Life Support Systems Solutions from Space for Earth

Sofia Figueiredo dos Santos & Elena Maria Campanaro

25/09/2025

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ESA Academy

Development of

expertise, know-how &

standard professional practice

in the space activities domain

ESA **Academia** **Industry**

University Students

from ESA Member States, Latvia, Lithuania, Slovakia and Canada

ESA Academy

Training

TRAINING SESSIONS
- Onsite
- Hybrid
- Online

ESA e-Learning Platform
->learn.esa.int

Projects

EXPERIMENTS
- Parabolic Flights
- Orbital Robotics Laboratory
- Space Rider
- ICECubes ISS Facility
- REXUS/BEXUS

SATELLITES
- Fly Your Satellite!
- Fly Your Satellite! Test Opport.
- Fly Your Satellite! Design Booster

ROCKETS
- Fly a Rocket

Engagement

SCHOLARSHIPS
- Summer schools
- Academic programmes

INTERNSHIPS

CONFERENCES
- Student sponsorships
- European Space Education Conference

OTHER LEARNING OPPORTUNITIES
- Downstream hackathons
- Student Aerospace Challenge
- European Rocketry Challenge
- External partners' training courses

Life Support Systems Solutions from Space for Earth

- Developed by ESA's Education Office
  - in collaboration with the Life Support and Physical Sciences Instrumentation Section
  - with the support of the Commercialisation Department
- Two-week training session ran from 10 to 21 March 2025
  - First week held onsite, at ESEC-Galaxia, and the second week online
- Delivered by 12 trainers coming from ESA, Academia and Industry

Objective

- To explore how space-based life support systems can inspire sustainable solutions on Earth

Eligibility Criteria

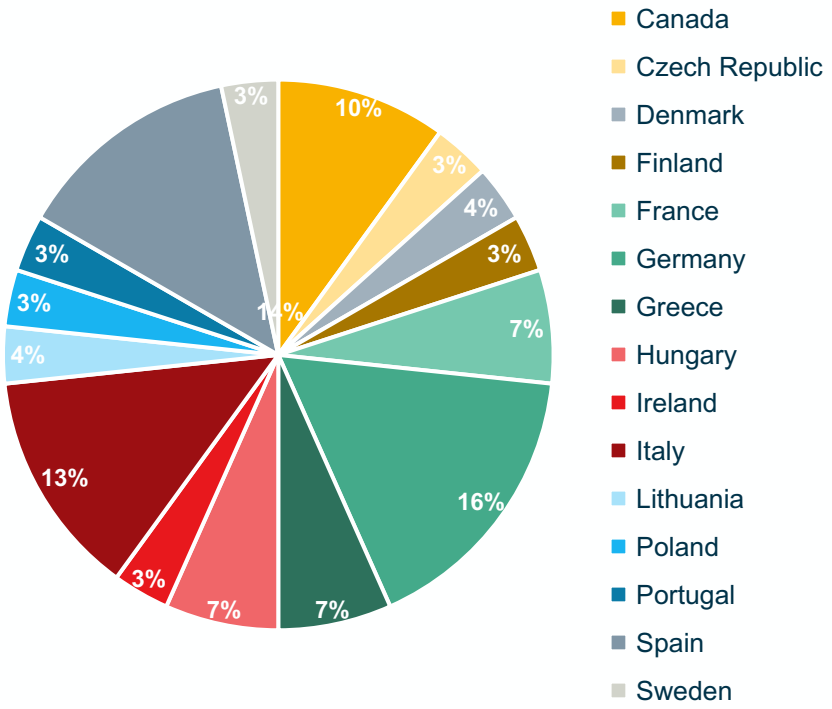
To participate, students had to fulfil the following criteria at the time of application:

- aged minimum 18 years old. ESA Academy and relevant partners will only appraise applications from students who have **no or limited professional experience in relevant engineering or space-related topics**;
- be a citizen of an ESA Member State, Canada*, Latvia, Lithuania, and Slovakia;
- be enrolled as a **Bachelors, Master or Ph.D. student** in an university (not graduating before the training course);
- **be studying an engineering, science, business, or environmental sciences-related subject**. Students from interdisciplinary programmes combining STEM elements are also welcome.
- have a basic understanding of biochemical reactions, ecological and biological systems, and an interest in space technology and sustainability.

