Space Survival Case Study:
Exploring Survival & Sustainable Lunar Mining

Project Objective:

To create a poster and presentation that depicts an innovative lunar mining and space survival operation and explores the concept of sustainable resource extraction on the Moon. Students will engage in research and a case study where they will explore solutions to address the challenges of space survival and lunar mining.

Learning Outcomes:

- Gain understanding of lunar mining operations and the importance of sustainability
- Develop creativity and craftsmanship through the arts
- Foster critical thinking about the environmental impact of resource extraction on the Moon
- Promote awareness of global issues and encourage action towards achieving sustainable development goals

Materials Needed:

- Access to research and learning resources
- For hand-crafted posters, materials such as; poster board, markers, printed photos, scissors and glue.
- For digital posters, access to design software

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Sustainable Development Goals

What are the SDGs?

The United Nations Sustainable Development Goals (SDGs) are seventeen international goals aimed at improving the quality of life, preserving the environment, and promoting sustainable development for 2030. The goals are complementary as all of the components contribute to a holistic approach towards making the world a better place for everyone in the long run.

Exploration and mining in space are activities that have the potential to benefit humanity and the planet, and also cause harm. For example, innovation in space technology can assist with climate prediction and adaptation, however human actions in space may cause harm or raise new challenges to the planet (ie: greenhouse gas emissions, pollution, and social unrest).

SDGs Connection to Project

The Sustainable Development Goals (SDGs) aren't just about life on Earth—they can also help guide our actions beyond our planet. As humanity looks toward the future, space exploration and activities like lunar mining hold the potential to transform industries, generate new technologies, and address global challenges such as climate change and sustainable resource management. However, this transition also raises important questions about how we ensure that this progress is equitable and environmentally responsible.

This Careers in Space Exploration activity directly connects with several key SDGs by encouraging students to consider future careers, sustainability, innovation, and opportunities in the space sector. By exploring the connection between careers in space and the global goals, students will gain a deeper understanding of how their work on this project fits into the bigger picture of the future of work.

Sustainable Development Goals
https://sdgs.un.org

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Sustainable Development Goals

SDGs Connection to Project

Industry, Innovation, and Infrastructure. By exploring sustainable resource extraction and innovative technologies for lunar mining, the activity aligns with the goal of promoting inclusive and sustainable industrialization.

Sustainable Cities and Communities. The activity encourages thinking about sustainable practices for habitation and resource extraction, which relates to building sustainable communities, even in extraterrestrial environments.

Responsible Consumption and Production. By considering sustainability in resource usages and discussing ways to minimize environmental impact, this activity targets responsible consumption and production patterns

Climate Action. The discussion on sustainable practices and environmental impacts of resource extraction ties into the broader goal of taking action to combat climate change and its impacts.

Partnerships for the Goals. The activity fosters collaboration and partnership by encouraging students to explore these complex issues together and develop innovative solutions.

Survival Case Study

Project Steps:

Introduction to Lunar Mining & Sustainability (Whole Class)

Introduce students to the concept of lunar mining, focusing on the unique challenges of extracting resources from the Moon while prioritizing sustainability. Begin by discussing the importance of sustainable practices in space exploration and how these principles align with global efforts to meet the Sustainable Development Goals (SDGs). Highlight that mining on the Moon must be conducted in ways that minimize environmental impact, utilize renewable energy, and reduce waste, ensuring the long-term viability of space exploration without harming extraterrestrial environments.

Case Study & Research (Individual or Group)

Introduce students to the case study of Dr. Aztrow Naught, an astronaut leading a groundbreaking mission as part of the Lunar Exploration Initiative. Dr. Aztrow's mission is to establish a sustainable mining base on the Moon while overcoming the same challenges faced by unsustainable mining practices on Earth.
Dr. Aztrow begins her mission with only a basic setup: temporary shelter, solar panels, and a small greenhouse. As she works to expand her lunar base to accommodate additional astronauts, there are new ethical, social, and legal dilemmas specific to outer space.

