Student Spaceflight Experiments Program

General Program Briefing

Revised February 3, 2020

National Center for Earth and Space Science Education
and the Arthur C. Clarke Institute for Space Education

Inspire…then Educate

SSEP Student Spaceflight Experiments Program

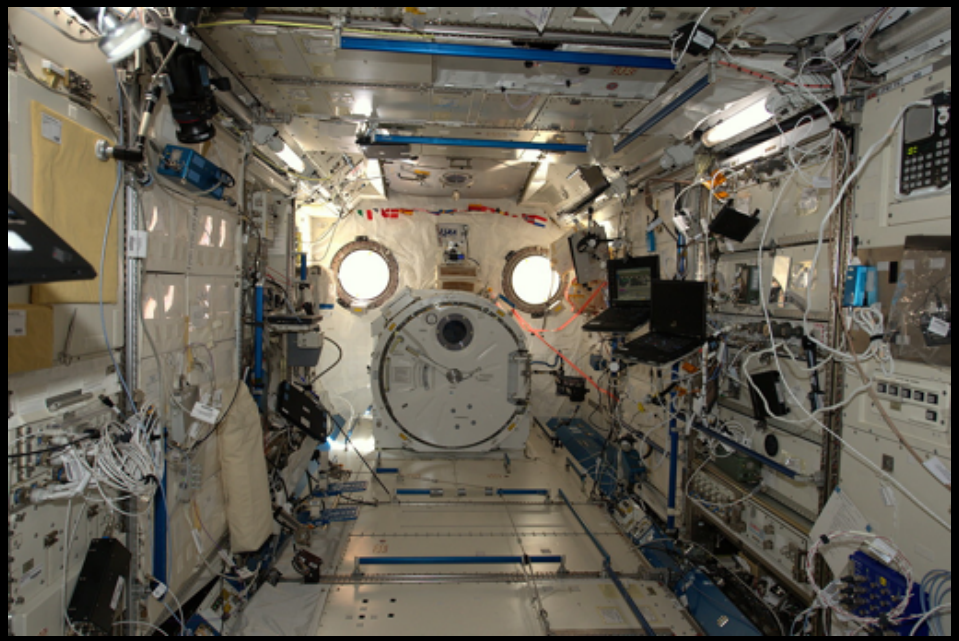
Created to Address U.S. Strategic Need, SSEP:

11th graders from Fitchburg, MA run titrations to optimize their SSEP flight experiment

- Is a high caliber STEM education program for grades 5-16 tuned to next generation national science education standards;
- Is designed to be a national model for inspiring and engaging the next generation of scientists and engineers, and to address science literacy.

SSEP Student Spaceflight Experiments Program

Breaking New Ground in Commercial Space:



Inside the Kibo Module of ISS. Photo courtesy of NASA.

SSEP is the first pre-college STEM education program that is both – a U.S. national initiative and implemented as an on-orbit commercial space venture.

National Center for Earth and Space Science Education

Inspire…then Educate

SSEP Student Spaceflight Experiments Program

Committed to Student Ownership in Exploration, to Science as a Journey, and to the Joys of Learning

In each SSEP community:

- One student team designed experiment is selected to fly to the ISS to be conducted by astronauts.
- Local educators deliver the SSEP microgravity curriculum to typically 300+ students.
- Over 9 weeks, teams of 3-5 students each design a microgravity experiment and write a formal research proposal vying for the community's flight slot.
- A formal proposal review culminates with a National Review Board selecting the community's flight experiment.
- Student teams are given the opportunity to present their experiment design at their very own research conference, typically held at the Smithsonian National Air and Space Museum.

SSEP Student Researchers from Southside High School, San Antonio, TX.

Deep Investment in Partnership:

Strategic Partners – the SSEP Team

The Student Spaceflight Experiments Program (SSEP) is a program of the National Center for Earth and Space Science Education (NCESSE) in the U.S., and the Arthur C. Clarke Institute for Space Education internationally. SSEP is enabled through a strategic partnership with Nanoracks LLC and DreamUp PBC, which are working with NASA under a Space Act Agreement as part of the utilization of the International Space Station as a National Laboratory. NCESSE, the Clarke Institute, Nanoracks, and Dream Up are designated SSEP Strategic Partners.

