SDG9 Future of Space
MM4:Space Innovation and Enterprise

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Experimentation and Exploration

Lesson 3 Exploring Space Entrepreneurship

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

Lesson Title and Summary: Exploring Space Entrepreneurship

IIn this lesson, learners will explore the entrepreneurial aspects of commercialising space, including identifying opportunities, overcoming challenges, considering the implications and developing innovative business solutions.

The lesson builds the foundation for a deeper understanding of the entrepreneurial aspects of commercialising space and inspires learners to explore career opportunities in space entrepreneurship.

The lesson will support learners to see the significance of entrepreneurship in driving innovation, investment, and economic growth in the space industry, including the role of startups and private ventures in advancing space exploration.

Vocabulary: Business Models, Competitive Advantage, Market Demand, Open Source Space, Space Entrepreneurship, Start-ups

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: What is Space Entrepreneurship?
- Teacher's Guide: What is Space Entrepreneurship?
- Paper / pens
- AV equipment
- Computers with internet access

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Activity Instructions

Activity 1: What is Space Entrepreneurship? (25 mins)

1. In pairs, ask learners to complete part 1, Worksheet: What is Space Entrepreneurship?, defining key terms in their own words.
2. Learners will have to divide up the tasks to ensure they finish the activity in the time allocated
3. Ask learners to type their definitions into a shared document in the e-classroom e.g. Microsoft Teams or Google Drive or shared space to develop a 'hive mind' glossary.

Activity 2 Activity 2 What is Space Entrepreneurship? - Key Players (25 mins)

1. Ask learners to complete part 2, Worksheet: What is Space Entrepreneurship? - Key Players section - by researching two of five key entrepreneurial ventures.
2. Working in pairs, learners will select one of the companies/entrepreneurs each to research.
3. Ask learners to share the goals, achievements, and business strategies of two of these companies, to consider their role in disrupting the traditional space industry through innovation and enterprise.
4. Once learners have completed their research, they read should read each other's findings and discuss at least 2-3 of the following questions. This can also be done as a whole class activity.

    - 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 commercialisation 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?

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

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EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter lesson, complete Activity 1 only. Use any remaining time to summarise their learning and check their understanding or explore the case studies as preparation for the following lesson.

Option B: Complete Activity 1, and facilitate a brief discussion on what they have found out about the role of entrepreneurship in driving innovation and growth in the space industry.

Extension: For a longer lesson: Ask learners to share their insights related to their research on Space entrepreneurship. See Teacher's Guide for examples of deeper discussion questions.

Option B: Use their insights to initiate a discussion on the opportunities and challenges faced by space entrepreneurs, such as securing funding, navigating regulatory frameworks, and developing innovative technologies. See Teacher's Guide for examples of key prompt / discussion questions.

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

Case Studies:

- Space X - Elon Musk https://www.spacex.com/
- Rocket Lab USA https://www.rocketlabusa.com/
- Virgin Galaxy / Richard Branson https://www.virgingalactic.com/
- Blue Origin - Jeff Bezos (Amazon) https://www.blueorigin.com/
- ConsenSYS Space (open source space) https://www.consensys.space/

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

Local Trip / Expertise / Additional Work and Assessments

Invite a speaker from a company on the Enterprise Ireland Space Directory for a class zoom

Learners can explore Enterprise Ireland's Space Directory to select an Irish Space entrepreneurial company and consider their innovations, goals innovations and achievements and business strategies. This could be extended to a case study see supporting resources in MM2, Lesson 1. Learners can also assess the impacts positively and negatively of the businesses using the discussion questions in Lesson 1 from this module and present their findings using SDG 12 Future of Innovation and Enterprise, MM7: Media Communication module 1 - 4 https://www.muinincatalyst.com/innovation-media

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Activity 1 Concise Definitions of the Key Terms

KEY TERM	SHORT DESCRIPTIONS
Business Model	Frameworks that define how a company creates, delivers, and captures value, outlining its revenue streams and operational strategies.
Competitive Advantage	A unique edge that allows a business to outperform its competitors, often through cost efficiency, innovation, or differentiation.
Disruption	A significant change in an industry or market caused by innovative technologies or business models that challenge established norms and competitors.
Market Demand	The total quantity of a product or service that consumers are willing and able to buy at a given price over a certain period.
Open Source Space	Collaborative, publicly accessible space projects or technologies, where designs and data are shared openly for innovation and development.
Space Entrepreneurship	The pursuit of business opportunities in space-related industries, including innovation in satellite technology, space travel, and space-based services.
Space Exploration	The investigation and discovery of outer space through the use of astronomy, spacecraft, and technologies, with the goal of advancing scientific knowledge and understanding of the universe beyond Earth.
Space Innovation	The development of new technologies, processes, or solutions that advance the exploration, commercialization, or utilization of space.
Space Law and Regulation	Rules and laws governing industry practices, safety standards, and compliance, especially critical in space exploration and commercial activities.
Start-ups	Newly established companies, often focused on innovation and rapid growth, seeking to disrupt existing markets or create new ones.