Dr. Aztrow reaches out to her mission control team—the students—for advice and solutions in key areas like survival, technology, sustainability, mining operations, and legal frameworks. Students will work in teams to research one of these sectors. Each team will provide recommendations to help Dr. Aztrow develop sustainable systems for energy, mining, waste management, and ethical resource extraction on the Moon. Encourage students to think about how their solutions can support SDGs, such as affordable clean energy, economic growth, and environmental protection.

Survival Case Study

Project Steps:

Poster Design (Individual or Group)

Students will translate their research and case study findings into poster and presentation that illustrates an innovative lunar mining and space survival operation

- **Lunar Landscape:** Students should create detailed illustrations of their ideas and concepts within their sector
- **Mining Equipment and Facilities:** Students should label key structures, such as mining equipment, habitats, and energy sources (e.g., solar panels).
- **Sustainability Features:** Encourage students to label features important within their sectors.

Presentation & Reflection (Individual or Group)

Once the research and posters are complete, students will present their designs to the class, explaining their sector ideas and concepts. During the presentations, students will:

- Walk through the various components of their poster, explaining how each element supports their sector
- Emphasize sustainable features such as renewable energy use, waste reduction, and efficient resource management.
- Use related visuals and infographics to explain their ideas and concepts

After each presentation, allow time for peer feedback, encouraging students to ask questions and discuss different approaches to space survival and sustainable lunar mining. When all presentations are complete, engage in a discussion and brainstorm to explore how the innovative ideas in each sector could combine and complement one another.

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Project Introduction

Case Study

In the early 2030s, Dr. Aztrow Naught embarks on a historic mission as part of the Lunar Exploration Initiative, tasked with laying the groundwork for mining on the Moon sustainably. Learning from the past, the lack of sustainable mining on Earth has presented many challenges such as environmental degradation, resource depletion, and social impacts. Thus, Dr. Aztrow employs the expertise of her mission control teams to establish humanity's presence beyond Earth through sustainable In-Situ Resource Utilization (ISRU).

When Dr. Aztrow arrives on the moon's surface, she is equipped with a very basic setup to adequately provide for the primary needs of one person (a temporary shelter, small green house, solar panels, water generator); she must expand and improve her lunar base in order to facilitate more astronauts.

Dr. Aztrow needs to adapt to the new life on the moon considering ethical implications, navigating legal frameworks, and other important factors.

So she contacts her mission control teams (the students!) for guidance in various sectors.

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Research

Students will be split into groups and assigned to a missions control team. They will then conduct research in their teams and use their creative thinking to improve the lunar base and design their own.

General Research Questions:

- What is lunar mining?
- What technologies are needed for lunar mining?
- What professions are involved in the lunar mining process?
- Why is lunar mining benecial?
- How can lunar mining be more sustainable?
- What are your innovative ideas and concepts for your sector?

Mission Control Teams

1. Survival Sector
2. Social Sector
3. Sustainability Sector
4. Technology Sector
5. Mining Sector
6. Legal Sector
7. Investigation Sector

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Mission Contral Teams

Survival Sector

You have been assigned to the Survival sector. Dr. Aztrow is currently looking for solutions to improve her life on the moon. How can lunar settlements be built/improved using sustainable ISRU solutions while still maintaining survival needs? Considering the holistic approach of indigenous ways of knowing, why is it important that Dr. Aztrow's well-being is accounted for spiritually, mentally and emotionally as well? What methods will ensure that Dr. Aztrow's well-being is maintained holistically during mining expeditions?

1. Research the different ways of survival on the moon and types of lunar settlements
2. Research how mental, emotional and spiritual well-being may be impacted on the moon
3. What are your ideas and strategies for survival needs and ISRU?

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Mission Contral Teams

Social Sector

You have been assigned to the Social sector. Dr. Aztrow must consider the ethical implications for the lunar mining operation. What ethics are involved in lunar mining? What can you learn from the Indigenous approach to collaboration about the importance of including various perspectives in the development and enforcement of ethics? What kind of a system can be implemented to ensure that ethical decisions are enriched by diverse perspectives? How can you improve on the overall concept and structure of lunar mining to make it as ethical as possible?

