

National Aeronautics and  
Space Administration



# NASA STEM

## HIGHLIGHTS 2022



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*Above: A young child dressed in an astronaut spacesuit is one of the spectators gathering on the Max Brewer Bridge in Titusville, Florida, to witness NASA's Artemis I launch. Credits: NASA/Steven Scifer  
Cover: Students from the Students to Launch program watch the Artemis I launch from the bleachers at NASA's Kennedy Space Center. Credits: NASA/James Ryan*

# NASA Strategic Objective 4.3

## Build the next generation of explorers

### Engage students to build a diverse future STEM workforce

#### Lead Office

Office of Science, Technology, Engineering, and Mathematics (STEM) Engagement (OSTEM)

#### Objective Overview

NASA makes vital investments toward building a diverse STEM workforce. The scope of our STEM engagement comprises all endeavors to attract, engage, and educate students and to support educators and educational institutions. Given the Nation's need for a skilled STEM workforce and projected demand, NASA clearly has a vested interest in attracting, engaging, and preparing its future STEM professionals. The national STEM ecosystem will benefit from NASA contributions to attract and retain students on STEM pathways, with increased attention on underserved and underrepresented students. Recent national and international tests show that in the last decade,

U.S. students have demonstrated little or no growth in mathematics and remain ranked in the middle of advanced economies on international science and mathematics assessments.

NASA will implement strategies to broaden student participation to increase diversity, equity, inclusion, and accessibility (DEIA) in STEM through NASA opportunities and activities. While the number of women and underrepresented minorities earning STEM degrees has grown in broad science and engineering occupations over the last decade, significant underrepresentation remains in areas critical to NASA such as engineering and computer and mathematical sciences. NASA is committed to building a diverse, skilled future STEM workforce—our next generation of explorers with the technical skills needed to carry forward our Nation's vital mission and work in aeronautics and space into the future.



Above: NASA Administrator Bill Nelson and NASA's SpaceX Crew-3 astronauts Raja Chari, left, and Mark Vande Hei, right, answer questions from students during their visit to Amidon-Bowen Elementary School, Thursday, Dec. 8, 2022, in Washington. Credits: NASA/Keegan Barber  
Opposite: Students to Launch program participants simulate a news conference during a tour of NASA's Kennedy Space Center. Credits: NASA/Frankie Martin



## NASA's Office Of STEM Engagement

**NASA's Office of STEM Engagement (OSTEM)** is committed to inspiring the students of the Artemis Generation and supporting the educators and caregivers who guide them to discover their own unique skills, interests, and capabilities. By investing in today's students, we're building the highly capable, diverse STEM workforce our nation will need to accomplish our long-term goals in aeronautics and space exploration.

The OSTEM enterprise manages the Congressionally-appropriated \$147 million (FY22) STEM Engagement program and provides guidance and strategic direction of the agency's STEM engagement portfolio. OSTEM's projects, activities, and funding opportunities are all geared toward achieving our vision: to immerse students in NASA's work, enhance STEM literacy, and inspire the next generation to explore.

#### Our portfolio is designed to achieve OSTEM's strategic goals:

- Attract diverse groups of students to STEM through learning opportunities that spark interest and provide connections to NASA's mission and work.
- Create unique opportunities for a diverse set of students to contribute to NASA's work in exploration and discovery.
- Build a diverse future STEM workforce by engaging students in authentic learning experiences with NASA's people, content, and facilities.

OSTEM's four projects are tailored to connect broad groups of students and educators to relevant NASA opportunities and resources. The Next Generation STEM Project (Next Gen STEM) reaches the K-12 and informal education audience and innovates new ways to reach those who are historically underrepresented and underserved in STEM. The National Space Grant College and Fellowship Project (Space Grant) leverages a national network of state consortia, academia, and partner organizations to develop opportunities for students to engage in the agency's work. Through NASA Established Program to Stimulate Competitive Research (EPSCoR), the agency boosts the research infrastructure in jurisdictions that have not participated equitably in competitive aerospace and aerospace-related research activities, while NASA's Minority University Research and Education Project (MUREP) provides opportunities for students at Minority-Serving Institutions and enhances institutions' capacity for cutting-edge research.