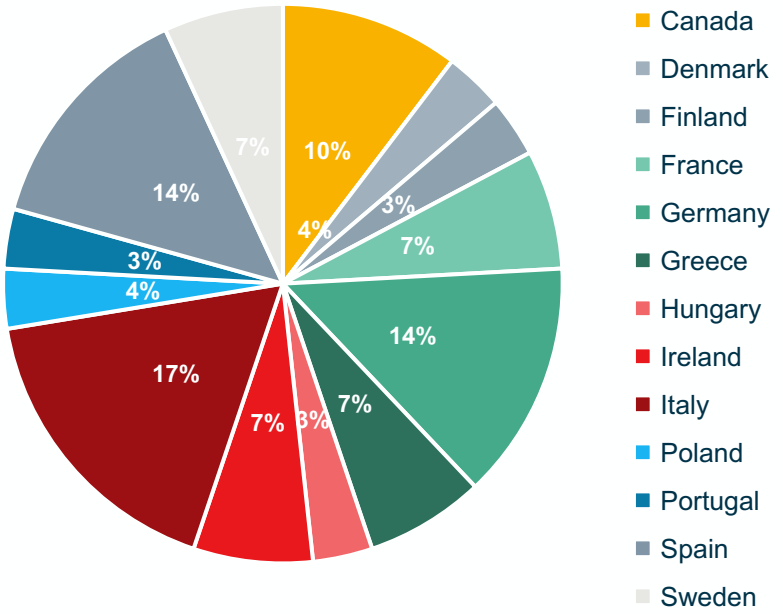
Profile of Students

- **30** University Students
- **14** ♀ and **16** ♂

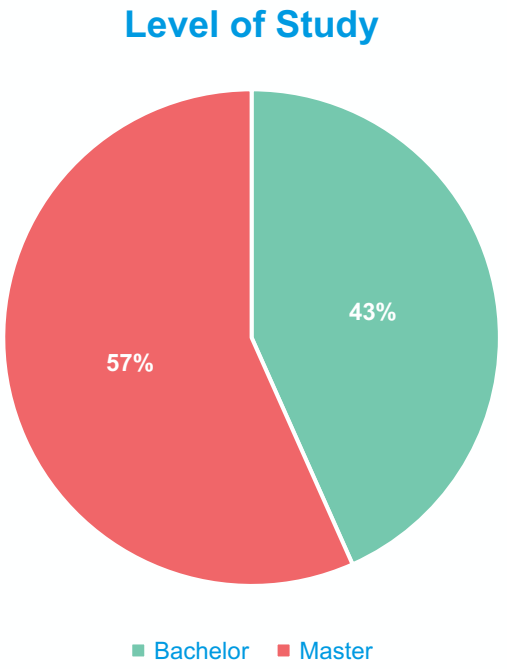
15 Nationalities



13 University Countries



Profile of Students



Bachelor Students' Fields of Study

Current Fields of Study

- Engineering
- Natural Sciences
- Business
- IT

Additional Degrees Held

Chemistry, Psychology, Biochemistry, Bioinformatics

Master Students' Fields of Study

Current Fields of Study

- Engineering (Aerospace, Mechanical, Space Systems)
- Life Sciences & Environment (Biomedicine, Ecology, Biotechnology)
- Urban Development
- Management Studies

