youth hack the Canadian Space Agency's (CSA) *space brain* by imagining solutions to open-ended problems and questions related to the Lunar Gateway and other space missions. It allows youth to explore the science, technology, engineering and mathematics (STEM) learning processes through real-world problems the CSA is looking to solve.

You don't have to be a space enthusiast to take part in this challenge: you just need a bit of empathy for yourself and your fellow humans. We want youth to discover the role they can play in space exploration now, and in the future when they study in STEM or choose a career path in STEM. Above all, this is an invitation for youth to share their experience and curiosity and help expose our experts to fresh perspectives and spark innovation.

The initiative targets youth in Grades 6 to 8, and in Grades 9 to 12. For each of the age groups the topic remains the same, **but the assessment criteria and worksheets used for the projects differ**. Participants are encouraged to work in teams of up to six, but individual entries are accepted.

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Activity summary

Background: Canada and the global space community are preparing for the Artemis and Lunar Gateway missions that will take humans back to the Moon and later on to Mars. With these ambitious goals come changes to space missions that will require new approaches for maintaining astronaut mental health and wellness, which is the theme of this year's Space Brain Hack.

Objective: Youth will explore astronaut well-being on space missions to design and develop a solution that takes some constraints into account. Participants can work collaboratively to design a solution to an aspect of the problem; share their ideas outside of their groups to get feedback; assess the feedback and their solution applicability and limitations; then revise their solutions, which can be submitted to our annual Space Brain Hack challenge.

The challenge: **How can astronauts maintain their mental health and well-being on long-duration journeys, potentially deeper into space?** Keeping in mind the constraints presented to you by your educator, design a solution for one or more astronauts that will:

- provide them with sensory simulation and a virtual escape from their work and stressful environment; or
- help them maintain connection with family and friends and with the home planet.

Outline: **Below is an outline of the activity you can use for either a single-day or a multi-day format.**

1) Use the CSA-provided introductory presentation to introduce the challenge.
2) Support participants with additional resources (see end of document), and the student worksheet to guide teams on the challenge solution format.
3) Participants work in teams of six or less to brainstorm a solution to the proposed challenge and record their ideas in the accompanying student worksheet.
4) Participants present their project idea to others (fellow students, friends, family, educators, invited experts, etc.) to gain different perspectives on their solution.
5) Participants explore the feedback, the possibilities and the limitations of their idea. The teams then fill out the worksheet outlining the solution they would like to submit.

Curriculum themes

Science: Researching, critically analyzing resources, how to use technology to improve our lives.

Space science: International Space Station environment, astronauts, types of missions and what astronauts do on those missions, science experiments conducted in space, technology available on missions, impact of microgravity on the body, ways that earthly materials behave in space, how body movement is different in space.

Health: Mental well-being, resilience and coping, physical health, social emotional learning, stress management, positive motivation, family and community, nutrition and exercise.

Art: Digital arts, drawing, media, photography.

Language arts and social studies: Writing up a proposal, presenting the proposal, researching and reporting.

Outcomes: Students will leave this activity with a deeper understanding of

- mental health and well-being in a variety of environments in space and on Earth
- how circumstances can be actively altered to positively affect mental health and well-being
- professionals' current efforts to support astronauts' well-being
- how technology is being used to aid in improving well-being

Skills: Students will work to develop the following:

- ability to critically analyze a problem to be solved
- ability to identify and review relevant materials and ideas
- knowledge of the STEM learning process:
  - how to generate unique and creative ways to design a solution to solve the problem
  - how to prepare an initial solution
  - how to analyze or test it
  - how to obtain constructive feedback to strengthen their solution
  - how to modify and revise their solution before submission

Getting started

In order to complete the activity, you will need:

1) the PowerPoint presentation from the website
2) student worksheets – for either Grades 6–8 or Grades 9–12
3) this educator guide, including the list of guiding questions and resources in the annex

The presentation

The presentation introduces the challenge to the participants and offers the foundation necessary to begin the thinking and analysis process. It provides background information on the topic, constraints for the project and a chance to engage with the subject material. *Speaker notes* are included, as well as *discussion questions* to help generate interest and reflection. The participants are designing a solution to help one or more astronauts aboard Artemis missions, missions to the future Lunar Gateway or both! The participants will thus have to ensure their solutions respect the spacecraft and environmental limitations (no reading in front of a cozy fire!). These constraints are listed on the last slide, and it's recommended to leave the slide up on the screen as they work on their ideas.

Student worksheets

There are two different worksheets. Select the one that is relevant to the participants' grade level: Grades 6–8 or Grades 9–12.