1. Research common ethical issues related to mining and resource harvesting
2. Research how ethics on the moon differ from on Earth
3. What are your ideas and strategies for the social sector in regards to space survival and lunar mining?

Survival Case Study:
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Mission Contral Teams

Sustainability Sector

You have been assigned to the sustainability sector. What are some sustainable practices that can be used in Dr. Aztrow's survival set-up or during mining expeditions? What approaches from indigenous principles of environmental stewardship can you learn from? Which professions might be involved in implementing sustainable practices on the moon?

1. Consider how autonomous technology and the practice of recycling can be useful
2. Research about the environmental impacts that lunar mining has on the moon
3. What are your ideas and strategies for sustainability for space survival and lunar mining?

Survival Case Study:
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Mission Contral Teams

Technology Sector

You have been assigned to the technology sector. What types of equipment and machinery would help Dr. Aztrow achieve her objective? Why is it important to develop new technology with an awareness of its impact on the surrounding environment, considering the indigenous approach to holistic thinking. How can Dr. Aztrow utilize technology to improve her survival set-up and lunar mining tactics?

1. Research new and existing space equipment and machinery, considering impacts technology can have on the environment
2. Research how 3D printing and additive manufacturing may be useful
3. What are your ideas and strategies for technology in space survival and lunar mining?

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Mission Contral Teams

Mining Sector

You have been assigned to the Mining sector. What are some mining, processing, and rening techniques involved in lunar mining? What types of equipment is used for lunar mining? Why is it important to consider the indigenous approach to resource use to ensure that mining processes are efficiently utilizing resources and time?

1. Research the mining methods used in the past on Earth
2. Research the types of resources that can be mined on the moon
3. What are your ideas and strategies for the mining sector for space survival and lunar exploration?

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Mission Contral Teams

Legal Sector

You have been assigned to the Legal sector. What are some legal issues that Dr. Astrow may face as she is on her mission? What professions could be involved with legal issues on the moon? How could the Indigenous way of knowing and respect support in this sector?

1. Research the types of international agreements relating to the moon 2.
2. Research ownership and property rights in space
3. What are your ideas and strategies in the legal sector for space survival and lunar exploration?

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Mission Contral Teams

Investigation Sector

You have been assigned to the Investigation sector. What type of exploration techniques will allow her to collect samples safely for her research? Considering the Indigenous way of harmony and balance, why is it important that Dr. Aztrow obtains her samples without disturbing the lunar environment? What equipment and technology can Dr. Aztrow use to conduct her research?

1. Research about lunar geology and its importance
2. Research about existing research processes on the moon
3. What are your ideas and strategies in the Investigative sector for space survival and lunar exploration?

