SDG9 Future of Space
MM4:Space Innovation and Enterprise

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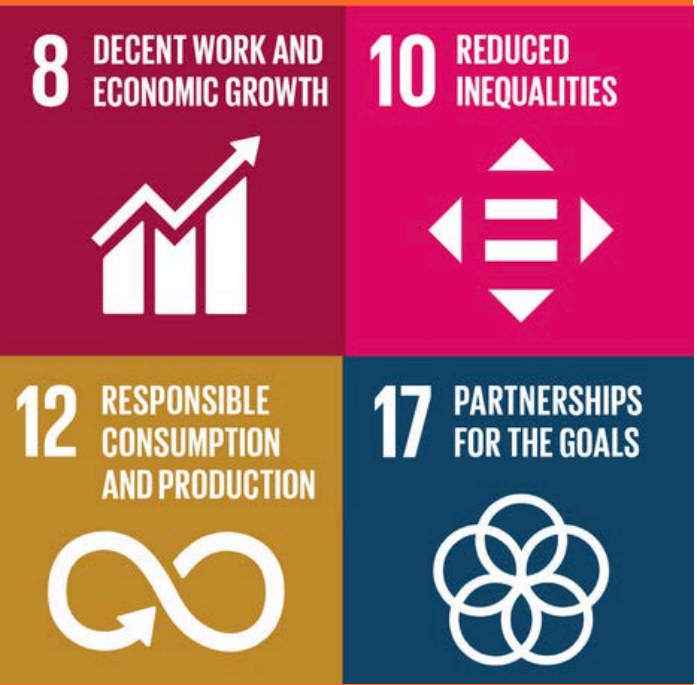
Experimentation and Exploration

Lesson 2 Developing a Space Venture Idea

Subject Areas: CSPE/ SPHE, Design, English and Communication, Science, Sustainability, Technology



Lesson Title and Summary: Developing A Space Venture Idea

In this lesson, learners continue their exploration of emergent needs and opportunities in space, by expanding on Lesson 1, activity 2's Space Venture remix.

This lesson enables students to develop an understanding of the process of generating ideas starting with the Space Venture Remix Grid and then using the remix method to develop their own Space Venture idea. This lesson supports learners in highlighting and understanding the importance of interdisciplinary collaboration and innovation in addressing the complex requirements of future space missions.

Vocabulary: Agility; Creativity; Disruptive Innovation; Emergent, Enterprise; Innovation, SWOT, Ventures

In this lesson, the learner will:

- continue to explore space and the emerging opportunities and implications for developing goods, services and innovation in space
- develop their own source of ideas and gain confidence using experimental approaches
- develop skills around idea generation using variables
- practice transferring and applying knowledge and skills
- will develop their creativity, innovation, and critical-thinking skills

Materials

- Worksheet: Space Venture Remix Grid
- Lesson 1 worksheets if completed
- Worksheet: Space Venture SWOT Analysis
- Teacher's Guide: Space Venture Remix
- Paper / pens
- AV equipment
- Computers with internet access

MM4: Space Innovation and Enterprise
L2 Developing a Space Venture Idea

Activity Instructions

Activity 1: Learner-driven Space Venture Remix Grid (30 mins)

1. If continuing from lesson 1, explain the activity – learners will use their worksheets from Lesson 1 to design a Space Venture
2. If not a continuation from Lesson 1 use the table in the Teachers Guide or the article in the media box 'The commercialisation of outer space' to support learners' understanding of the emerging Space Industry and to generate ideas.
3. Organise learners into small groups of 3, numbering each themselves 1 - 3 within the group, explaining that each person in the group should fill in a complete set of 4 boxes on their remix grid using a different space industry and challenge.
4. As in lesson 1, randomly ask 4 groups to contribute to the variable pool, out of which they will design their venture e.g. "Group [select a group] tell me what's written in the Space Industry / Challenge Theme (the first box) of person 2's worksheet and write their answer on the board.
5. Repeat three more times using random selection until you have something on the board for each of the worksheet boxes.
6. Ask learners to design a Space Venture from this group of variable pool.
7. Alternatively, in step 3 ask learners to pick a variable for each box from their worksheets to create the focus for their Space Venture and develop their ideas using that variable pool.

Activity 2 Undertaking a SWOT Analysis (20 min)

1. Explain the acronym SWOT and the role of a SWOT analysis
2. Model the activity using the collaborative 'variable pool' from the board with the Remix SWOT worksheet.
3. Ask the groups to undertake the same process using the worksheet: Space Venture SWOT Analysis, so they have a SWOT analysis on 3 Space Challenge themes that emerged from the first part of the lesson.
4. Depending on time, ask learners to reflect on the activities, is there anything that surprises them? How does the prospect of Space Exploration make them feel, excited, fearful or indifferent?

