STEAM EDUCATION FOR SUSTAINABLE DEVELOPMENT and FUTURES LITERACY

SGD9 Future of Space

Programme Phase 2: Experimentation and Exploration

Micro-Module 4: Space Innovation and Enterprsise

SUBJECT AREAS: CSPE/ SPHE, Design, English and Communication, Environment, Science, Sustainability, Technology

MM4: Space Innovation and Enterprise

Experimentation and Exploration

Curriculum Areas

CSPE/ SPHE, Design, English and Communication, Environment, Science, Sustainability, Technology

In this module learners, will explore the intersection of space entrepreneurship and the myriad of career opportunities available in the space industry. With the onset of the commercialisation of space, the burgeoning field of space tourism, the potential of resource mining increases the potential of space as a marketplace for goods, services, and innovation.

Through hands-on activities, real-world examples, and interactive discussions, learners will gain insights into the future possibilities and educational pathways in space-related fields.

This module will support learners to develop a deeper understanding of the commercial aspects of space exploration, gain exposure to diverse career options in the space industry, offering inspiration to pursue their passions in STEAM fields with a focus on space entrepreneurship.

In this module, the learner will…

- gain an understanding of the commercialisation of space
- explore space entrepreneurship and emerging opportunities
- examine inclusion in the space industry
- become aware of open-source space exploration
- gain insights into the impact of space tourism
- explore career pathways in the space industry
- envision future possibilities in space exploration and entrepreneurship

This module includes:

- Lesson plans and accompanying resources
- Optional assessments
- Skill support resources

Lesson 1: The Commercialisation of Space
In this lesson, learners are introduced to the commercial space industry, its key players, and ventures in space entrepreneurship, and to explore space as a marketplace for goods, services, and innovation.

Resources: Worksheets: Space Commercialisation Overview, Space Venture Remix Grid, Teacher's Guide: Space Commercialisation Overview

Lesson 2: Develop a Space Venture Idea
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.

Resources: Worksheets: Space Venture Remix Grid, Space Venture SWOT Analysis Teacher's Guide: Space Commercialisation Overview

Lesson 3: Space Entrepreneurship
In this lesson, learners will explore the entrepreneurial aspects of commercialising space, including identifying opportunities, overcoming challenges, considering the implications and developing innovative business solutions.

Resources: Worksheet: What is Space Entrepreneurship? Teacher's Guide: What is Space Entrepreneurship?

Lesson 4 - 6: Inclusion in the Space Industry 1 - 3
In these three linked lessons, learners will consider the importance of diversity and inclusion in space entrepreneurship, with a focus on the participation of women, indigenous communities, people of colour, and differently-abled individuals. The lessons collectively highlight challenges and opportunities of promoting inclusive practices in space-related industries, identifying the barriers that marginalised groups face and considering ways to overcome them.

Lesson 4: Focuses on Female Space Professionals
Resources: Worksheets: Female Space Professionals, Planning Your Poster, Teacher's Guide: Female Space Professionals

Lesson 5, focuses on showcasing Indigenous and People of Colour Space Professionals
Resources: Worksheets: Indigenous and People of Colour Professionals , Planning Your Poster, Teacher's Guide: Indigenous and People of Colour Space Professionals

Lesson 6: Focuses on Differently Abled Space Professionals
Resources: Worksheets: Differently-Abled Space Professionals, Planning Your Poster, Teacher's Guide: Differently-Abled Space Professionals

Lesson 7: Exploring Open Innovation in Space
This lesson introduces the concept of open-source space entrepreneurship and innovation. Learners will examine initiatives driving innovation and democratising access to space technology and resources by looking at real-world examples.

Resources: Worksheet: Open Innovation in Space, Open Innovation in Space - Projects, Teacher's Guide: Open Innovation in Space

Lesson 8: Space Tourism
In this lesson, learners will get an overview of the emerging Space Tourism sector, examining current and future possibilities for civilian space travel and reflect on the ethical considerations and challenges in commercialising space for tourism.

Resources: Worksheets: Engineering Space Tourism, Teacher's Guide: Engineering Space Tourism

Lesson 9: Space Tourism 2 - Create your own Space Tourism event
In this lesson, learners will build upon their previous knowledge to develop a space venture focused on civilian space travel. They will collaborate to define the aims and objectives of their space tourism event, considering factors such as target audience, mission profile, and ethical considerations.

Resources: Worksheets: Creating a Space Tourism Event, Peer review: Creating a Space Tourism Event, Teacher's Guide: Enterprise Planning, Lesson 10

Lesson 10: Space Related Careers
In this lesson, learners are introduced to the range of career paths within the space industry. Through exploration and discussion, they gain insight into diverse roles such as aerospace engineering, astrophysics, space medicine, and space entrepreneurship.

Resources: Worksheets: Generating a Space Tourism Logo, Planning a Space Tourism Venture
 Lean Canvas, Teachers Guide: Dragon's Den Event

Lesson 11: Future Possibilities in Space Exploration and Entrepreneurship
In this lesson, learners will explore future trends and developments in space entrepreneurship, examining the potential societal and economic impacts of space innovation.

Resources: Worksheet: Exploring Space Careers Challenge

Lesson 12:
In this lesson, learners will explore future trends and developments in space entrepreneurship, examining the potential societal and economic impacts of space innovation.

Resources: Start up Space Venture, Teaching Guide: Setting up a Start-up Hub in a School

Module concept, design and and development: Dr. Anita McKeown
Peer review, recommendations and contributions: Rebecca White and Dr Jessica Garska

Using the Resources:
If you wish to use these resources, we can offer an induction and online support throughout the module to help you plan integration into your projects and timetable. To register for this option, please contact us e:hello@futurefocus21c.com For more information on the resources please visit www.muinincatalyst.com

Setting up an online learning environment for the lessons on this module:
Our lessons integrate the use of virtual learning environments. To ensure seamless use of our lessons, a module should be setup on your school's virtual learning environment such as Teams, Google Classroom, etc. Learners are encouraged to upload documents to share with their peers. If your virtual learning environment does not support document sharing, we recommend OneDrive or Google Drive.