OSTEM also supports students in developing their STEM skills through challenges and competitions, and authentic work experiences in which students can contribute to the agency's missions as interns or fellows.

The next great leap is just beginning. In the pages ahead, find out about OSTEM's latest efforts to prepare the Artemis Generation for the future of exploration.

*FY 2022 Preliminary Performance Data will be finalized after completing the data verification and validation process.*

Students from Northeastern University's 2022 BIG Idea Challenge team test their snake-like rover, COBRA: Crater Observing Bio-inspired Rolling Articulator.

# OSTEM PROJECTS



# NASA EPSCoR

## Lasting improvements in research and development

NASA's [Established Program to Stimulate Competitive Research \(EPSCoR\)](#) works to build research infrastructure in regions of the U.S. that historically have had fewer opportunities to participate in competitive research and development (R&D). Through partnerships with government, academia, and industry, EPSCoR funds research that contributes to solving many of the challenges inherent in the agency's ambitious missions and future goals.

EPSCoR programs are currently present in **28 jurisdictions** that have not historically participated equitably in competitive R&D activities. These jurisdictions include 25 states, the Commonwealth of Puerto Rico, the U.S. Virgin Islands, and Guam. NASA is one of six federal agencies that conduct EPSCoR programs: National Science Foundation, Department of Energy, Department of Defense, NASA, Department of Agriculture, and National Institutes of Health.

In addition to contributing to the research infrastructure in EPSCoR jurisdictions, EPSCoR awards support investigations critical to the agency's missions. For example, heat shield materials, which protect spacecraft from the extreme temperatures encountered during planetary reentry, are a vital area of study for the agency. In FY 2022, a heat shield technology investigation selected by EPSCoR in 2019 successfully completed its mission. Developed by the University of Kentucky, the Kentucky Re-Entry Probe Experiment (KREPE) tested thermal protection system material and instrumentation as it reentered Earth's atmosphere in December 2021. The university was selected



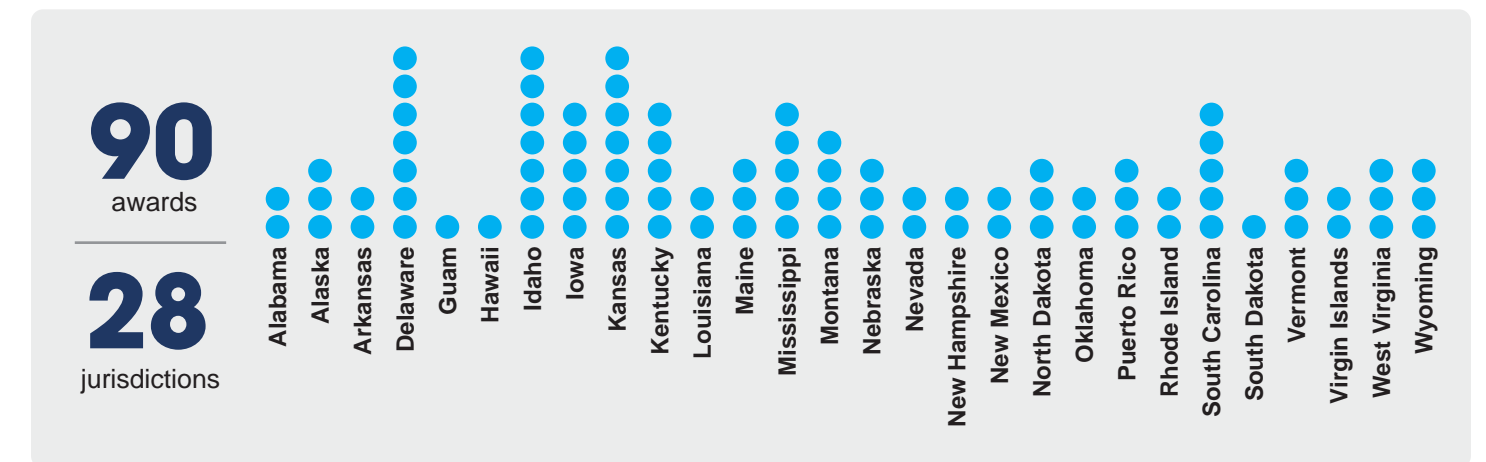
PlanBlue's Guy Rigot operating the DiveRay while conducting benthic surveys in Apra Harbor, Guam. Credit: Tom Schils

months later to build on this success through an [EPSCoR Rapid Response Research \(R3\)](#) award. Read more about KREPE on page 49.

