SDG9 Future of Space
MM4:Space Innovation and Enterprise

MM4: Space Innovation and Enterprise

Experimentation and Exploration

Lesson 8 Engineering Space Tourism

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

Lesson Title and Summary: Engineering Space Tourism

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

Learners will undertake an individual analysis and then a collaborative comparative analysis of three commercial spacecraft and their specifications. Learners will research the spacecraft's key features, capabilities, and technologies utilised in each spacecraft, such as propulsion systems, aerodynamics, and crew safety.

This lesson can be delivered as a stand alone lesson or used as the scaffolding lesson for a linked lesson, Lesson 9, that supports learners to imagine and plan their own space venture.

Vocabulary: Civilian Space Flight, Commercialisation, Launch Systems,

In this lesson, the learner will:

- gain insight into the emerging space tourism industry.
- gain insights into the design and engineering involved in
- explore the potential for civilian space travel in the near future.
- investigate the ethical dilemmas associated with commercialising space for tourism.
- engage in discussions to cultivate critical thinking and creativity in approaching space challenges.

Materials

- Worksheet: Engineering Space Tourism
- Teacher's Guide: Engineering Space Tourism
- Paper / pens
- AV equipment
- Computers with internet access

MM4: Space Innovation and Enterprise
L8 Engineering Space Tourism

Activity Instructions

Activity 1: Exploring Commercial Spacecraft (25 mins)

1. Working in pairs, assign numbers 1 - 3 in rotation until all pairs in the class have a number.
2. Learners' will research their assigned commercial spacecraft designed for civilian space travel, depending on their number using Worksheet: Engineering Space Tourism.Learners should use official websites, news articles and scientific publications to gather information on the space crafts specifications.
3. Use a timer to allow learners 10 mins to research their assigned spacecraft.
4. On completion, learners should find another pair with a different spacecraft and share their findings, compare notes.
5. Ask learners to identify similarities and differences between the spacecraft.
6. Depending on time, also ask learners, with the the same assigned spacecraft to share their findings with the class to see if they have the same findings. This can be carried out as a verbal 'round-robin'.

Activity 2: Future possibilities, Challenges and Opportunities (25 mins)

1. Working in the same pairs, learners should choose another spacecraft to research.
2. Using Worksheet: Future Possibilities and Opportunities to complete a second table.
    - Learners will focus on the future plans, developments and upgrades that the companies are planning.
    - Learners will consider the ethics and sustainability of the ventures based on what they have learned
3. Use the remaining time to discuss the learners' perspectives on space tourism.
4. If undertaking lesson 9, ask learners to begin thinking about what sort of Space Tourism venture they might create, this can be playful and creative, exploring the following questions e.g.
    - where will it go, does it have a name?
    - who lives there?
    - what will tourists do?

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
L8 Engineering Space Tourism

EXTENSION / REDUCTION ACTIVITIES

Reduction: For a shorter lesson, complete Activity 1 only

Extension: For a longer lesson, host a walking debate with 3 or 4 questions to expand learners' critical thinking. Some key questions could be around the environmental impact, equitable access, responsible tourism or ethical integrity of the venture e.g.

- Should businesses be legally required to prioritise environmental sustainability over profit, even if it means higher costs for consumers?
- Is it fair for advanced technologies to be available only to wealthy countries or individuals, or should access to innovation be a global right?
- Should certain natural or cultural sites be off-limits to tourists to preserve them, even if it limits economic opportunities for local communities?
- Can a company truly be considered ethical if its business practices benefit some people but harm others in different parts of the world?

See Teacher's Guide for more prompt questions

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

Virgin Galactic launches civilian crew to edge of space in historic flight [2:17] https://www.youtube.com/watch?v=JVa1Ntq5hjQ

First all-civilian space crew blasts off on SpaceX rocket [2:53 mins] https://www.youtube.com/watch?v=Bh6K1KylFgo

New Shepard Human Flight History [2.23] https://www.youtube.com/watch?v=dgAXeB16SoY

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

Local Trip / Expertise / Additional Work and Assessments

Explore ESA's Enterprise Ireland's Irish Space Directory and research any of the organisations who are using open source principles, software or working as collaborative communities.