The worksheet must be used to enter the final solutions that are to be submitted as a .pdf file as described in the *Submission process* section below. The participants can use a blank sheet of paper and/or online tools to brainstorm and research, settle on one idea per group and prepare the draft solution before entering it in the worksheet. If the worksheets are filled in by hand, the handwriting must be legible to be considered for the challenge.

You can create your own schedule to run this challenge, but options are provided below. Whatever you choose, the participants' final creations are only eligible for the challenge if submitted to the Canadian Space Agency no later than **Thursday, February 23, 2023, at 11:59 p.m. PST.**

Note: Participants may need access to the Internet or the library to research various topics as they design their solution.

Flexible activity formats

The challenge offers a flexible format allowing you to select the depth and length of the engagement with the participants for in-person or virtual sessions.

A minimum of 2.5 hours is required to run the activity using the single-day approach. However, the challenge can run over multiple sessions based on whatever works for you.

2.5-hour format

- The educator gives an introduction using the presentation provided. – 30 minutes
- Brainstorming. – 1.5 hours
  - The participants explore the resources, ask questions, bounce ideas around and come up with a final design or idea.
  - The educator (or an invited expert*) takes time with each of the teams to discuss their solution and provide some feedback for improvement.
- The participants incorporate the feedback into the design or idea. – 15 minutes
- The participants fill out their worksheets. – 15 minutes
- The educator submits their worksheets to the CSA following the process described below.

Multi-day format (minimum time of three days with 60- to 90-minute sessions)

Day 1

- The educator gives an introduction using the presentation provided. – 30 minutes
- The participants brainstorm and explore the worksheet while considering the additional resources. – 30 to 45 minutes

Day 2

- The participants continue their brainstorming and research, settle on one idea per group and prepare their draft solution on a blank sheet of paper and/or using online tools. – 30 to 40 minutes
- The educator (or an invited expert*) takes time with each of the teams to discuss their solution and provide some feedback for improvement. – 20 to 30 minutes

Day 3

- The participants incorporate the feedback into the final design or idea. – 20 minutes
- The participants fill out their worksheets with their final version, and clearly identify the changes they made based on feedback in the final "Reality Check" question. – 15 minutes
- The educator submits their worksheets to the CSA following the process described below.

Virtual format

The challenge can also be completed in a virtual format using your preferred web-conference program:

- The educator shares the presentation.
- The educator provides youth with the fillable .pdf version of the worksheet to help guide their thinking.
- Participants break out into teams using a breakout room function or work individually to brainstorm ideas using a virtual collaboration tool.
- They present the ideas to the educator, invited expert* or the entire group for feedback.
- They go back to the team, finalize the idea and fill in the final .pdf worksheet to be submitted.

* NOTE: Educators are encouraged to invite local experts to inspire their students. They can consult the Canadian Space Ambassadors program list to find experts in their region.

Submission process

For the challenge, we ask that **educators submit** the completed worksheets in .pdf format to the online form on the CSA website.

1) On the **first page**, we ask the participants to identify their project (project title).
   This is required to participate. **Please double-check this section**.
2) Participants also need to fill out **ALL the sections** to the best of their ability, so we're able to get the clearest picture of the solution they submit.
3) If the worksheets are filled out by hand, it's important that the handwriting be legible to be considered for the challenge.

IMPORTANT: Save each document, using your name (as the educator) following this format: firstname_familyname.
If you submit more than one file, simply add a number at the end (e.g. firstname_familyname1, firstname_familyname2).
Submissions are due by **Thursday, February 23, 2023, at 11:59 p.m. PST.**

Project assessment criteria

All the eligible entries will be assessed based on the age group and criteria listed below.

Should several entries get the same grade, a draw will be held to determine a winner.

Grades 6 to 8	
Assessment Criteria	Description
Communication	A. How complete is your solution? Does your solution accurately address the problem? Does it solve only part of or all aspects of the problem? B. How clear and well described are your diagram and explanations? How easy is it for others to read and understand your explanations and diagram?
Innovation	A. Does your solution approach the problem in a new or innovative way? Is it different from current solutions and/or is it a variation of something that has already been done but applied in an innovative way? B. Is the solution adaptable to different contexts? Will it be helpful for an individual or a small group of people, or can it be adapted to many?
Validity	A. How are the constraints of the problem considered in the design of your solution? B. How sound are the scientific concepts applied to your solution? Is the solution logical and realistic?
Critical thinking	A. Is there evidence that your solution was modified following feedback? If no changes were made, was an explanation included?