Nanoracks

dreamUp

Deep Investment in Partnership:
National Partners & Sponsors

SSEP National Partners provide unique assets and capabilities that enhance the program on a national level. NCESSE and the Clarke Center are proud to partner with the following organizations on the SSEP –

- Smithsonian National Air and Space Museum
- International Space Station National Laboratory – Managed by the Center fo the Advancement of Science in Space (CASIS)
- Subaru of America, Inc.
- The National Space Grant College and Fellowship Program
- Magellan Aerospace
- Big Kid Science
- NASA Nebraska Space Grant Consortium
- Carnegie Institution of Washington/ Carnegie Academy for Science Education

Deep Investment in Partnership:
Local Partners & Sponsors

SSEP Local Partners provide that enables SSEP at the community level. Each community has its own unique approach to their SSEP community experience. Local partners assist communities in successfully delivering the SSEP experience, and include school districts, private schools, NASA Space Grant lead institutions, other Universities, businesses, foundations, private philanthropists, and local research institutions. NCESSE and the Clarke Center are proud to partner with these institutions and individuals that are introducing the frontiers of human exploration – and real science – to grade 5-16 students.

- Over 1,250 Local Partners have supported 303 SSEP community programs in 191 unique communities across the U.S., Canada, and Brazil. To date, 58 communities have taken part in at least 2, and as many as 9, flight opportunities.
- Over 2,400 schools have participated in SSEP programming with their grade 5-16 students.
- 34 Space Grant consortia have provided partial support for 142 of the 303 SSEP community programs conducted to date.

The Basics

- SSEP was launched in June 2010 by NCESSE in partnership with NanoRacks, LLC. It is now almost 10 years old.
- A U.S. national Science, Technology, Engineering, and Mathematics (STEM) education initiative that gives typically 300+ students across a community the ability to design and propose real microgravity experiments to fly in low Earth orbit, first aboard the Space Shuttle and now aboard the ISS.

Student Researchers from Dillard Elementary School, Elk Grove, CA analyzing the first in a series of trials testing the hatch rate and growth of fairy shrimp.

- SSEP immerses and engages students and their teachers in real science—on the high frontier—so that students, as early as 5th grade, are given the chance to be researchers —and experience science firsthand.

Launch History

16 SSEP Flight Opportunities Since June 2010

To date, SSEP Missions have flown on:

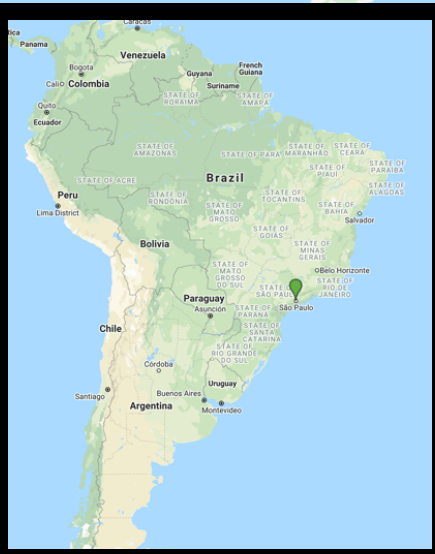
- STS-134 (final flight of Space Shuttle Endeavour)
- STS-135 (final flight of the U.S. Space Shuttle Program)
- M1: SpaceX-D1 (demonstration flight for SpaceX commercial resupply)
- M2: Space X-1
- M3a: Orb-D1 (demonstration flight for Orbital Sciences commercial resupply)
- M3b/M4: Orb-1
- M5: Orb-2
- M6: Orb-3 (lost), SpaceX-5 (re-flight)
- M7: SpaceX-7 (lost), SpaceX-8 (re-flight)
- M8: SpaceX-9
- M9: SpaceX-10
- M10: SpaceX-11
- M11: SpaceX-12
- M12: SpaceX-15
- M13: SpaceX-18

Top left, ISS Commander Sunita Williams activates a SSEP FME Mini-lab. Bottom left, Astronaut Ricky Arnold, on the ISS holding the SSEP Mission 12 flight mini-lab from Hillsborough County, FL .