You can also use Google Sites or Microsoft Sway to encourage learners to present their work over the year - this can easily be set up to reflect the aims of TY and provide a showcase for their work as well as an assessment tool.

Setting up a Canva Education account.
As our lessons integrate design, our lessons also refer to Canva. Educators and schools are able to open a free Canva for Education account by registering here: https://www.canva.com/education/ Canva for Education provides primary and secondary school teachers and students with premium features and templates. You can then also set up lessons and invite your learners to the class.

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Activity 2 Overview of Space Commercialisation

INDUSTRY	DESCRIPTION
Satellite communications	
Launch services	
Satellite imaging	
Space-based manufacturing	
Space tourism	
Asteroid mining	
Space Food and Nutrition	
Space Tech: Travel and Transportation	
Space Clothing and Personal Protective Equipment (PPE)	
Space Shelter and Habitats	

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

INDUSTRY	DESCRIPTION
Space Technology - Data Services / Communication	
Space Healthcare / Medical Services	
Space Tech: Energy / Power Generation	
Space Tech: Environmental Monitoring and Resource Management	

ACTIVITY 2 SPACE VENTURE REMIX GRID - INSTRUCTIONS

Emergent (arising or developing) 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.

Using the information from the table you completed for activity 1 you will complete the boxes in the worksheet Worksheet: Space Venture Remix Grid.

1. Select one of the industries from the table above - e.g. Space Food and Nutrition
2. Write your selection in the challenge box and think about what are the challenges to this industry e.g. food production in space, alternative production such as hydroponics or aquaponics - you can use the internet to find out what these are,
3. Once you have selected your industry and your challenge begin to complete the other boxes answering the questions in the worksheet boxes -
4. Finally, once you have completed your boxes - what is your product service or innovation for Space Exploration.

Using the example of fSpace ood and nutrition, this could be

- What Are the possible Challenges for the selected Space Challenge, challenges could be no sun / water, long distances, dead seeds
- Obstacles to the solutions - minimal space and trying to reduce weight for transportation
- How would you overcome the obstacles - vacuum packing or dehydrating to reduce size and weight

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.

MM4: L1WSb 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 FOR YOUR SELECTED SPACE THEME

OBSTACLES TO DEVELOPING SOLUTIONS TO THE CHALLENGE

HOW WOULD YOU OVERCOME THE OBSTACLES

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

Activity 1 Concise Definitions of the Key Terms

KEY TERM	SHORT DESCRIPTIONS
Business Model	
Competitive Advantage	
Disruption	
Market Demand	
Open Source Space	
Space Entrepreneurship	
Space Exploration	
Space Innovation	
Space Law and Regulation	
Start-ups	

MM4: L3WS WHAT IS SPACE ENTREPRENEURSHIP?

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Activity 2 What is Space Entrepreneurship? - Key Players

1. Working in pairs, select one of the companies/entrepreneurs each below to research.
2. Look at the goals/achievements of the companies and how they disrupted the Space Industry through innovation and enterprise. Once you have completed your research, read each other's findings and discuss using the following questions

   - What are the potential benefits and risks of private companies leading the future of space exploration compared to government agencies?
   - How do you think space exploration will impact life on Earth in terms of technology, economy, and society?
   - What ethical or environmental concerns arise from the commercialization of space, and how should these companies address them?
   - How do you think space tourism and the accessibility of space travel will change human perspectives on space and our planet?
   - In your opinion, what should be the top priority for space exploration—scientific discovery, business opportunities, or human settlement? Why?

CASE STUDY	DETAILS	INNOVATION / DISRUPTION
Space X - Elon Musk https://www.spacex.com/		
Richard Branson / Virgin Galaxy https://www.virgingalactic.com/		

CASE STUDY	DETAILS	INNOVATION / INSPIRATION
Rocket Lab USA https://www.rocketlabusa.com/		
ConsenSYS Space (open source space) https://www.consensys.space/		
Blue Origin / Jeff Bezos https://www.blueorigin.com/		

MM4: 4WS FEMALE SPACE PROFESSIONAL

Assigned Space Explorer:

Background:

Space Sector / Profession:

Contributions to the Space Industry:

Anecdotes / Facts:

Create a showcase Poster: Each member of the group should take one of the bullets below and include the following points on your poster.

- **A brief biography of the space explorer, highlighting key milestones and achievements.**

- **Images or photographs depicting the space explorer in action or participating in space missions.**

  - Make sure you have permission to use the image (s)you have selected
  - Download and save your images to your online learner folder space - by right-clicking the image, select save as image, naming it clearly and save

- **Quotes or inspirational messages from the space explorer.**

- **Optional: Fun facts or trivia about the space explorer's life and career**

MM4: 4WSB PLANNING YOUR POSTER

Points to consider when planning you showcase poster and choosing a template:

1. Choosing a Layout/Template:

- Balance between text and visuals: Select a template that offers space for both written content (biography, quotes) and visuals (images, photographs). Ensure it's easy to read and visually appealing.
- Sections: Choose a design that allows you to organise content into clear sections (e.g., "Biography," "Key Milestones," "Quotes," "Fun Facts") so the viewer can navigate the poster easily.
- Image placement: Choose a template with designated spaces for images, ideally near or alongside the text they relate to (e.g., images of space missions next to key milestones).

2. Biography Section:

- Brief, impactful biography: Ensure the biography section is concise with key life milestones (e.g., education, career beginnings, major space missions). Highlight significant achievements such as space missions, leadership roles, or contributions to space science.
- Text formatting: Use bullet points or short paragraphs to keep it clear and readable. Avoid long blocks of text.

3. Images or Photographs:

- Choose high-quality images: Use clear, high-res. images of the space explorer, showing them in action (e.g., during space missions, training, or key moments in their career).
- Captions: Add short captions to the images to explain what's happening or the significance of the moment.

4. Quotes or Inspirational Messages:

- Highlight with design: Use a distinct font or colour for quotes to make them stand out. Place them in visually prominent spots on the poster, like near the top or in the middle, where they'll catch attention.
- Relevance: Select quotes that reflect the space explorer's philosophy, motivation, or views on space exploration and science.