Additional Degrees Held

Business Administration, Economics, Civil Engineering, Space Sciences

Schedule – 1st Week @ESEC

From	To	Monday 10/03/2025	Tuesday 11/03/2025	Wednesday 12/03/2025	Thursday 13/03/2025	Friday 14/03/2025	From	To
08:00	08:15	Bus to ESEC-Galaxia					08:00	08:15
08:15	08:30	Security check	Bus to ESEC-Galaxia	Bus to ESEC-Galaxia	Bus to ESEC-Redu	Bus to ESEC-Galaxia	08:15	08:30
08:30	08:45	Welcome and Introduction	MELiSSA C4B Higher Plant Compartment	Commercialisation of Technology and Data Beyond Space	Visit of ESEC-Redu	MELiSSA Case Studies: VUNA NEXUS & Hydrohm	08:30	08:45
08:45	09:00						08:45	09:00
09:00	09:15						09:00	09:15
09:15	09:30	Introduction to Environmental Control and Life Support Systems					09:15	09:30
09:30	09:45						09:30	09:45
09:45	10:00				Bus to ESEC-Galaxia		09:45	10:00
10:00	10:15	Break	Break	Break	Break	Break	10:00	10:15
10:15	10:30						10:15	10:30
10:30	10:45	Introduction to Closed-Loop Environmental Control and Life Support Systems	MELiSSA C1 Thermophilic anaerobic bacteria	Technology Transfer Methodologies	Introduction to Entrepreneurship and Business Incubation and New Venturing Creation	Team Work	10:30	10:45
10:45	11:00						10:45	11:00
11:00	11:15						11:00	11:15
11:15	11:30	MELiSSA Project and Applications					11:15	11:30
11:30	11:45						11:30	11:45
11:45	12:00						11:45	12:00
12:00	12:15	Lunch	Lunch	Lunch	Lunch	Lunch	12:00	12:15
12:15	12:30						12:15	12:30
12:30	12:45						12:30	12:45
12:45	13:00	MELiSSA Project and Applications	MELiSSA C2 Microbial Electrolysis Cell	Ideation Workshop	Team Work	Presentations Set-Up	12:45	13:00
13:00	13:15					Presentation - Team 1 + Q&A	13:00	13:15
13:15	13:30						13:15	13:30
13:30	13:45	Team Project Assignment				Presentation - Team 2 + Q&A	13:30	13:45
13:45	14:00	MELiSSA C5 CREW		Team Work			13:45	14:00
14:00	14:15					Presentation - Team 3 + Q&A	14:00	14:15
14:15	14:30		MELiSSA C3 Nitrification Transformation				14:15	14:30
14:30	14:45					Presentation - Team 4 + Q&A	14:30	14:45
14:45	15:00						14:45	15:00
15:00	15:15			Break	Break	Break	15:00	15:15
15:15	15:30	Break					15:15	15:30
15:30	15:45			Check-In + Team Work + livestream to remaining trainers) 15:30-15:55 Check-in Team 1 15:55-16:20 Check-in Team 2 16:20-16:45 Check-in Team 3 16:45-17:10 Check-in Team 4 17:10-17:35 Check-in Team 5 17:35-18:00 Check-in Team 6	Team Work	Presentation - Team 5 + Q&A	15:30	15:45
15:45	16:00	MELiSSA C4A MicroAlgae and Photoreactor	Break				15:45	16:00
16:00	16:15					Presentation - Team 6 + Q&A	16:00	16:15
16:15	16:30		Design a Mini Closed-Loop System				16:15	16:30
16:30	16:45					Wrap-Up	16:30	16:45
16:45	17:00					Conclusion	16:45	17:00
17:00	17:15						17:00	17:15
17:15	17:30	Team Work					17:15	17:30
17:30	17:45						17:30	17:45
17:45	18:00						17:45	18:00
18:00	18:15	Bus to the hotel	Bus to the hotel	Bus to the hotel	Bus to the hotel	Bus to the hotel	18:00	18:15