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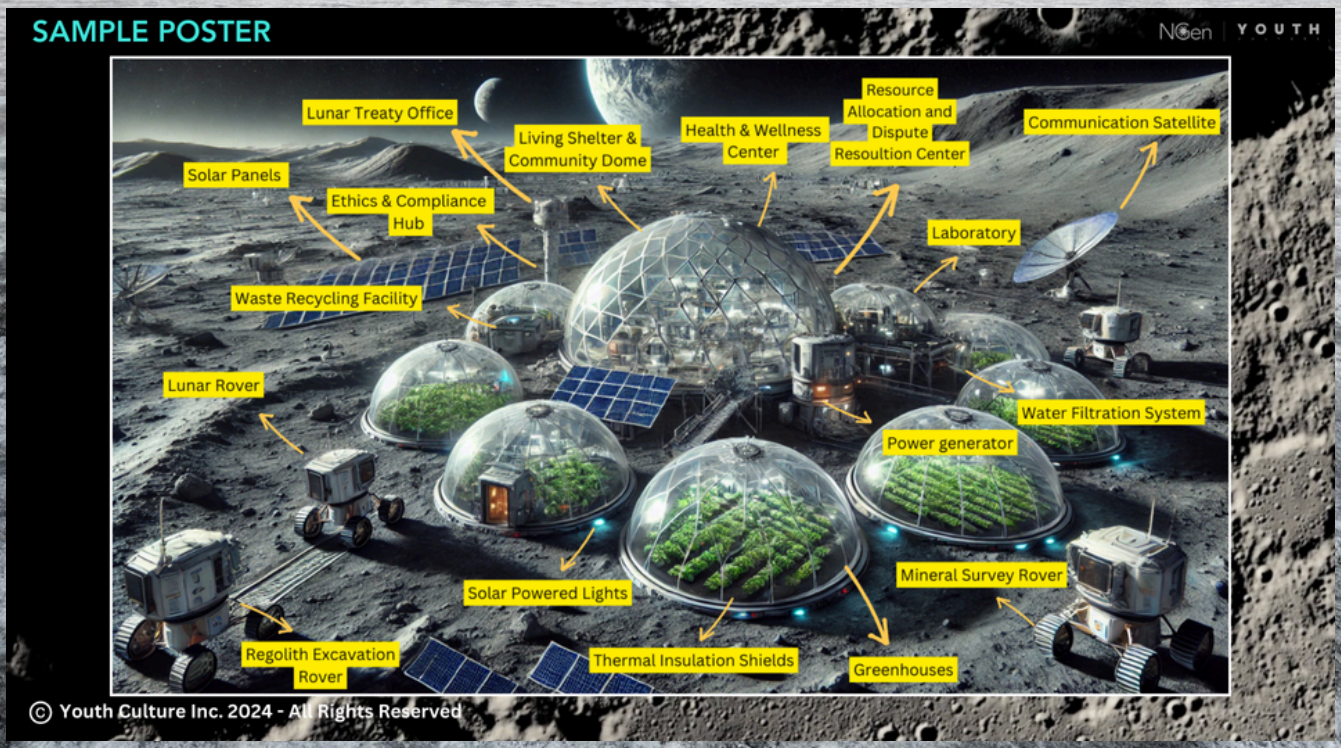
Poster Design and Presentation

Poster

Students will create posters and present their innovative ideas and concepts for their sector. Students can include infographics or flowcharts to explain their ideas. During the presentation, students will share their research findings and outline their ideas including the different elements they included on their poster, encouraging interactive discussion and peer feedback on their approach.

Sample poster (see next page for larger version)