5. Fun Facts or Trivia (Optional):

- Placement: Set aside a small section for "Fun Facts" that's separate from the main biography. This could be at the bottom or in the side margins for easy visibility.
- Engage your audience: Include interesting, lesser-known facts (e.g., personal hobbies, unique experiences in space, or unexpected career paths) to make the space explorer more relatable.

6. Design and Visual Appeal:

- Color scheme: Consider Choosing colours that align with the space theme (e.g., dark blues, blacks, and silvers) and that also make the text and images stand out.
- Typography: Ensure the font size is large enough for easy reading, with headings and key information in bold or larger fonts.

7. Conclusion / Call to Action (Optional):

Closing thought: Include a final section summarising the impact and contributions or encouraging others to explore careers in space.

MM4: 5WS INDIGENOUS PEOPLE AND PEOPLE OF COLOUR SPACE PROFESSIONALS

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Assigned Space Professional:

Background:

Space Sector / Profession:

Contributions to the Space Industry:

Anecdotes / Facts:

Create a showcase poster: Each member of the group should take one of the bullets below and include the following points on your poster.

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- **Images or photographs depicting the space explorer in action or participating in space missions.**

  - Make sure you have permission to use the image (s)you have selected
  - Download and save your images to your online learner folder space - by right-clicking the image, select save as image, naming it clearly and save

- **Quotes or inspirational messages from the space explorer.**

- **Optional: Fun facts or trivia about the space explorer's life and career**

MM4:5WSB PLANNING YOUR POSTER

Points to consider when planning you showcase poster and choosing a template:

1. Choosing a Layout/Template:
- Balance between text and visuals: Select a template that offers space for both written content (biography, quotes) and visuals (images, photographs). Ensure it's easy to read and visually appealing.
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2. Biography Section:
- Brief, impactful biography: Ensure the biography section is concise with key life milestones (e.g., education, career beginnings, major space missions). Highlight significant achievements such as space missions, leadership roles, or contributions to space science.
- Text formatting: Use bullet points or short paragraphs to keep it clear and readable. Avoid long blocks of text.

3. Images or Photographs:
- Choose high-quality images: Use clear, high-res. images of the space explorer, showing them in action (e.g., during space missions, training, or key moments in their career).
- Captions: Add short captions to the images to explain what's happening or the significance of the moment.

4. Quotes or Inspirational Messages:
- Highlight with design: Use a distinct font or colour for quotes to make them stand out. Place them in visually prominent spots on the poster, like near the top or in the middle, where they'll catch attention.
- Relevance: Select quotes that reflect the space explorer's philosophy, motivation, or views on space exploration and science.

5. Fun Facts or Trivia (Optional):
- Placement: Set aside a small section for "Fun Facts" that's separate from the main biography. This could be at the bottom or in the side margins for easy visibility.
- Engage your audience: Include interesting, lesser-known facts (e.g., personal hobbies, unique experiences in space, or unexpected career paths) to make the space explorer more relatable.

6. Design and Visual Appeal:
- Color scheme: Consider Choosing colours that align with the space theme (e.g., dark blues, blacks, and silvers) and that also make the text and images stand out.
- Typography: Ensure the font size is large enough for easy reading, with headings and key information in bold or larger fonts.

7. Conclusion / Call to Action (Optional):
- Closing thought: Include a final section summarising the impact and contributions or encouraging others to explore careers in space.

MM4: 6WS DIFFERENTLY ABLED SPACE PROFESSIONALS

Assigned Space Professional:

Background:

Space Sector / Profession:

Contributions to the Space Industry:

Anecdotes / Facts:

Create a showcase poster: Each member of the group should take one of the bullets below and include the following points on your poster.

- **A brief biography of the space explorer, highlighting key milestones and achievements.**

- **Images or photographs depicting the space explorer in action or participating in space missions.**

  - Make sure you have permission to use the image (s)you have selected
  - Download and save your images to your online learner folder space - by right-clicking the image, select save as image, naming it clearly and save

- **Quotes or inspirational messages from the space explorer.**

- **Optional: Fun facts or trivia about the space explorer's life and career**

MM4:6WSB PLANNING YOUR POSTER

Points to consider when planning you showcase poster and choosing a template:

1. Choosing a Layout/Template:
- Balance between text and visuals: Select a template that offers space for both written content (biography, quotes) and visuals (images, photographs). Ensure it's easy to read and visually appealing.
- Sections: Choose a design that allows you to organise content into clear sections (e.g., "Biography," "Key Milestones," "Quotes," "Fun Facts") so the viewer can navigate the poster easily.
- Image placement: Choose a template with designated spaces for images, ideally near or alongside the text they relate to (e.g., images of space missions next to key milestones).

2. Biography Section:
- Brief, impactful biography: Ensure the biography section is concise with key life milestones (e.g., education, career beginnings, major space missions). Highlight significant achievements such as space missions, leadership roles, or contributions to space science.
- Text formatting: Use bullet points or short paragraphs to keep it clear and readable. Avoid long blocks of text.

3. Images or Photographs:
- Choose high-quality images: Use clear, high-res. images of the space explorer, showing them in action (e.g., during space missions, training, or key moments in their career).
- Captions: Add short captions to the images to explain what's happening or the significance of the moment.

4. Quotes or Inspirational Messages:
- Highlight with design: Use a distinct font or colour for quotes to make them stand out. Place them in visually prominent spots on the poster, like near the top or in the middle, where they'll catch attention.
- Relevance: Select quotes that reflect the space explorer's philosophy, motivation, or views on space exploration and science.

5. Fun Facts or Trivia (Optional):
- Placement: Set aside a small section for "Fun Facts" that's separate from the main biography. This could be at the bottom or in the side margins for easy visibility.
- Engage your audience: Include interesting, lesser-known facts (e.g., personal hobbies, unique experiences in space, or unexpected career paths) to make the space explorer more relatable.