REFLECTIVE EXERCISE: 3-2-1 (10 mins)

- Three things they feel they have learnt from the tasks
- Two things they found most interesting and would like to explore more
- One – their opinion they have about the tasks

Use Post-its or a mentimeter survey - www.mentimeter.com to gather reflections

MM4: Space Innovation and Enterprise
L2 Developing a Space Venture Idea

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter lesson: complete Activity 1 only

Extension: For a longer lesson: Learners can also visit Enterprise Ireland - media box to see if Irish companies are dealing with any of the space industry challenges in the woksheet: Space commercialisation overview .

Option B: Ask learners to generate 3 different Space Ventures, (product, service or innovation) ideas from the variable pool used in the class.

MEDIA BOX: (materials, online video links, extra resources, case studies etc)

Design Thinking Ideate [4:04 mins] https://www.youtube.com/watch?v=zbLxs6te5to

Space Foundation - Non Profit https://discoverspace.org/about/about-the-space-foundation/

Article: The commercialisation of outer space https://www.nortonrosefulbright.com/en/knowledge/publications/102a426e/the-commercialisation-of-outer-space#section3

Enterprise Ireland https://www.enterprise-ireland.com/en/supports/become-more-innovative/space-esa-homepage/esa-directory

Local Trip / Expertise / Additional Work and Assessments

Design Your Own Space Venture: Learners can use Activity 2, to design their own space venture, considering factors e.g. target market, mission objectives, technology requirements, and potential revenue streams - see Lesson 6 - 12 resources for support.

Use the questions from Lesson 1: Extension Activity in the Teacher's Guide to encourage them to consider the implications of their Space Venture to create a research project for the class - allocating the questions across small groups. Learners can present their findings using SDG 12 Future of Innovation and Enterprise, MM7: Media Communication module 1 - 4 https://www.muinincatalyst.com/innovation-media

For a larger project or assessment, use resources from the Problem to Pitch module - https://www.muinincatalyst.com/problem2pitch to support learners to develop their venture ideas and present them to the class.

MM4: L2TG SPACE VENTURE REMIX

ACTIVITY 1 SPACE VENTURE REMIX GRID

Instructions for Using the Worksheet: Space Venture Remix Grid

Explain the activity – learners will use generate the answers to the boxes using their completed worksheets from lesson 1 or you can project the table on the next two pages, by placing them on a slide.

1. Organise learners into groups of 3 and ask learners to complete the worksheet: Space Venture Remix Grid by brainstorming together so they can place an answer in each box

- Select one of the industries from the table they completed in activity e.g Space Food and Nutrition
- Write their selection in the Space Industry / Challenge theme box and think about what are the challenges to this industry e.g. food production in space, alternative production such as hydroponics or aquaponics - they can use the internet to find out what these are,
- Once they have selected their industry and challenge theme they begin to complete the other boxes answering the questions in the worksheet boxes -
- Finally, once they have completed the boxes e.g. they should devise a product, service or innovation for Space Exploration.

Using the example of Space Food and nutrition, this could be

  - What are the possible challenges for the selected Space Challenge theme, e.g. could be no sun / water for growth, long distances, dead seeds
  - Obstacles to developing the solutions - minimal space and trying to reduce weight for transportation
  - How would you overcome the obstacles - vacuum packing or dehydrating core substances to reduce size and weight

Possible Service: Our service uses new technology to ensure the long life of seeds and transport them in space by vacuum packing and a unique seed dispersal system designed to be small and light yet durable, making it suitable for long-distance space exploration.

2. Once the learners have completed their boxes ask four random groups for input from the grid e.g.

- Group one, person 3 tell me what's written in your 'Space Industry and Challenge theme' box, write their answer on the board.
- Group 2, person 1, give me an item that's listed in your 'Challenges list' box, write their answer on the board.
- Repeat until all the boxes are filled.

3. Ask the groups to start coming up with possibilities for a business, activity or service that include the 4 variables, the more random the variables the better to push their creativity.