Community Network:

303 SSEP Community Programs To Date

To date, SSEP programming has been conducted by communities in 42 states and the District of Columbia in the U.S., 5 Provinces in Canada, and a community in Brazil.



Track Record To Date

Students from Winfield, AL remove kudzu seeds from pods before scarifying them.

Students from Houston record Planarian pre-flight data.

5th grade students from Fort Bend, TX conduct a trial of their project, "Growing *Solanum Tuberosum* in microgravity"

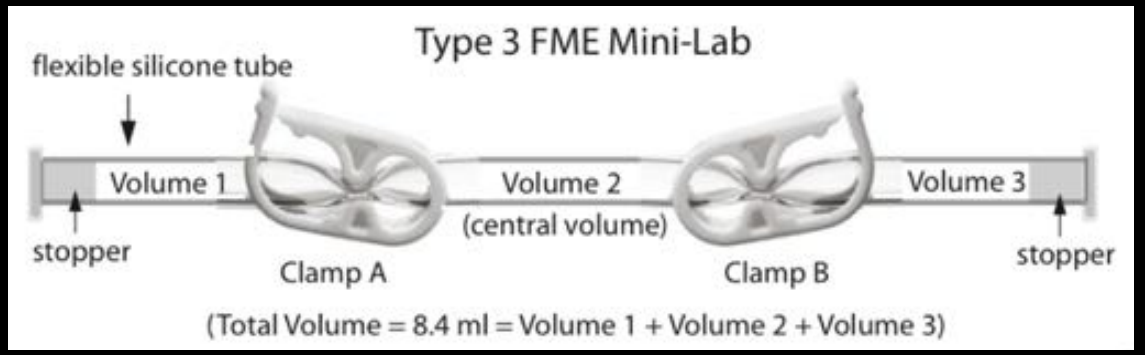
- 303 community programs have been delivered in 191 communities from 42 states, the District of Columbia, 5 Provinces in Canada, and a community in Brazil.
- 58 communities have participated in at least 2 and as many as 9 flight opportunities, reflecting the sustainable nature of the program.
- 126,600 grade 5-16 students across 2,482 schools were fully immersed in microgravity experiment design and proposal writing.
- 25,518 flight experiment proposals received from student teams.
- 314 experiments selected for flight. 281 experiments have flown. 33 experiments representing Mission 14 are expected to launch Summer 2020.
- 9 National Conferences held at the Smithsonian National Air and Space Museum and the Stephen F. Udvar-Hazy Center, the 10th is likely June/July 2020.

Flight Hardware:
Fluid Mixing Enclosure (FME) Mini-Lab

Student flight experiment teams receive real flight certified hardware fabricated by Nanoracks. Students assemble, fill, seal, and ship the FME Mini-lab to Nanoracks in Houston in preparation for launch.

Nanoracks

Above: loaded and assembled Type 3 FME Mini-lab
Right: graphic labeling components of a Type 3 FME Mini-lab

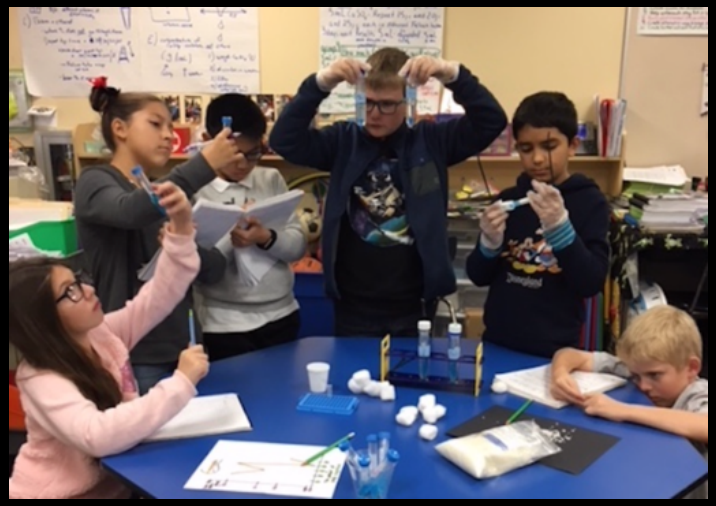


Fluid Mixing Enclosure (FME) Mini-Lab:
Heat Sealed Containment

- Each SSEP experiment must pass NASA Flight Safety Review to ensure samples pose no risk to the astronaut crew, ferry vehicles, or ISS.
- More levels of containment = less restrictions on samples.
- The current FME Mini-lab has 3 containment levels: the main silicone tube together with two polyethylene bags heat sealed around the tube.