6. Design and Visual Appeal:
- Color scheme: Consider Choosing colours that align with the space theme (e.g., dark blues, blacks, and silvers) and that also make the text and images stand out.
- Typography: Ensure the font size is large enough for easy reading, with headings and key information in bold or larger fonts.

7. Conclusion / Call to Action (Optional):
Closing thought: Include a final section summarising the impact and contributions or encouraging others to explore careers in space.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Activity 1: Exploring Concepts in Open Source Projects

This activity will introduce you to key Concepts related to open-source space projects and how they apply in real-world scenarios. You will use the given project examples to illustrate the definitions and key terms.

Below are 5 important concepts linked to open-source space projects. You will complete the following three tasks

- Understand what each concept means.
- Use the open-source space projects examples - Worksheet: Open Source project examples and additional online research.
- Write a brief explanation and example for each concept, in the table below, in your notebook or a digital table you have created online.

KEY TERM	Your Explanation
Decentralisation	
Democratisation	
Innovation	
Open Source	
Rapid Prototyping	

Remember: Use the Task Support help on the next page and the worksheet with the project exmaples to help you complete the table

MM4: 7WS INTRODUCTION TO OPEN SOURCE INNOVATION IN SPACE

Decentralisation - NOT Centrally controlled

- Find an example where power or control is distributed (shared) among a network rather than concentrated in one central place or authority.
- Hint: Think about how open-source space projects allow people from all over the world to contribute.

Democratisation - the process that enables people to have a voice and power

- Task: Look for an example where space technology or data is made accessible to a wide audience, not just governments or large companies.
- Hint: Consider CubeSats or projects that make space exploration available to universities or individuals.

Innovation -

- Task: Find an example of a creative or new solution that changes how things are done in space technology or exploration.
- Hint: Look for something unique, like a new type of satellite or a new way to collaborate on space missions.

- Open Source

  - Task: Identify an open-source project where anyone can access and contribute to the software or hardware.
  - Hint: Think about satellite programs that share their designs and tools for free.

- Rapid Prototyping
  - Task: Look for an example where new designs or technologies are quickly created and tested.
  - Hint: CubeSats or open-source hardware might help speed up development.

Look at the companion Worksheet: Open Innovation in Space - Projects for details on the projects below

- CubeSats
- Open Source Satellite Programs
- Open Lunar Foundation
- NASA Open Source Software
- SpaceX Open Source Initiatives

After you have found examples for each concept, write 1-2 sentences explaining the concept and how the example you found illustrates it.

MM4: 7WSB OPEN INNOVATION SPACE PROJECTS

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Activity 1: Exploring Concepts in Open Innovation - Project Examples

- CubeSat: CubeSats are a class of nano-satellites that use a standard size and form factor these are small satellites typically built using off-the-shelf components and open-source hardware and software. CubeSats have revolutionised space exploration by enabling universities, research institutions, and even individuals to design, build, and launch their own satellites at a fraction of the cost of traditional satellites. Projects like the CubeSat Kit developed by NASA and the CubeSat standard developed by the California Polytechnic State University are examples of open initiatives that have democratised access to space. https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/CubeSats

- Open Source Satellite Programs: Organisations like Libre Space Foundation are dedicated to developing open-source hardware and software for satellite missions. They provide resources, tools, and platforms for collaboration among engineers, developers, and space enthusiasts worldwide. Their projects include ground stations, satellite tracking software, and mission control systems, all of which are freely available for anyone to use and contribute to. https://www.opensourcesatellite.org/

- Open Lunar Foundation: This organisation is focused on democratising access to the Moon by promoting open collaboration and resource-sharing among stakeholders in the space industry. They advocate for principles of transparency, inclusivity, and sustainability in lunar exploration and development, with the goal of enabling diverse participation and innovation. https://www.openlunar.org/

- NASA Open Source Software: CODE is a framework for the control and observation of resources, services, and applications. The technology supports the secure and scalable transmission of observed information to other programs, and it enables the secure execution of actions on remote computer systems. https://code.nasa.gov/

- SpaceX Open Source Initiatives: SpaceX, a leader in commercial space exploration, has released some of its software and hardware designs as open source. For example, the company's Dragon spacecraft avionics software is available on GitHub, allowing developers to contribute improvements and innovations. Additionally, SpaceX has open-sourced its mission data analysis tools, providing researchers and engineers with valuable resources for analyzing spacecraft telemetry data.

- Open Source Space Telescope: The Open Source Space Telescope project aims to design and build a low-cost, open-source space telescope that can be launched and operated by universities, research institutions, and amateur astronomers. By leveraging open collaboration and community involvement, the project seeks to make space-based astronomy more accessible and affordable for a wider range of users.
  -

Activity 1: Exploring Concepts in Open Innovation - Project Examples

Once the timer starts, you will work quickly with your partner to use your selected example as the starting point for the prototype. Complete the following question prompts for each stage of the design thinking process to help you think through some ideas before you start to prototype - you will have 10 mins.

Although you will work quickly there are some steps you can take to make sure you are still focused on your design problem.

1. Empathise: Think about how your idea will help to solve the problem and who might be involved in the problem. This will help you decide how you are going to address the problem.
2. Define: What is the problem your selected example is trying to fix or address. This is the same problem your prototype will have to address.
3. Ideate: What aspect of the problem will you address - will it be a new feature, new materials etc?

   - What is the primary goal / function of your innovation or idea?
   - What do you want your innovation to do / to achieve?
   - What specific tasks or experiments will it need to accomplish?
   - What performance criteria does the prototype need to meet e.g., accuracy, speed, endurance ?
   - What essential features and capabilities are required for your innovation idea?
   - How will your innovation contribute to scientific knowledge or technological advancement within Space Exploration?
   - What issues will you need to think about in the design / build of your prototype?

   - How will it be powered?
   - Will it need to communicate data? How will it do that?
   - Are there any health and safety issues? If so, what are they?
   - Will it need to withstand any environmental factors e.g. temperature, radiation, vacuum?
   - How will it get to space?
   - Think about the materials you will use, and how you will show this on your prototype
   - Think about wow will you show the different parts / function with the materials you have

4. Prototype: Think about what aspect of your selected inspiration example you want to iterate / explore prototype. Think about how you will iterate (improve, redesign, innovate) from the original example that is your inspiration - this is important as open source iterates other ideas and shares knowledge as part of its process. This is why you must share and publicly acknowledge your sources - so it's fair.

