SDG9 Future of Space
MM4:Space Innovation and Enterprise

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Experimentation and Exploration

Lesson 7 Exploring Open Innovation In Space

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

Lesson Title and Summary: 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.

In this lesson, learners will consider how collaboration, sharing knowledge and open source principles for design and innovation within space enterprise and entrepreneurship is beneficial. Learners will consolidate their learning by undertaking a rapid prototyping activity, to apply their learning by working as a team to iterate one of the ideas from the real-world examples.

Vocabulary: Decentralisation, Democratisation, Innovation, Open Source, Rapid Prototyping

In this lesson, the learner will:

- introduce the concept of open-source and collaborative communities in space enterprise and entrepreneurship, driving innovation and democratising access to space technology and resources.
- understand the significance of collaboration and open-source principles in the space industry.
- explore examples of successful open-source projects and collaborative communities in space enterprise and entrepreneurship.
- analyse the advantages of decentralised innovation and knowledge sharing in space exploration.

Materials

- Worksheet: Open Innovation in Space
- Worksheet: Open Innovation in Space - Projects
- Teacher's Guide: Open Innovation in Space
- Limited selection of crafting materials e.g. selection of cardboard (colour and texture), scissors, tape or glue
- Paper / pens
- AV equipment
- Computers with internet access

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Activity Instructions

Activity 1: Open Innovation in Space (25 mins)

1. Using the Teacher's Guide: Open Innovation in Space, introduce the concept of open innovation and open source production and collaborative communities in space innovation and enterprise, driving innovation and democratising access to space technology and resources.
2. Alternatively, use the video: What is Open Innovation (4:11mins]
3. Working in pairs, ask learners to complete the Worksheet: Open Innovation in Space and using the companion Worksheet: Open Innovation in Space - Projects complete the tasks to help them gather information for Activity 2.
4. Remind learners they may need to split the task between them to enable them to complete the task in the time given.
5. Briefly summarise and discuss the advantages of open collaboration, knowledge sharing, and decentralised innovation in the space industry.

Activity 2: Rapid Prototyping - Space Challenge (25 minutes)

1. As a class, watch the Video: Rapid Prototyping [2:37] to see the steps in the process learners will use this to develop a rapid prototype. See also the Teacher's guide for additional support.
2. Working in pairs, ask learners to select one of the project examples from activity 1. This can be the one that interests them most or this can be randomly assigned. They will use this selection to create a rapid prototype.
3. Learners will have 20 mins after listening to the video to create a rapid prototype - the task is deliberately restricted by time and materials. This helps learners understand the concept of working quickly and using materials to show an idea to help others understand their vision.

- 10 mins to plan - use a timer
- 10 mins to build - use a timer

4. Use the reflection period to ask learners to present their prototype to another pair using the 321 method to focus their presentation to each other e.g. they share three things they learnt from the task, 2 things they found most interesting and their opinion about the activities.

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 and ask learners to share their example and one of the ways in which the example helps define one of the concepts from the table.

Extension: For a longer lesson, learners choosing the same example from Activity 1 can come together to discuss their prototype from Activity 2 with each other and how they could improve their ideas. Allow 10 minutes for this and at the end of the time ask the larger groups to share their iteration / improvements and how they think working as a team would be beneficial for innovation in the space industry.

Option B: Allow learners time to improve their prototype based on peer feedback or their experience of assessing their Rapid Prototype as a group, without the pressure of a timer. This helps to embed the concept of iteration and testing, two key phases in the Design Thinking process.

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

What is Open Innovation?[4:11mins] https://www.youtube.com/watch?v=GD2wCS2xwWQ

Rapid Prototyping [2:37] https://www.youtube.com/watch?v=oDdOqLblmVQ

Formlabs, Rapid Prototyping [5:11 mins] https://www.youtube.com/watch?v=-TDn25K-Jh4

Sprouts, The Design Thinking Process [3:56 mins] https://www.youtube.com/watch?v=_r0VX-aU_T8

Everything I knew about Open Source, Ben Cotton https://opensource.com/article/18/2/spacex

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.

Invite a guest speaker from a space-related organisation or initiative that embodies the principles of open collaboration and innovation e.g.CubeSat project learners can explore the challenges and opportunities associated with open collaboration in the space industry.