Lecture
Visit
Group Project
Logistics
Workshop

Schedule – 2nd Week Online

From	To	Monday 17/03/2025	Tuesday 18/03/2025	Wednesday 19/03/2025	Thursday 20/03/2025	Friday 21/03/2025	From	To
08:30	08:45						08:30	08:45
08:45	09:00						08:45	09:00
09:00	09:15					Deadline slides	09:00	09:15
09:15	09:30						09:15	09:30
09:30	09:45					Introduction	09:30	09:45
09:45	10:00					Final Pitch - Team 1	09:45	10:00
10:00	10:15	Team Work (Webex breakouts)	Team Work, including Tutor Session 1	Team Work	Team Work, including Tutor Session 2		10:00	10:15
10:15	10:30						10:15	10:30
10:30	10:45					Break	10:30	10:45
10:45	11:00					Final Pitch - Team 2	10:45	11:00
11:00	11:15						11:00	11:15
11:15	11:30						11:15	11:30
11:30	11:45					Break	11:30	11:45
11:45	12:00					Final Pitch - Team 3	11:45	12:00
12:00	12:15	Team Project Status Update	Team Project Status Update	Team Project Status Update	Team Project Status Update		12:00	12:15
12:15	12:30						12:15	12:30
12:30	12:45					Lunch	12:30	12:45
12:45	13:00						12:45	13:00
13:00	13:15						13:00	13:15
13:15	13:30						13:15	13:30
13:30	13:45					Final Pitch - Team 4	13:30	13:45
13:45	14:00						13:45	14:00
14:00	14:15						14:00	14:15
14:15	14:30					Break	14:15	14:30
14:30	14:45					Final Pitch - Team 5	14:30	14:45
14:45	15:00						14:45	15:00
15:00	15:15						15:00	15:15
15:15	15:30					Break	15:15	15:30
15:30	15:45					Final Pitch - Team 6	15:30	15:45
15:45	16:00						15:45	16:00
16:00	16:15						16:00	16:15
16:15	16:30					Break	16:15	16:30
16:30	16:45					Conclusion	16:30	16:45
16:45	17:00						16:45	17:00

Lecture
Visit
Group Project
Logistics
Workshop

Team Project

Objectives

- **Develop and analyse an idea** for a Space for Earth application
- **Structure and refine your idea** to explore the potential for a commercial business application.
- **Validate your business thesis** with relevant stakeholders
- **Communicate** your findings and potential business **in a pitch**

Outline

1. **Ideation workshop (Week 1)**
    - Brainstorm ideas to create meaningful impact with MELiSSA know-how or technologies on Earth
    - Use Technology Transfer Canvas & Value Proposition Canvas to down-select ideas
2. **Refine ideas to business models (Week 1-2)**
    - Utilise the Business Model Canvas to shape your start-up / spin-off idea
3. **Validate your business model thesis (Week 2)**
    - Get feedback stakeholders and potential customers to validate your business idea
4. **Pitch your idea and business model thesis incl. your validation outcome (Week 2)**

Team Project

Evaluation

- **Innovation**
  - Assessment of the originality and uniqueness of the business idea
- **Feasibility**
  - Evaluation on the practical implementation of the proposed product/service
- **Potential Impact**
  - Assessment on the expected outcomes and benefits of the business model
- **Validation Approach**
  - Suitability of the strategy and method to validate the idea for a business model

Outcomes – Teams' Projects

ILSA	A low-cost anaerobic digester for greenhouses, converting organic plant waste into energy, heat, carbon dioxide, and liquid fertiliser.
VJTAL	A system that transforms organic hospital waste into cold atmospheric plasma, which could later be used for sterilisation within the same hospital.
FarmLoop	A farming waste management solution that uses Black Soldier Fly larvae to process animal manure, converting it into valuable resources such as energy and soil amendments.
Cyano Brix	A system that leverages cyanobacteria to capture carbon dioxide (CO_2) and convert it into calcium carbonate ($CaCO_3$), which can be utilized in sustainable cement production.
DRUiD	A modular, self-sustaining system that converts urine into clean water and sellable byproducts, designed for isolated communities and/or maritime vessels.
TERRA	A waste-to-energy solution that uses Microbial Fuel Cells (MFCs) to convert brewery organic waste and wastewater into electricity, supporting sustainability in the brewing industry.