Mission Highlight: SSEP Mission 13 to ISS

University System of Maryland students perform preliminary experiments and analyze cultures.



Elementary school students test their crystal experiment before flight.

Launch Vehicle:
SpaceX-18

Launch Date:
July 25, 2019 at 6:01 pm EDT

Return to Earth:
August 27, 2019, SpaceX-18

Payload Designation:
SSEP15 – *Gemini*
Named for NASA's Project Gemini

Number of Student Flight Experiments:
41
One for each of the 38 M13 communities;
36 communities flew 1 experiment, 1 community flew 2 experiments, and 1 community flew 3 experiments

National Center for Earth and Space Science Education
and the Arthur C. Clarke Institute for Space Education

Inspire…then Educate

Mission 13 to the ISS: Scope

- Number of Participating Communities: 38, with 1 community flying 2 mini-labs and 1 community flying 3 experiments
- Total Number of Students Fully Engaged in Experiment Design: 23,117 from grades 5-16
- Number of Student Team Proposals Submitted: 3,683
- Total Number of Proposals Submitted for Step 2 Review: 122
- Number of Students Engaged in Mission Patch Art and Design Competition: 34,145
- Total Number of Mission Patches Submitted: 21,200
- Total Number of Mission Patches Selected to Fly: 67

NASA image of SpaceX-15 night launch

Mission 13 to the ISS: Communities and Flight Experiments, 1-19

	Community	Selected Experiment
1	Sao Paulo, Brazil	Capillarity versus Gravity in the filtration process
2	Edmonton, AB, Canada	The Effect of Microgravity on the Germination of Nasturtium Officinale (Watercress)
3	Qualicum, BC, Canada	Investigating the Growth Patterns of Alfalfa (Medicago sativa) sprouts in microgravity: a potential nourishment for future manned spaceflights
4	Winfield City, AL	Purification of Water in Microgravity
5	Corcoran, CA	The Brine Shrimp Study
6	La Verne, CA	Flammulina velutipes growth in microgravity
7	Moreno Valley, CA	The Growth and Development of Sustainable Brine Shrimp in Microgravity
8	North Hollywood, CA	The Effects of Microgravity on Cell Recognition
9a	Riverside, CA - ES	The Effects of Microgravity on Saturated Copper Sulfate Crystals
9b	Riverside, CA - MS	Effects of Microgravity on Radish Seed Germination
9c	Riverside, CA - HS	Chenopodium quinoa Cell Development in Microgravity
10	Ashford/Willington, CT	Growing Beetroot Plants in Space
11	Hillsborough County, FL	Mung Bean Project 2018
12	Port St. Lucie, FL	The effects of microgravity on the germination of Culinary Lavender
13	Berea, KY	Rate of Rust Formation in Microgravity
14	Anne Arundel County, MD	The Structural Integrity of Concrete in Microgravity
15	Montgomery County, MD	Mixing cement with steel shavings
16	University System of Maryland (USM), MD	Biofilm Adhesion of E. coli to Annealed Porous and Smooth Aluminum in Microgravity
17	Fitchburg, MA	How is the Growth of the Bacteria Frankia alni Affected by Microgravity?
18	Redford, MI	Can peppermint seeds germinate in space?
19	Traverse City, MI	The Growth of Bacillus Subtilis on a Substrate Material in Microgravity