MM4: 7TG INTRODUCTION TO OPEN SOURCE INNOVATION IN SPACE

Introduction to Open Innovation and Open Source

Background Videos: Use these short videos to developing an understanding of Open Innovation and Open Source so you can briefly introduce key ideas at the start of the class.

You can also share then with you class and watch them together depending on time available or if you do flipped class rooms you can ask them to watch at home in advance of the next class.

What is open Innovation? https://www.youtube.com/watch?v=GD2wCS2xwWQ - gives an overview of Open Innovation, including the models of Open Innovation

What Is Open Source? | An introduction to open technology https://www.youtube.com/watch?v=Po-WbVjPxCI Breaks down exactly what open source is, highlight the differences between the levels of projects, and give you some encouragement for what to look for when you're ready to start contributing to a project.

Open Source & Innovation: Key Differences and Everyday Examples in 60seconds https://www.youtube.com/watch?v=UoE6I9vrXRI Short video sharing simply the difference between these two key terms, which although closely linked have key diferences

Lego Ideas - https://ideas.lego.com/ enables Lego creators to share their creations and creativity, enter challenges, showcase their proposals for new LEGO Ideas sets and vote for awesome models dreamt up by fellow fan designers

Activity 1: The aim is to keep students engaged and learning through exploration, while you serve as a guide rather than a content provider. After a brief explanation of the task that this is about learning through discovery and research, not memorisation. It is important that they undersand the key tasks so although it is on their worksheet; stating clearly and clarifying expectations will be useful. Key tasks are as follows:

- Research each concept.
- Find relevant examples using the links or internet searches.
- Write a short explanation connecting the concept to an example.

Let them know they will spend approximately 15 minutes researching and 10 minutes writing as this can help them manage their time while understanding how much is required. Even though there are set examples encourage them to do some additional independent research

As you monitor the room, you can check in on progress, making sure students are engaging with the resources and support them without solving it for them, using open-ended questions and encourage critical thinking e.g.

- What do you think this concept might mean? or
- Have you tried looking at the provided links?
- How does this example show democratisation?" to push deeper understanding.

Encourage learners to collaborate once they have done some research, written their explanations. If you have more time you can ask them to group together in fours and share and compare their findings.

After 15 minutes of research, remind students to start writing their explanations, if they haven't already done so - calrifying they should write 1-2 sentences for each concept, linking it to an example. Again depending on time available learners could briefly share one example they found interesting with the class.

Tips

- Foster Engagement: Promote the use of different resources, and encourage students to cross-check information they find online.
- Keep Time in Mind: Make sure students stay on track and remind them of time checkpoints.

Activity 2 Rapid Prototyping

This activity helps learners experience the speed and adaptability of rapid prototyping in a practical, engaging way. After watching the video Ensure learners understand the key steps of rapid prototyping (planning, building quickly, using simple materials).

Make sure Learners understand they are to select one project from Activity 1 (CubeSat, Open Lunar Foundation, etc.) as inspiration in which they will create a rapid prototype, using the skills from the video to show an improvement to the project they have selected e.g. cubesats can are small and easy to make and cheap to launch and used for low orbit purposes remote sensing, weather monitoring - so an iteration could be design a Cubesat kit that could enable schools to design a moon mission, or monitor space debris. A prototype could show scale, functionality or design and will help them visualise their idea and share with others.

Emphasise time limits and simple materials to simulate real-world constraints and set a timer for 10 minutes. This is their planning time they can sketch, outline and discuss their ideas on how they will represent their idea visually and practically, ensure pairs are discussing and sharing ideas effectively. They will answer the questions on the Worksheet: Open Innovation in Space - Projects to help them plan their prototype. You can project the questions on the next page to help them plan their prototype

When the timer goes of, set a second 10-minute timer - this is their building phase. Learners build their prototype using basic materials (paper, cardboard, markers, etc.). After the timer ends, ask pairs to briefly present their prototype to another pair or to the class. Remind learners to focus on showing their idea, not on perfection.

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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.

In this instance, learners can share with a pair and use the 321 method to focus their feedback.

MM4: 7WS INTRODUCTION TO OPEN SOURCE INNOVATION IN SPACE

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

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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

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.
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MM4: 7WSB OPEN INNOVATION SPACE PROJECTS

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