MM4: L2TG SPACE VENTURE REMIX

Background: Table providing an overview of Space Commercialisation industries

INDUSTRY	SHORT DESCRIPTIONS
Satellite communications	The use of satellites to transmit data, voice, and video across long distances for global telecommunications networks.
Launch services	Companies that provide the technology and logistics to send spacecraft, satellites, and payloads into space
Satellite imaging	Capturing Earth's surface and space imagery through satellites for applications such as mapping, environmental monitoring, and security.
Space-based manufacturing	The production of goods and materials in microgravity environments, offering unique advantages like precision and efficiency.
Space tourism	Commercial space travel experiences for private individuals, allowing non-astronauts to visit space.
Asteroid mining	The extraction of valuable minerals and resources from asteroids for use on Earth or in space-based industries.
Space Food and Nutrition	The development and provision of sustainable, nutritious food systems to support human life in space environments
Space Tech: Travel and Transportation	Innovations in spacecraft and propulsion systems to enable human and cargo transport in space
Space Clothing and Personal Protective Equipment (PPE)	Specialised attire and protective gear designed to safeguard astronauts from the harsh conditions of space
Space Shelter and Habitats	Structures and habitats designed for sustaining human life during space exploration, whether on spacecraft, the Moon, or Mars

MM4: L2TG SPACE VENTURE REMIX AND EXTENSION

INDUSTRY	DESCRIPTION
Space Technology - Data Services / Communication	Advanced technologies for handling data transmission, storage, and communication between space and Earth.
Space Healthcare / Medical Services	The development of medical technologies, treatments, and protocols tailored to the unique health challenges faced by humans in space.
Space Tech: Energy / Power Generation	Technologies for generating and harnessing energy in space, such as solar power and nuclear energy for spacecraft and space colonies.
Space Tech: Environmental Monitoring and Resource Management	Technologies to monitor and manage environmental conditions and resources, both on Earth and in space, for sustainable exploration.

These emergent needs reflect the multifaceted challenges and opportunities associated with space exploration, highlighting the importance of interdisciplinary collaboration and innovation in addressing the complex requirements of future space missions.

NEEDS	POSSIBLE ANSWERS
Food and Nutrition	• Development of sustainable food production systems for long-duration space missions. • Creation of nutrient-rich, shelf-stable foods that can withstand the rigors of space travel. • Exploration of alternative food sources such as hydroponics, aquaponics, and cellular agricul
Travel and Transportation	• Advancement of propulsion technologies for faster and more efficient interplanetary travel. • Development of reusable spacecraft and spaceplanes to reduce the cost of access to space. • Implementation of advanced life support systems to ensure the safety and well-being of crew members during extended space journeys.
Clothing and Personal Protective Equipment (PPE)	• Design of lightweight, durable, and protective space suits for astronauts working in harsh environments. • Development of smart textiles and materials with built-in sensors to monitor astronauts' health and performance. • Exploration of 3D printing technologies for on-demand production of clothing and PPE in space.

MM4: L2TG SPACE VENTURE EXTENSION

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

NEEDS	POSSIBLE ANSWERS
Shelter and Habitats	• Design of modular habitats and inflatable structures for lunar and Martian colonies. • Integration of sustainable and self-sufficient systems for water recycling, air purification, and waste management. • Implementation of radiation shielding technologies to protect astronauts from cosmic radiation and solar flares
Data Services and Communication	• Establishment of high-speed, reliable communication networks for real-time data transmission between Earth and space. • Development of autonomous navigation systems for spacecraft and satellites to enable precise positioning and maneuvering. • Implementation of secure data storage and encryption protocols to protect sensitive information transmitted in space.
Healthcare and Medical Services	• Research into preventive healthcare measures and countermeasures to mitigate the effects of microgravity and space radiation on astronauts' health. • Exploration of telemedicine and remote diagnostics technologies for providing medical care to astronauts on long-duration space missions. • Development of pharmaceuticals and medical treatments tailored to the unique challenges of space travel, such as bone density loss and muscle atrophy.
Energy and Power Generation	• Advancement of renewable energy technologies such as solar panels and nuclear reactors for powering spacecraft and habitats. • Exploration of in-situ resource utilisation (ISRU) techniques for extracting and utilising resources such as solar energy, water, and regolith on planetary surfaces. • Development of energy storage systems for storing excess energy generated during periods of high solar activity or daylight.
Environmental Monitoring and Resource Management:	• Implementation of remote sensing technologies for monitoring planetary environments and assessing resource availability. • Integration of AI and machine learning algorithms for analysing environmental data and predicting potential hazards or anomalies. • Exploration of sustainable resource extraction and utilisation techniques to minimise the environmental impact of human activities in space.

MM4: L2TG SPACE VENTURE REMIX

Extension from Lesson 1

Extension Activity: Use these questions to facilitate further discussion on the social, environmental, and economic implications of space exploration, along with positive and negative impacts.

If learners Design their Space Venture as a larger project these questions and considerations can be used to support them.