5. Test: How might you test your ideas, who could you talk with to get some feedback on your innovation and prototype.

   -

MM4: 8WS ENGINEERING SPACE TOURISM

Activity 1: Engineering Space Tourism

Using your assigned number, research the commercial space venture aligned to your assigned number. You will use your findings to undertake a comparative analysis with other classmates, once you have completed your research.

You will only have 10 minutes for this exercise, so allocate category

CATEGORY	1 SPACEX'S CREW DRAGON	2 BLUE ORIGIN'S NEW SHEPARD	3 Virgin Galactic's SpaceShipTwo
Tech specifications: • Dimensions • Payload capacity • Propulsion systems			
Mission Profiles: • Types of missions (e.g., orbital, suborbital), duration, • Destinations			
Commercialisation: • Target markets, • Pricing • Accessibility			
Safety and Reliability: • Abort systems, • Flight history, • Testing procedures			

MM4: 8WS ENGINEERING SPACE TOURISM

Activity 2 Future possibilities, challenges and opportunities

You will have 15 minutes to complete the table below on a different spacecraft / company than you have chosen for the first activity.

FUTURE PLANS	Details
Planned upgrades	
Upcoming Missions	
Potential advancements	
Crew Accommodation	
Accessibility	
Public Engagement and Education	
Interplanetary travel	

Once you have completed the table for Activity 2, you should consider with your partner the following in preparation for sharing with the class.

MM4: 8WS ENGINEERING SPACE TOURISM

Once you have completed the table for Activity 2, you should consider with your partner the following in preparation for sharing with the class.

Sustainability and Ethics

Environmental Impact:

- How does your project or idea minimize its impact on the environment?
- Are there any ways to reduce waste or use renewable resources in your venture?

Cultural Preservation:

- Does your project consider local cultures and traditions? How do you ensure they are respected and preserved?
- What steps can you take to avoid disrupting or commercializing cultural heritage?

Equitable Access:

- Who benefits from this project? How can you ensure it is accessible to diverse communities, regardless of socioeconomic status?
- Are there any barriers that might limit certain groups' access to your project? How can these be addressed?

Responsible Tourism (if applicable):

- If your project involves tourism, how do you promote responsible and respectful behavior among participants?
- How will you manage the balance between attracting visitors and maintaining the integrity of local environments and communities?

Long-Term Viability:

- How do you plan to sustain this project in the long run without compromising its ethical principles?
- What measures can you take to ensure that the project continues to benefit both people and the planet over time?

Activity 1: Planning your space tourism event

Use the table to help you develop your space tourism event by answering the questions using the prompts to help you plan your space tourism event. You can use the second page or a notebook to record your final answers for review by another group.

EVENT ASPECT	THINGS TO THINK ABOUT	NOTES
AIM: What is the aim of your space venture?	• To provide suborbital joyrides for thrills / pleasure to wealthy customers? • Or longer-duration orbital missions for scientific research or leisure purposes? • Or space public transport or any other ideas e.g. parties or celestial bodies viewing?	
Market: Who is your customer?	• Identify your customer based on what you decided was your aim. You will need to think about • Who they are, what they are interested in and their ability and willingness to pay	
Destination: Where are they going?	• Sub-orbital civilian flights to the edge of space? • Orbital mission to the International Space station? • Or a yet to be explored planet?	
Experience: What will be the overall experience?	• Functional, luxury or themed? • What facilities will there be? • Will it be like a cruise ship or more like an aeroplane? • If it is not research or educational design a memorable and immersive customer experience that aligns with the objectives of the space tourism venture. • Consider aspects such as pre-flight training, launch preparations, in-flight activities, accommodations, and post-flight celebrations or souvenirs	

MM4: 9WS CREATE A SPACE TOURISM EVENT

Activity 1: Planning your space tourism event

You can use this page or a notebook to record your final answers for review by another group.

EVENT ASPECT	THINGS TO THINK ABOUT
AIM: What is the aim of your space venture?	
Market: Who is your customer?	
Destination: Where are they going?	
Experience: What will be the overall experience?	

MM4: 9WSB PEER REVIEW: SPACE TOURISM EVENT

Activity 2: Peer Review your space tourism event

After reviewing another pair's / group's Space Tourism Event, use the following questions to help you provide thoughtful feedback. Consider the environmental, ethical, and practical aspects of your peer's design.

EVENT ASPECT	Feedback Considerations	FEEDBACK
Environmental Impact	Sustainability • Does the event design address environmental sustainability? If so, how? • What additional steps could be taken to reduce the environmental impact (e.g., waste reduction, energy use)? Carbon Footprint: • Has the group considered the carbon footprint of the event, especially regarding space travel? • How could they make the event more eco-friendly?	
Ethical Considerations	Cultural Sensitivity: • Does the event respect local cultures and traditions, particularly if it involves different locations on Earth or space habitats? • Are there any cultural or ethical aspects that could be improved? Long-Term Impact: • Does the event contribute positively to the space tourism industry or to local communities? • What measures could they include to ensure ethical integrity over time?	

MM4: 9WSB PEER REVIEW: SPACE TOURISM EVENT

Activity 1: Peer Review your space tourism event

After reviewing another pair's / group's Space Tourism Event, use the following questions to help you provide thoughtful feedback. Consider the environmental, ethical, and practical aspects of your peer's design.