Grades 9 to 12	
Assessment Criteria	Description
Communication	A. How complete is your solution? Does your solution accurately address the problem? Does it solve only part of or all aspects of the problem? B. How clear and well described are your diagram and explanations? How easy is it for others to read and understand your explanations and diagram?
Innovation	A. Does your solution approach the problem in a new or innovative way? Is it different from current solutions and/or is it a variation of something that has already been done but applied in an innovative way? B. Is the solution adaptable to different contexts? Will it be helpful for an individual or a small group of people, or can it be adapted to many?
Validity	A. How are the constraints of the problem considered in the design of your solution? B. How soundly are the scientific concepts applied to your solution? Is the solution logical and realistic?
Critical analysis	A. What limitations of your solution are identified? How have you discussed the limitations? B. What feedback did you receive? Is there any evidence that your solution was modified following this feedback? If no changes were made, was an explanation included?

We hope your group enjoys the Space Brain Hack! If you have any questions, please reach out to us at stimjeunesse-youthstem@asc-csa.gc.ca. We want to make sure your experience is rewarding, too.

ANNEX

Additional guiding questions

1) Introduction to mental health
   a. What is mental health and why is it important?
      i. What activities or actions would help you take care of your mental health?
      ii. Why is it important to take care of our mental health?
      iii. What hurdles might astronauts in space face if they did the same activities as you do to take care of your mental health?
      iv. Can you think of different mental health challenges that will arise as we move farther into space?

2) How would different environments impact how we take care of our mental well-being?
   a. What are some of the differences between the environments in which you live and where astronauts could live in space (e.g. space station, lunar base, Mars base, spaceship)?
      i. Thinking of the approaches you use to maintain your own mental well-being, make a list of what you think you could do during a long-duration mission or bring with you.

3) Mental well-being in space
   a. What challenges could astronauts face on space missions, and how could they affect their mental health?
      i. Have you experienced something similar down here on Earth?
      ii. If you were to spend time in space, what issues do you think might affect you the most?
      iii. How can being resilient help astronauts in space?

4) Solutions to help with the well-being of astronauts in space
   a. Can you think of any potential hurdles to those solutions?
      i. Could these solutions be applied to people on Earth?
      ii. Have you considered how different solutions might be used for different mental health issues?

5) Limitations
   a. Can you think of any situations where your solution may not work?
   b. Would it require any additional technology or preparatory work to be useful?
   c. Are you able to identify the pros and cons of your solution?

Additional background information

Physical health

To maintain their health and fight the adverse effects of microgravity, astronauts have individual nutrition programs and they exercise for at least 1.5 hours each day.

Mental well-being

A team of experts support astronauts and help them remain mentally healthy. Astronauts follow a schedule and routine that ensures their time is well managed and that they get sufficient sleep. They also receive care packages prepared by the ground team and their families that contain photos, little gifts, surprises or special meals. For long-duration missions aboard the International Space Station, astronauts can communicate via email and they have daily opportunities to video call with their family members. They also have some leisure time with and without crew members. They can watch movies, listen to music, connect with family and friends, and read news from Earth. Some of these activities may not be possible or as frequent during Artemis and Gateway missions.

Moon

Countries from around the world are getting ready to send humans farther into our solar system, beyond the International Space Station. At a distance of 384,400 km from our planet on average, the Moon represents a crucial stepping stone in humanity's quest to travel onwards to Mars. Canada will be participating in the exploration of the Moon:

- A Canadian Space Agency astronaut will fly aboard the Artemis II mission slated for 2024 – the first crewed mission to orbit the Moon since 1972.
- We will contribute a smart robotic system called Canadarm3 to the Lunar Gateway, which is a small space station that will orbit the Moon.
- We will send a rover to the Moon in the next five years.

You can read more about Canada's contribution in the toolkit listed in *Additional resources*.

Communication

Depending on where the Orion capsule or the Gateway are located around the Moon, it will take from 2.4 to 2.7 seconds for a message to make it from Earth to the Moon and back, with an average of 2.56 seconds.

To demonstrate the time delay in communications, you can conduct the following optional activity with the participants:

Ask two participants (or a team) to stand at opposite ends of the room. Using a stopwatch, get the first one to say "hello." Ask the second participant to wait for 2.5 seconds. Once the 2.5 seconds are up, the next student has an opportunity to respond. Repeat this for 1 minute.

Additional resources

The following toolkits are provided as a convenience and are not required reading to complete the project. Educators may want each team to consult one or two links within the kits and share their findings with the rest of the group.

Toolkit for educators and youth – Mental health and isolation

Toolkit for educators and youth – Artemis and the Moon