Social Implications:

- Discussion Questions:
  - How does space exploration inspire and engage people around the world?
  - What are some potential benefits of space exploration for society, such as inspiring innovation, fostering international collaboration, and promoting STEM education?
  - How might space exploration contribute to addressing global challenges such as climate change, resource scarcity, and sustainable development?
  - What ethical considerations should be taken into account in space exploration, such as ensuring equitable access to space resources and protecting cultural heritage sites on other planets?
- Positive Impacts:
  - Inspiring future generations to pursue careers in science, technology, engineering, and mathematics (STEM).
  - Fostering international cooperation and diplomacy through collaborative space missions and partnerships.
  - Stimulating technological innovation and spin-off technologies that benefit society, such as GPS, medical imaging, and water purification systems.
- Negative Impacts:
  - Exacerbating existing social inequalities by diverting resources away from pressing societal needs such as poverty alleviation and healthcare.
  - Generating space debris and environmental pollution in Earth's orbit, posing risks to satellites and spacecraft.
  - Potentially leading to geopolitical tensions and competition over space resources, such as rare minerals and water ice.

Environmental Implications:

- Discussion Questions:
  - What are the environmental impacts of space exploration on Earth and beyond?
  - How does space debris affect the sustainability of space activities and the safety of spacecraft and satellites?
  - What are the potential risks and benefits of resource extraction and utilization on celestial bodies such as the moon and asteroids?
  - How can space exploration contribute to environmental monitoring and protection efforts on Earth, such as tracking climate change and natural disasters?

MM4: L2TG SPACE VENTURE REMIX

Extension Activity

- Positive Impacts:
  - Advancing our understanding of Earth's climate and environment through space-based observation and remote sensing technologies.
  - Facilitating the development of sustainable technologies and practices for resource utilisation in space, such as in-situ resource utilisation (ISRU).
  - Providing opportunities for environmental monitoring and protection efforts on Earth, such as tracking deforestation, pollution, and natural disasters.
- Negative Impacts:
  - Generating space debris and orbital debris that pose risks to operational spacecraft and satellites, as well as to future space missions.
  - Potentially disrupting ecosystems and geological formations on other celestial bodies through resource extraction and human activities.
  - Introducing contaminants and biological hazards to other planets and celestial bodies, potentially compromising scientific research and astrobiology studies.

Economic Implications:

- Discussion Questions:
  - How does space exploration contribute to economic growth and development on Earth?
  - What are the economic opportunities and challenges associated with commercial space activities such as satellite communication, space tourism, and asteroid mining?
  - How can space exploration stimulate innovation, entrepreneurship, and job creation in industries such as aerospace, technology, and manufacturing?
  - What are the potential economic risks and benefits of investing in space exploration compared to other priorities such as healthcare, education, and infrastructure?
- Positive Impacts:
  - Stimulating economic growth and investment in high-tech industries such as aerospace, telecommunications, and satellite imaging.
  - Creating new opportunities for job creation, entrepreneurship, and innovation in space-related sectors and downstream industries.
  - Generating revenue and economic value through commercial space activities such as satellite launches, space tourism, and space-based services.
- Negative Impacts:
  - Diverting resources and funding away from pressing societal needs such as healthcare, education, and poverty alleviation.
  - Exacerbating income inequality and social disparities by benefiting primarily wealthy individuals and corporations.
  - Potentially leading to economic instability and speculative bubbles in space-related industries, particularly in the absence of clear regulatory frameworks and oversight.

L2WS SPACE VENTURE REMIX GRID

Team Name _____

This worksheet will help you play with ideas for Space Ventures using your work from activity 2 Space Ventures Remix Grid

Fill in the boxes - we will then work with the whole group to develop a number of possible ideas.

WHAT IS YOUR SELECTED SPACE INDUSTRY AND CHALLENGE THEME

LIST THE POSSIBLE CHALLENGES IN FOR YOUR SELECTED SPACE THEME

OBSTACLES TO DEVELOPING SOLUTIONS TO THE CHALLENGE

HOW WOULD YOU OVERCOME THE OBSTACLES

L2WSB SPACE VENTURE SWOT ANALYSIS

Name _____

Date _____

Use this adapted SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis to consider each of your group's Space Venture ideas.

Take one idea from each of the group members and work together to complete the boxes for each Space Venture

VENTURE PURPOSE	STRENGTHS	WEAKNESSES	USERS / CLIENTS OPPS AND THREATS

VENTURE PURPOSE	STRENGTHS	WEAKNESSES	USERS / CLIENTS OPPS AND THREATS

VENTURE PURPOSE	STRENGTHS	WEAKNESSES	USERS / CLIENTS OPPS AND THREATS