Learners could also create a presentation highlighting the unique strengths and weaknesses of their assigned spacecraft and provide insights into the broader landscape of commercial spaceflight.

MM4:8TG ENGINEERING SPACE TOURISM

Engineering Space Tourism: Space Craft Background

SpaceX's Crew Dragon:

- SpaceX's Crew Dragon, also known as Dragon 2, is a crewed spacecraft developed by SpaceX, the aerospace company founded by Elon Musk. It is designed to transport astronauts to and from the International Space Station (ISS) as part of NASA's Commercial Crew Program. Crew Dragon is equipped with advanced safety features, including an abort system that can quickly propel the spacecraft away from the rocket in the event of an emergency. It made its maiden uncrewed test flight, Demo-1, in March 2019, followed by the Crew Dragon Demo-2 mission in May 2020, which marked the first crewed flight of the spacecraft and the first crewed launch from American soil since the Space Shuttle program ended in 2011.

Blue Origin's New Shepard:

- New Shepard is a suborbital spacecraft developed by Blue Origin, an aerospace company founded by Jeff Bezos, the CEO of Amazon. Named after astronaut Alan Shepard, the first American to journey into space, New Shepard is designed for space tourism and suborbital research missions. The spacecraft consists of a crew capsule mounted on top of a reusable rocket booster. It is capable of carrying up to six passengers to the edge of space, where they experience a few minutes of weightlessness before returning to Earth. New Shepard has completed multiple successful test flights since its first launch in April 2015, demonstrating its reliability and safety for future commercial operations.

Virgin Galactic's Spaceship Two:

- SpaceShipTwo is a suborbital spaceplane developed by Virgin Galactic, a spaceflight company founded by Sir Richard Branson. It is designed to carry paying passengers on brief journeys into space, offering them the opportunity to experience weightlessness and observe the curvature of the Earth from above. SpaceShipTwo is launched from a carrier aircraft, WhiteKnightTwo, at high altitude before igniting its rocket engine to ascend to the edge of space. Once in space, the spacecraft's passengers are able to unstrap from their seats and float freely in the cabin for a short period before returning to Earth. Virgin Galactic has conducted numerous test flights of SpaceShipTwo, with plans to begin commercial operations in the near future.

MM4:8TG ENGINEERING SPACE TOURISM

List of debate and additional discussion questions

These questions can serve as a starting point for discussions and considerations regarding the sustainability and ethics of space tourism, encouraging thoughtful reflection and dialogue on these important topics.

Environmental Impact:

- Debate Question: Does space tourism contribute to environmental degradation, such as carbon emissions from rocket launches and space debris accumulation in Earth's orbit?
- Discussion questions: What measures can space tourism companies implement to minimise their environmental footprint, such as developing greener propulsion technologies or offsetting carbon emissions?
- How might the preservation of Earth's delicate ecosystems be balanced with the pursuit of space exploration and tourism?

Equitable Access:

- Debate Question: Space tourism should be more accessible to a broader and more diverse range of people, including those from underrepresented communities and developing countries?
- Discussion Questions: What barriers currently exist that prevent equitable access to space tourism, such as high costs, technological barriers, or geographic disparities?
- How can space tourism companies promote inclusivity and diversity within their workforce and customer base, ensuring that everyone has the opportunity to participate in the spacefaring experience?

Cultural Preservation:

- Debate Question: Does Space Tourism impact indigenous communities, cultural heritage sites, and sacred landscapes on Earth and potentially in space?
- Discussion Questions: What steps can space tourism operators take to respect and preserve cultural diversity, traditions, and heritage sites in the regions where they operate?
- How can space tourism contribute to cultural exchange, education, and appreciation of diverse cultures, languages, and traditions?

Responsible Tourism Practices:

- Debate Question: Should space tourism companies engage more with local communities and stakeholders to ensure that their activities benefit rather than harm the communities / places they launch from?
- Discussion questions: What ethical considerations should space tourists and operators keep in mind when visiting celestial bodies, such as the Moon or Mars, to avoid contamination, interference with scientific research, or damage to pristine environments?
- What codes of conduct or guidelines should govern space tourism activities to promote responsible behavior, safety, and sustainability in space and on Earth?

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?