EVENT ASPECT	Feedback Considerations	FEEDBACK
Equitable Access	Inclusivity: • Who is the target audience for this event? Is the event accessible to people of different economic or social backgrounds? • How could the event be made more inclusive? Cost: • Does the event seem affordable for a wide range of participants, or is it only accessible to the wealthy? • Suggest ways to make it more financially accessible to a broader audience.	
Event Feasibility and Creativity	Feasibility: • Does the event seem realistic and achievable with current technology and resources? • What challenges might they face in making the event a reality? Creativity: • How creative is the event concept? Does it bring new or innovative ideas to space tourism? • What elements of the event could be developed further to enhance its uniqueness? •	

MM4: 9WSB PEER REVIEW: SPACE TOURISM EVENT

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Activity 1: Peer Review your space tourism event

After reviewing another pair's / group's Space Tourism Event, use the following questions to help you provide thoughtful feedback. Consider the environmental, ethical, and practical aspects of their design.

EVENT ASPECT	Feedback Considerations	FEEDBACK
Suggestions and Improvements	Overall Impressions: - What did you like most about their event idea? - What could be improved to make the event more compelling or sustainable? Open Feedback: - Any additional thoughts, questions, or feedback not covered in the prompts above?	

MM4: 10WS GENERATING A SPACE TOURISM LOGO

Activity 1: Generating a Space Tourism Logo

Firstly select one of the business name generators

- Shopify shopify https://www.shopify.com/tools/business-name-generator?index
- Namelix https://namelix.com/

and use the information from your Space Tourism planning worksheet, from Lesson 9 e.g.

- what is your space tourism business,- sub orbital pleasure trips and party events
- industry, Space Tourism,
- brand personality... quirky fun, customer focused

to create your business summary which you will input to generate your business name e.g. Space Tourism, sub orbital pleasure trips and party events, quirky fun, customer focused

Once you have a business name, you will now use this name to create a Logo for your Space Tourism Venture

1. Watch the video 5 Logo Design Tips to Help Fuel Your Creativity
   https://www.youtube.com/watch?v=DiVygGdXuHE
2. Use one of the Logo Generators from the media box to create a logo for your Space Tourism Event / Venture

   - https://www.design.com/logo-maker
   - www.Looka.com
   - www.canva.com
   - https://www.vistaprint.ie/logomaker
   - https://www.adobe.com/express/create/logo
   - www.wix.com

3. Once you have completed your logo - upload to your e-classroom (Google Drive, Microsoft Teams or other online shared space) with your Space Venture Idea
4. If you are having a longer class you can use a business card template template from www.canva.com with your name, role in the business, contact details and logo

MM4: 10WS PLANNING A SPACE TOURISM VENTURE

Activity 1: Planning your space tourism venture

Use the table to help you develop the space tourism venture that will sell your space tourism event. The questions will help you plan your venture and you can use the second page or a notebook to record your final answers for review by another group.

BUSINESS DETAIL	BUSINESS CASE	NOTES
Marketing and Promotion: Who is your audience?	• Think about your marketing and promotion. How will you generate interest, raise awareness and attract your customers to your venture? • Who are your customers, what style of marketing attracts them, where will you find or connect to your customers? • Imagine how you might use traditional and digital marketing channels, social media platforms, public relations, events, and partnerships to reach target audiences effectively.	

Partnerships and Collaborations: Will you collaborate, get any sponsors? Why?	• Do you need any specialist expertise for your venture?
	
	    ◦ Aerospace companies
	    ◦ Space agencies
	    ◦ Tourism organisations
	    ◦ Catering
	
	• What resources do you need?
	• What networks could be useful to you?	

Experience: What will be the overall experience?	• Functional, luxury or themed? • What facilities will there be? • Will it be like a cruise ship or more like an aeroplane? • If it is not research or educational design a memorable and immersive customer experience that aligns with the objectives of the space tourism venture. • Consider aspects such as pre-flight training, launch preparations, in-flight activities, accommodations, and post-flight celebrations or souvenirs	

MM4: 10WS PLANNING A SPACE TOURISM VENTURE

Activity 1: Planning your space tourism venture

Use the table to help you develop the space tourism venture that will sell your space tourism event. The questions will help you plan your venture and you can use the second page or a notebook to record your final answers for review by another group.

BUSINESS DETAIL	BUSINESS CASE	NOTES
Safety:	• Prioritise safety and risk management throughout the planning process. • Identify potential hazards and risks associated with space travel, and develop protocols and contingency plans to mitigate them. • Consider factors such as crew training, medical requirements, emergency procedures, and insurance coverage.	
Regulatory Compliance:	• Familiarise yourselves with the regulatory frameworks governing commercial spaceflight, including licensing, permits, safety regulations, and liability issues. • Ensure compliance with applicable laws and regulations to operate the space tourism venture legally and responsibly.	

Financial Planning: Where are they going?	• You will need a comprehensive financial plan if anyone is to invest. You will need to consider factors such as spacecraft development, launch services, training facilities, marketing, and insurance and outline
	
	   ◦ the initial investment required,
	   ◦ operating costs,
	   ◦ revenue projections,
	   ◦ pricing strategies, and potential source of funding or investment.
	
	•	

Problem
List your customer's top 3 problems

-worry that pet will get lost
-worry that pet is up to no good when home alone
-miss pet and want a way to connect while at work

Existing Alternatives
List how these problems are solved today

There are various collars on the market that track your pet's location. Some track steps and various other stats. There is a separate camera device that can be worn by your pet, but nothing exists that works as a GPS, camera and communication device in one.

Solution
Outline a possible Solution for each problem

worry that pet will get lost-you will be able to track your pet at all times.
worry that pet is up to no good when home alone-you will be able to see what your pet is doing at all times.
miss pet and want a way to connect while at work-you will be able to connect using your voice while you're away

Key Metrics
List the key numbers, that tell you how your business is doing

Number of units sold.

Unique Value Proposition
Single, clear compelling message, that turns an unaware visitor into an interested prospect

Love Paws makes it possible to be with your pet even when you're away.

High Level Concept
List your x for y analogy (e.g. youtube = flicker for videos

Love Paws is the Nest of pet tracking devices.

Unfair Advantage
Somthing, that can't be easily copied or bought

I am Cesar Milan, world famous dog trainer and I have my own TV show and numerous celebrity clients.

Channels
List your path to customers

Give away for free to celebrity pet owners and celebrity TV personalities on Animal Planet, then do a billboard, print and web and social media campaign.