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Activity 2 Case Study Achievements and Innovations / Disruptions

These companies have each disrupted the space industry in unique ways, from lowering costs and increasing access to space to introducing entirely new markets like space tourism and open-source space exploration.

SPACEX – ELON MUSK

- Reusable Rockets: SpaceX pioneered reusable rocket technology with the Falcon 9, dramatically lowering the cost of launching payloads into space.
- Private Human Spaceflight: SpaceX became the first private company to send astronauts to the International Space Station (ISS) with its Crew Dragon spacecraft.
- Starship Development: SpaceX is developing Starship, a fully reusable spacecraft designed for missions to the Moon, Mars, and beyond, aiming to make interplanetary travel feasible.
- Starlink Satellite Network: SpaceX launched the Starlink project, deploying a constellation of satellites to provide global high-speed internet access, especially in underserved regions.
- Disruption: SpaceX's innovations have pushed the space industry toward greater efficiency and commercial viability, challenging traditional government space agencies and competitors.

ROCKET LAB USA

- Small Satellite Launch Services: Rocket Lab developed the Electron rocket, specifically designed for small satellite payloads, making space access affordable and frequent for smaller missions.
- Reusability: Rocket Lab is advancing rocket reusability with plans to recover and reuse Electron's first stage, similar to SpaceX, but on a smaller scale.
- Photon Satellite Platform: Rocket Lab introduced Photon, a customisable satellite platform that enables businesses to send payloads to space without needing their own satellite infrastructure.
- Rapid, Frequent Launches: Rocket Lab offers a high cadence of launches with smaller, more flexible payloads, disrupting the industry by democratising access to space for startups and research institutions.
- Disruption: By focusing on small, cost-effective launches, Rocket Lab has opened space to more players and industries, making space missions more accessible.

RICHARD BRANSON / VIRGIN GALACTIC

- Space Tourism Pioneer: Virgin Galactic was the first company to focus on making space travel accessible to private individuals, launching the commercial space tourism industry.
- Suborbital Flights: Virgin Galactic’s SpaceShipTwo was designed to carry passengers on suborbital spaceflights, offering the experience of weightlessness and viewing Earth from space.
- Commercial Spaceport: Virgin Galactic built the world's first purpose-built commercial spaceport, Spaceport America, to support regular space tourism flights.

- Sustainable Space Travel: The company is focused on making space travel environmentally sustainable, with goals to minimise the environmental impact of suborbital flights.
- Disruption: Virgin Galactic disrupted the traditional perception of space exploration by positioning space as a potential consumer experience, expanding the space economy into the tourism sector.

CONSENSYS SPACE (OPEN SOURCE SPACE)

- Open-Source Space Technology: ConsenSYS Space promotes the use of open-source platforms for space exploration, offering public access to tools and data to foster global collaboration.
- Space Data Marketplace: They developed TruSat, a decentralised, community-driven system to track satellites, helping increase transparency and access to satellite data.
- Democratising Space Access: By advocating for open-source projects, ConsenSYS Space seeks to make space technology accessible to non-governmental players, including private individuals and small organisations.
- Blockchain in Space: They integrate blockchain technology to create decentralised systems for space data sharing and collaboration, enabling trust and transparency in space operations.
- Disruption: ConsenSYS Space challenges traditional space ownership and control by opening space exploration and data access to a wider audience, beyond corporations and governments.

BLUE ORIGIN – JEFF BEZOS

- Reusable Rocket Technology: Blue Origin developed the New Shepard rocket, capable of vertical takeoff and landing, with a focus on reusability, similar to SpaceX's model.
- Commercial Space Travel: The company is working on suborbital space tourism, offering commercial flights for private individuals aboard New Shepard.
- New Glenn: Blue Origin is developing New Glenn, a heavy-lift orbital rocket designed to rival SpaceX's Falcon Heavy, aimed at launching large payloads into space.
- Vision for Space Habitats: Blue Origin's long-term vision includes enabling millions of people to live and work in space, with plans for space habitats and colonies.
- Disruption: Blue Origin has challenged existing space companies by combining reusability, a long-term vision for space colonisation, and a focus on space tourism, contributing to the commercial shift in the space industry.