Mission 13 to the ISS: Communities and Flight Experiments, 20-38

	Community	Selected Experiment
20	Kansas City, MO/KS	The Growth of Mint in Microgravity
21	Clark County, NV	Will Quinoa Grow in Microgravity?
22	Stockton University - Galloway, NJ	Analysis of double-stranded break repair in haploid *Saccharomyces cerevisiae* under spaceflight conditions
23	Ocean City, NJ	The Effect of Microgravity on the Hatch Rate and Development of *Artemia salina*
24	Springfield, NJ	*Triops longicaudatus* growth and development in Microgravity
25	Jefferson County, NY	Rust Investigation
26	Suffolk County, NY	Effect of Microgravity on the Effectiveness of Probiotics
27	WNY STEM - Buffalo/Niagara, NY	The effect of Microgravity on *Bacillus subtilis* on subsequent Terrestrial behavior
28	Hunker, ND	Kefir Water
29a	Hershey, PA	Effects of Microgravity on the Growth of Algae Cysts and Lipid Production
29b	Hershey, PA	The effect of microgravity on the adhesion and curing of oil-based artist paint
30	Pittsburgh, PA	Transcriptomic Analysis of *Escherichia coli* Response to Ciprofloxacin in Microgravity
31	Knox County, TN	How to produce a synthetic soil from waste generated on board ISS
32	Burleson, TX	Earthworms to Space Worms
33	Ector County, TX	Activation of *C. Novyi*, a novel cancer treatment, in Microgravity
34	Klein, TX	The Effect of Self-Assembled Monolayers on Microgravity Protein Crystallization
35	Marfa, TX	Eradicating Bacteria Growth in Microgravity
36	Pharr, TX	What are the effects of microgravity on the cellular growth of *Spinacia oleracea*?
37	Raleigh County, WV	Effects of Microgravity on the Growth of *Caulobacter Crescentus*
38	Forward - Grantsburg, WI	What Happens to the Germination of *Solanum lycopersicum var. cerasiforme* seeds in Microgravity?

SSEP 2019 National Conference:

Stephen F. Udvar-Hazy Center, July 1-2, 2019

Photos of SSEP Student Researchers, and attendees of the 2019 SSEP National Conference

In Their Own Words

[SSEP] may be the most important development for the future of the U.S. space program.

– **J.R. Dailey, Director of the Smithsonian National Air and Space Museum**

EPIC MOTIVATION & INSPIRATION to be the best student scientist ambassadors for Canada & the world. The program has meant a monumental shift in thinking about science and its future impacts. Our kids have dreamt huge dreams of cures, treatments, and solutions to some of the world's greatest challenges: disease, health promotion, hunger, food production, waste reduction and innovative fuel sources. It has impacted the way they view science, engineering, technology and math in an exhilarating and captivating way. . . Simply put it has been MAGICAL!

—Maria Nickel, SSEP Community Program Director

It is not often that an opportunity like SSEP comes along, with such an opportunity to create a lasting legacy for students, communities, and the nation. As the Director of the Indiana Space Grant Consortium, I am honored and humbled to support this worthy addition to Indiana's legacy of spaceflight and exploration; as someone who has had a passion for space since I was six, I am excited for, and in awe of, what the students from Avicenna Academy in Crown Point are accomplishing so early in their lives.

—Barrett S. Caldwell, Ph.D., Director, Indiana Space Grant Consortium

This whole thing is so unbelievable. We are doing real science research that really matters. What we design will really fly in space aboard the very last space shuttle mission. This could be a life-changer for me. It is something that I will someday tell my grandkids about. How cool!

—Isaac Jepsen, SSEP Student Researcher (Senior), Iowa

Providing this kind of life-changing opportunity to students is what keeps us energized to come to work every morning. . .

—Terry Teays, PhD., Assistant Director, Maryland Space Grant Consortium

SSEP is the best real life application program that my students have ever experienced!

—Alison Thammovongsa, SSEP Community Program Director

This might be the best experience I have ever had. The opportunity to work with others that enjoy science as much as I do was great. It opened my eyes to how the scientific method is used in real life. This has shown me that if you work as a team and bounce ideas off each other you can accomplish anything.

—Alex A., SSEP Student Researchers (Grade 8), North Carolina


All those that work on the frontiers of human exploration
were children once that dared to dream.