Customer Segments
List your customer segments and users

Ideal customers are middle to high income, tech-savvy pet owners who spend a significant time away from their pets.

Early Adopters
List the characteristic of your ideal customer

Early adapters are pet owners who love to keep up and own the latest tech innovations as soon as they come out.

Cost Structure
List your fixed and your variable costs

Product design, sourcing of materials, production costs, engineering, marketing, PR.

Revenue Streams
List your sources of revenue

We will initially sell online with the goal to being on the shelves of major pet stores by end of year.

PRODUCT | MARKET

9 INDUSTRY INNOVATION AND INFRASTRUCTURE

MM2 10WSB: LEAN CANVAS

PROBLEM
List your top 1-3 problems.

EXISTING ALTERNATIVES
List how these problems are solved today.

SOLUTION
Outline a possible solution for each problem.

KEY METRICS
List the key numbers that tell you how your business is doing.

UNIQUE VALUE PROPOSITION
Single, clear, compelling message that states why you are different and worth paying attention.

HIGH-LEVEL CONCEPT
List your X for Y analogy e.g. YouTube = Flickr for videos.

UNFAIR ADVANTAGE
Something that cannot easily be bought or copied.

CHANNELS
List your path to customers (inbound or outbound).

CUSTOMER SEGMENTS
List your target customers and users.

EARLY ADOPTERS
List the characteristics of your ideal customers.

COST STRUCTURE
List your fixed and variable costs.

REVENUE STREAMS
List your sources of revenue.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

MM4: 11WS EXPLORING SPACE CAREERS CHALLENGE

Activity 1: Generating a Space Tourism Logo

You will complete the following series of challenges to explore career paths, educational requirements, scientific space discoveries and space professionals.

Challenge 1 - Career Paths

1. Identify three different career paths in space exploration using the following resources / from the following list

2. Create a definition for each of their roles based on what they do

Challenge 2 - Educational Requirements

1. For the three career paths you have identified, find three universities/colleges offering programmes that help people become qualified.

Challenge 3 - Discoveries and Breakthroughs

1. **Find one recent breakthrough or development in the space industry and summarise its significance.**

   ○ Why is this breakthrough important for the future of space exploration or tourism? (Consider how it advances technology, reduces costs, or makes space travel more accessible.)

   •

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

- How does this development impact society or industries on Earth? (Think about new job opportunities, technological spin-offs, or how it might inspire future generations.)
- What challenges does this breakthrough address in space exploration, and how does it help overcome them? (Consider whether it solves issues related to sustainability, safety, or affordability in space travel.)

Challenge 4 - Space Professionals

- **Find and watch a TED talk or interview featuring a professional working in the space industry**

- **Summarise your understanding about what they do .**

  - What is the main role or focus of the professional's work in the space industry?
  - (Consider whether they focus on engineering, research, policy, or another aspect of space exploration.)
  - What challenges do they face in their job, and how do they work to overcome them?
  - (Think about technical, environmental, or ethical issues they address in their role.)
  - How does their work contribute to the overall goals of space exploration or space tourism?
  - (Consider how their specific work impacts advancements in technology, accessibility, or sustainability in space.)

MM4: 12WS CONSIDERING THE POSSIBILITIES OF THE FUTURE SPACE INDUSTRY

Activity 1 Considering the possibilities of the future Space Industry

The future of space exploration holds vast opportunities for careers and business across various disciplines. As technology advances and humanity's presence in space expands, new opportunities will continue to emerge across sectors of the space industry.

First, answer the self- assessment questions below

Self-Assessment:

1. What aspects of space exploration fascinate and excite you the most?

2. Reflecting on your skills and passions, which areas of the space industry do you feel drawn to? (e.g., science, engineering, entrepreneurship)

3. How can you use your interests and talents to contribute meaningfully to the space industry?

4. Think about how you will explore your selected area of the space industry through education, research, networking, and hands-on experiences and see if this appeals to you?

Use the Space Skills Alliance Transferable Skills list to help you in this self-assessment
https://craft.spaceskills.org/themes/Transferable%20skills

Below are just a few examples of the diverse and exciting career / ventures possibilities that the future of space exploration holds. Select one of the Future Possibilities within Space Exploration that interests you most. This will be the focus of your new venture.

MM4: 12WS CONSIDERING THE POSSIBILITIES OF THE FUTURE SPACE INDUSTRY

- Space Mining: As technology advances, space mining could become a reality, leading to opportunities for careers in asteroid mining, resource extraction, and space resource utilisation. Professionals in this field may include geologists, mining engineers, roboticists, and space resource specialists.

- Space Colonisation: Establishing permanent human settlements on other planets, such as Mars, presents numerous career opportunities in fields like aerospace engineering, habitat design, life support systems, agriculture, and medicine. Careers in space colonisation may involve roles in research,architecture, design, construction, logistics, and governance.

- Space Manufacturing: In-space manufacturing, utilising resources found in space to produce goods, holds potential for reducing the costs of space exploration and enabling long-duration missions. Careers in space manufacturing may include materials scientists, engineers, 3D printing specialists, and robotics experts.

- Space Science and Exploration: Advancements in space telescopes, probes, and robotic missions offer opportunities for careers in space science and exploration. Professionals in this field may study planets, moons, asteroids, and other celestial bodies to understand their composition, origins, and potential for supporting life.

- Space Medicine and Health: With the increasing duration of space missions and plans for long-term space habitation, there's a growing need for professionals in space medicine and health. Careers in this field may involve researching the effects of microgravity on the human body, developing medical technologies for space travel, and providing healthcare for astronauts.

- Space Law and Policy: As commercial space activities expand, there's a need for legal and policy experts to navigate issues related to space governance, property rights, liability, and international cooperation. Careers in space law and policy may include space lawyers, policymakers, diplomats, and regulatory specialists.

- Space Communications and Navigation: Ensuring reliable communication and navigation systems is crucial for space missions and satellite operations. Careers in space communications and navigation may involve developing satellite networks, ground control systems, and deep space communication protocols.