Activity 2 Case Study Discussion Questions

SpaceX – Elon Musk

- How has SpaceX changed the space industry with its reusable rocket technology, and what do you think this means for the future of space exploration?

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- What role does private industry play in space exploration today compared to government agencies like NASA?
- What are some challenges SpaceX might face in making space travel accessible to the public, and how could they overcome them?
- SpaceX plans to colonise Mars. What are the potential benefits and risks of this plan for humanity?
- Do you think space exploration should prioritise technological innovation or focus on environmental and ethical concerns? Why?

Rocket Lab USA

- What makes Rocket Lab's small satellite launch services unique in the space industry, and how does it compare to larger companies like SpaceX?
- Why do you think small satellites and cheaper launch services are important for science, business, and global communications?
- Rocket Lab focuses on frequent, lower-cost launches. How do you think this could impact industries beyond space exploration?
- How could Rocket Lab’s Electron rocket, designed for smaller payloads, contribute to global access to space?
- What role do you think smaller companies like Rocket Lab play in the global space race compared to giants like SpaceX or Blue Origin?

Richard Branson / Virgin Galactic

- Virgin Galactic aims to bring space tourism to the public. What are the potential benefits and drawbacks of making space travel a luxury experience?
- Do you think space tourism should be a priority for the space industry, or should efforts focus more on exploration and scientific research? Why?
- What are the environmental impacts of space tourism, and how could companies like Virgin Galactic reduce them?
- How could commercial space tourism shape the future of human presence in space, and what societal changes might come from it?
- If given the opportunity, would you want to travel to space as a tourist? Why or why not?

ConsenSYS Space (Open Source Space)

- How does the idea of open-source space exploration differ from traditional space exploration approaches by companies like SpaceX or NASA?
- What are the benefits and potential risks of making space technology and data openly accessible to the public?
- How could open-source collaboration, like ConsenSYS Space, help democratise space exploration and make it accessible to more people and countries?
- Do you think open-source space projects will speed up or slow down space innovation? Why?

ConsenSYS Space (Open Source Space)

5. How could open-source space technologies contribute to solving global challenges on Earth, like climate change or internet access?

Blue Origin – Jeff Bezos

1. How does Blue Origin's vision of building space habitats and creating a space-based economy compare with other companies' goals, such as SpaceX's colonisation of Mars?
2. Do you think Jeff Bezos' focus on space tourism and developing a space economy is realistic or too ambitious? Why?
3. How can companies like Blue Origin ensure the long-term sustainability of space resources and prevent exploitation?
4. What challenges do you think Blue Origin will face in achieving its goal of making space travel more affordable and accessible?
5. Blue Origin envisions millions of people living and working in space. What impact could this have on Earth's society, economy, and environment?

This activity can also be supported with resources from Lesson 1, extension activity - impact.

Extension Activity

Lesson 1 Extension Activity: Use these questions to facilitate a discussion on the opportunities and challenges faced by space entrepreneurs, fostering critical thinking and deeper understanding among learners. These questions can also be set as a research activity focused on Ireland.

Securing Funding:

- What are some common sources of funding for space entrepreneurship ventures?
- How do space entrepreneurs attract investors and secure funding for their projects?
- What are the main challenges space entrepreneurs face when seeking funding, and how can they overcome these challenges?

Navigating Regulatory Frameworks:

- What are some of the regulatory bodies and frameworks that govern space activities?
- How do space entrepreneurs navigate regulatory hurdles and ensure compliance with international and national space laws?
- What are some potential risks and consequences of non-compliance with space regulations, and how can space entrepreneurs mitigate these risks?

Developing Innovative Technologies:

- What role does innovation play in the success of space entrepreneurship ventures?
- What are some examples of innovative technologies developed by space entrepreneurs, and how have these technologies transformed the space industry?

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- What are the main challenges space entrepreneurs face in developing and implementing innovative technologies, and how can they address these challenges?

Market Demand and Competition:

- What factors influence market demand for space-based products and services?
- How do space entrepreneurs identify and assess market opportunities in the space industry?
- What are some strategies space entrepreneurs use to differentiate their offerings and stay competitive in the market?

International Collaboration and Partnerships:

- How important is international collaboration in the success of space entrepreneurship ventures?
- What are some examples of successful partnerships between space entrepreneurs and international space agencies or organisations?
- What are the benefits and challenges of collaborating with international partners, and how can space entrepreneurs maximise the benefits while mitigating the challenges?

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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	

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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/		

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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/		