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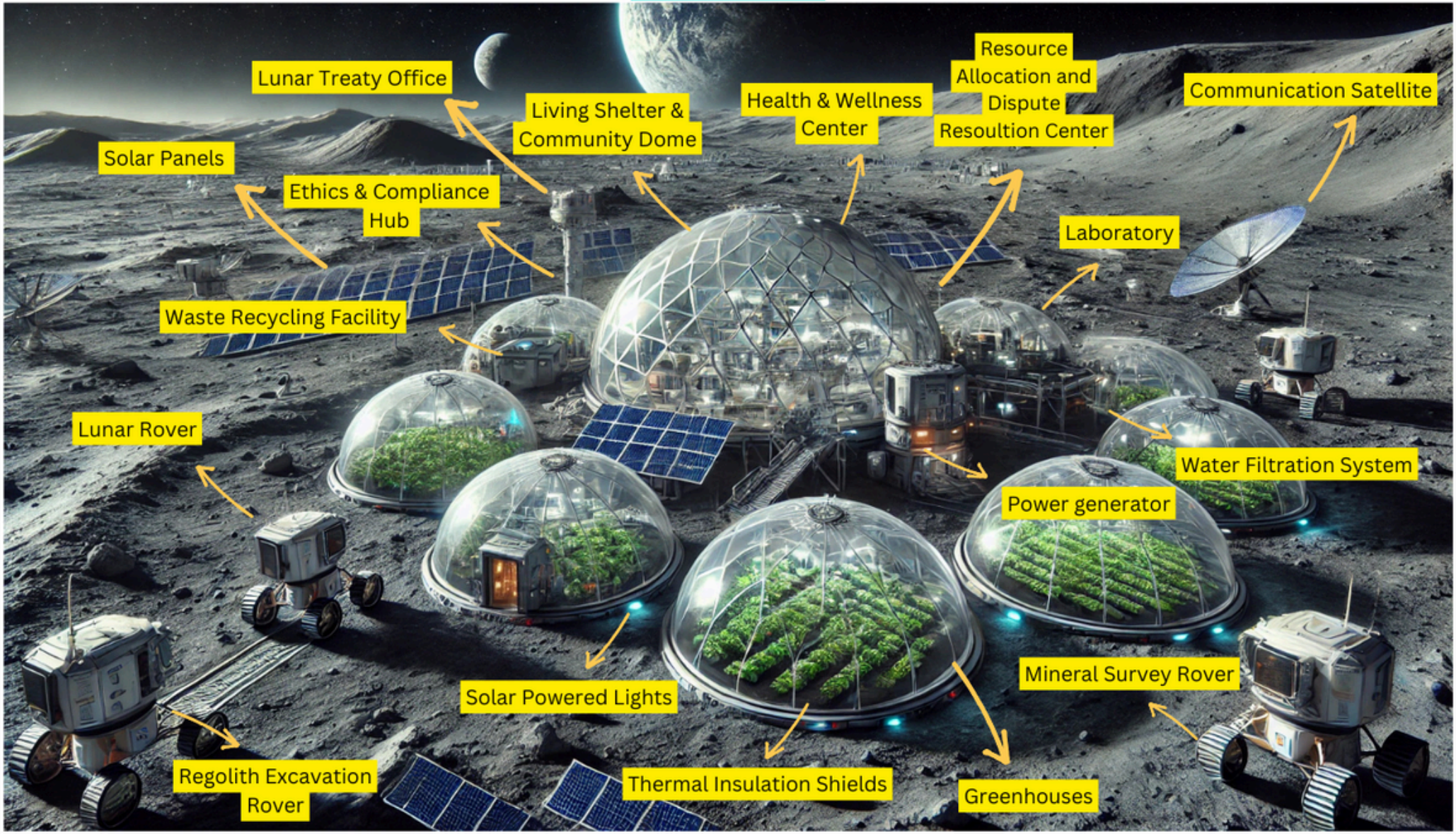
Lunar Mining & Space Survival Case Study

SAMPLE POSTER



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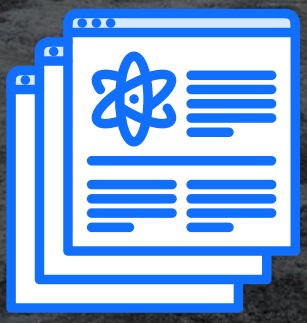
Learning Resources

Survival Sector

https://airandspace.si.edu/explore/stories/apollo-astronaut-life0012

Sustainability Sector

https://www.nasa.gov/spacesustainability/



Social Sector

https://www.ncbi.nlm.nih.gov/books/NBK589344/

Investigation Sector

https://curator.jsc.nasa.gov/lunar/

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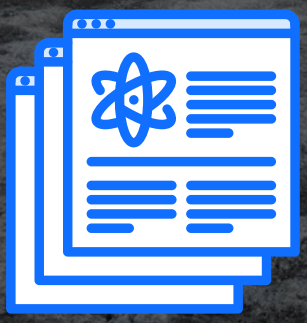
Learning Resources

Technology Sector

https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/reporting/indigenous-ways-of-knowing

Technology Sector

https://www.nasa.gov/feature/living-and-working-on-the-moon/



Mining Sector

https://lunarexploration.esa.int/explore/science/224

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Learning Resources

Legal Sector

https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html

Legal Sector

https://www.spacefoundation.org/space_brief/international-space-law/