- Space Environmentalism: With the growing presence of satellites and space debris in Earth's orbit, there's a need for professionals to address environmental concerns in space. Careers in space environmentalism may include space debris mitigation specialists, satellite tracking experts, and sustainability advocates.

- Space Education and Outreach: As public interest in space exploration grows, there's a demand for educators, communicators, and outreach specialists to inspire and educate the next generation of space enthusiasts. Careers in space education and outreach may involve teaching, science communication, museum curation, and public engagement initiatives.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Activity 2 Startup Space Venture

You are a serial entrepreneur, someone who starts multiple businesses, often stepping back or selling before starting another 1. You are looking at the Space Industry for your latest venture. Use the supporting resource to consider the future possibilities and select the one that interests you most.

Area of the Space Industry for your Venture :

Type of Role: Who's doing what
Consider the roles involved in a start up and review your skills from worksheet one and see how you can assign roles and divide the tasks to answer the questions. These key roles are the basics for a start up - you will have to share responsibilities as you are only a team of 3 / 4, everyone in the team will share the role of founder / Entrepreneur unless there is an obvious team member for this role - this must be decided by the team.

> Founder/Entrepreneur:
> Responsibilities: The founder or entrepreneur is the visionary leader of the startup, responsible for coming up with the initial idea, setting the overall direction and strategy, and inspiring others to join the journey. They drive innovation, make critical decisions, and oversee the development and growth of the startup.

> Product Manager:
> Responsibilities: The product manager is responsible for translating the founder's vision into a tangible product or service. They work closely with the development team to define product requirements, prioritize features, and ensure that the product meets the needs of the target market. They also gather feedback from users and iterate on the product to improve its usability and functionality.

> Marketing and Communications Specialist:
> Responsibilities: The marketing and communications specialist is responsible for promoting the startup's product or service to the target audience. They develop marketing strategies, create compelling content, and execute campaigns across various channels such as social media, email, and events. They also engage with customers, build brand awareness, and communicate the value proposition of the startup to the market.

> Technical Lead/Chief Technology Officer (CTO):
>
> Responsibilities: The technical lead or CTO is responsible for overseeing the technical aspects of the startup, including software development, hardware implementation, and technological infrastructure. They lead the technical team, make decisions regarding technology stack and architecture, and ensure that the product is built using best practices and cutting-edge technologies. They also collaborate with other team members to align technical solutions with the overall business strategy and goal

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Operations Manager:

Responsibilities: The operations manager is responsible for managing the day-to-day operations of the startup, ensuring that processes run smoothly and efficiently. They oversee administrative tasks, coordinate logistics, and manage resources such as finances, facilities, and human resources. They also identify areas for improvement and implement solutions to optimize operational efficiency, enabling the startup to scale and grow effectively.

Part 2 Complete the Questions to help you plan your new Space Venture

Once your roles are decided and areas of responsibility divide the questions between the team and work through the ones you are responsible for. You should allow time to share your answers with your start-up business partner to get feedback / more ideas.

Identify Market Needs and Opportunities:

1. What are the current trends and emerging technologies in the space industry?
2. Are there any specific challenges or unmet needs in the space market that your startup could address?
3. How can you conduct market research to gain insights into potential opportunities and gaps in the space industry?
4. Who are the key players and stakeholders in the space market, and how can you learn from their experiences and perspectives?

Problem-Solving and Innovation:

1. What innovative solutions can you brainstorm to address the identified market needs or challenges in the space industry?
2. How can you apply your skills and knowledge to create value and make a positive impact in the space market?
3. What unconventional approaches or out-of-the-box ideas can you explore to solve problems in the space industry?
4. How can you foster a culture of creativity and innovation within your startup team?

MM4: 12WS CONSIDERING THE POSSIBILITIES OF THE FUTURE SPACE INDUSTRY

What will your startup focus on:

1. What specific problem or opportunity will your startup address in the space industry?
2. Who are your target customers or stakeholders, and what are their needs and pain points?
3. What unique value proposition does your startup offer, and how does it differentiate from existing solutions?
4. How will you monetise your business idea and generate revenue streams in the space market?

Build a Network and Seek Mentorship:

1. Who are the professionals, experts, and mentors in the space industry that you admire and respect?
2. How can you connect with them through networking events, industry conferences, or online communities?
3. What questions or challenges do you have that could benefit from the insights and guidance of experienced mentors?
4. How can you build and nurture relationships with mentors who can provide valuable advice and support throughout your entrepreneurial journey?

Acquire Relevant Skills and Knowledge:

1. What specific skills and knowledge are essential for success in the space industry and entrepreneurship?
2. How can you continuously learn and acquire these skills e.g. courses, workshops, or hands-on experiences?
3. What resources and learning opportunities are available to help you develop your entrepreneurial skills and expertise?
4. How can you leverage your strengths and talents while also building new skills to adapt to the dynamic nature of the space industry?

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9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Prototype and Test:

- What features or functionalities will your prototype or MVP (Minimum Viable Product) have to address the identified market needs?
- How can you design and develop a prototype that effectively demonstrates the value proposition of your startup to potential customers or stakeholders?
- What feedback mechanisms and testing methods will you use to gather feedback and validate your assumptions about your startup idea?
- How will you iterate and refine your prototype based on the feedback received to ensure that it meets the needs and expectations of your target market?

Secure Funding and Resources:

1. What are the different funding options available to support your startup in the space industry (e.g., grants, investors, crowdfunding)?
2. How can you prepare a compelling pitch or business plan to attract potential investors or funders to support your startup?
3. What resources and support services are available through incubators, accelerators, or co-working spaces to help you launch and grow your startup?
4. How can you leverage your network and connections to access funding and resources that will enable your startup to succeed in the competitive space market?

Execute and Iterate:

1. What specific action steps will you take to execute your business plan and launch your startup in the space industry?
2. How will you measure and track the progress and performance of your startup against your goals and milestones?
3. What strategies and mechanisms will you implement to gather feedback from customers and stakeholders and iterate on your product or service?
4. How will you adapt and pivot your startup based on the lessons learned and insights gained from your experiences in the space market?