Feedback

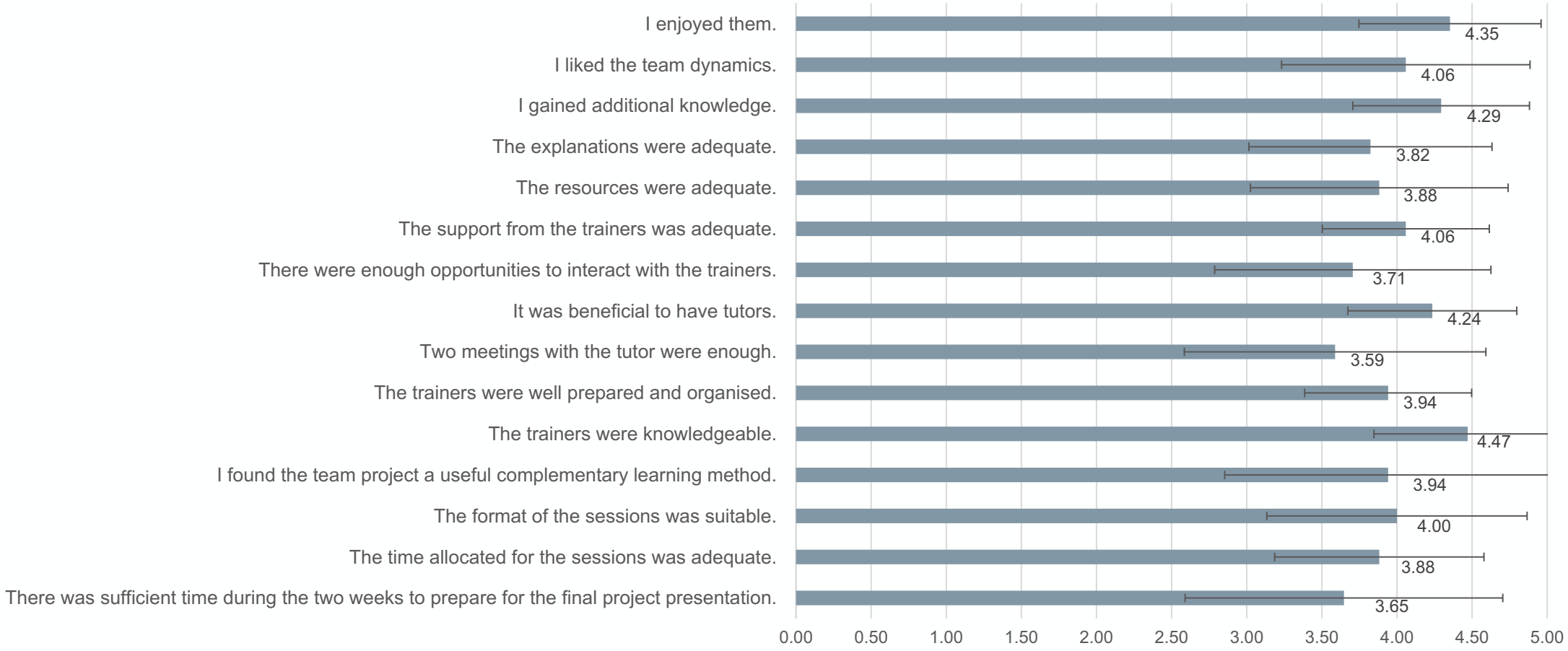
Students Feedback - 17/30 completed

General Impression of the Event

Feedback

Students Feedback - 17/30 completed

General Impression of the Team Project sessions



Feedback & Way forward

Call for Applications

- Highlight the **business-oriented nature** of the course to align participants expectations

Lectures

- Add **quizzes and exercises** to boost engagement and lighten the lecture heavy days
- On the Compartments' lectures, shift slightly toward **technology and real-world applications,** offering practical insights beyond scientific theory
- Include a MELiSSA loop slide at the start of each lecture to serve as a visual anchor, and provide thematic continuity

Schedule

- Move **online sessions to the afternoon** to accommodate participants in Canadian time zones, among others
- Space the two course weeks **2 to 3 weeks apart** to allow time for better idea validation with stakeholders
- Replace daily online sessions with **one-weekly check-in** for progress and tutor support

Workshop: Design a Mini Closed-Loop System

- Allocate more time for deeper design work and development of more robust solutions

Acknowledgments

We gratefully acknowledge all lecturers, tutors, and contributors who helped shape this course.

Special appreciation goes to:

- the **MELiSSA team**, for providing the conceptual framework and ongoing support
- **ESA's Commercialisation Department**, for designing and supporting the team project
- **VUNA NEXUS** and **Hydrohm**, for sharing their experience and lessons learned
- our **ESA Education colleagues**, for the organisation

Finally, thank you to the **participating students**, whose engagement and valuable input helped shape this first edition and will no doubt guide its evolution.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