NASA EPSCoR awarded more than \$22.7M to fund universities in FY 2022 to further critical research that will provide a boost to space exploration technologies while benefiting those institutions and students conducting the research. Through the [International Space Station Flight Opportunity](#) and [Suborbital Flight Opportunity](#) awards, EPSCoR provided avenues for students to design investigations to be conducted in the microgravity environment aboard the space station, or through suborbital flights available through the agency's Space Technology Mission Directorate. EPSCoR's cooperative agreements enabled students to contribute to studies that align with NASA's priorities, and Rapid Response Research (R3) fast-tracked the development of research projects that could quickly benefit the agency.

## FY2022 EPSCoR Awards

**\$22.7M** in awards to institutions



Learn more about EPSCoR at [nasa.gov/stem/epscor/home/index.html](https://nasa.gov/stem/epscor/home/index.html)

# MODEL SPACESUITS

## NASA's EPSCoR Funds Model Spacesuits



Pablo de León tests out his spacesuit in an external environment. Credits: Pablo de León

Ever since he was a young boy watching the televised lunar landings from his hometown of Cañuelas, Argentina, Pablo de León knew he wanted to contribute to human space exploration. Now, as chair of the Department of Space Studies at the University of North Dakota (UND), he's using NASA EPSCoR funding to design and develop 3D-printed spacesuit models that may support future exploration of Mars.

De León moved to the United States more than 30 years ago to fulfill his dream of contributing to human spaceflight and, for the past 17 years, he has been a professor at UND, conducting critical research in the area of planetary spacesuits. Most recently, he received a \$750,000 grant – spread across three years – from NASA's EPSCoR to develop

a 3D-printed spacesuit model and identify key technologies that may reduce the logistical supply chain needed from Earth when astronauts begin venturing back to the Moon and to Mars.

In addition to the 3D-printed spacesuit technology, de León and his graduate students will also look into re-utilizing the spacesuit. They will determine if it is possible to melt the plastic and recreate the special filament they use for the 3D-printed suits to build another one when it breaks down.

"The advantage here is that eventually, in the future, astronauts will be able to take the equipment with them to manufacture parts — or an entire spacesuit — at their location," de León said. "Then, they won't have to depend so much on Earth; they'll be able to solve these problems themselves."

Some additional factors de León is considering while developing a suit for Mars include dust protection, temperature regulation, mobility, and the weight astronauts will be able to withstand in an environment that has roughly one-third the gravity of Earth.

De León noted that EPSCoR grants also allow the university to fund graduate students as research assistants, providing them with the ability to participate in unique, hands-on projects that increase their expertise while giving them the practical training necessary for a career in the space industry, de León believes the future for his students — and even younger kids studying STEM — is a bright one full of opportunity.

"There have been two moments in history where the opportunity to work in space flourished. One was the 1960s, in the beginning of the Apollo Program, and the other is right now, where history is being written again," he said. "This is like a new renaissance of space activities. There are so many opportunities to contribute to the future of humanity in space, and we need bright, young people who will be interested in embracing these careers and paving the way for what will be the next step in human exploration of deep space."

**"To me, as a researcher, EPSCoR has been incredibly useful because we're able to open new lines of research because we otherwise wouldn't have funding to start development."**



Pablo de León tests sample collection tools at the Lunar Regolith Lab at NASA's Kennedy Space Center in Florida. Credits: NASA

# NASA MUREP

## Enhancing research, academic and technological capabilities of MSIs

**NASA's Minority University Research and Education Project (MUREP)** is expanding the agency's reach in communities historically underrepresented in STEM by offering opportunities for college students at Minority Serving Institutions to contribute to the agency's exploration goals and boosting these schools' research capacity and infrastructure. Through MUREP's competitive awards, research opportunities, and engagements at career fairs and conferences throughout the year, NASA is investing in the Artemis Generation and a diverse future workforce.

MUREP's array of opportunities are available to Historically Black Colleges and Universities (HBCU), Hispanic-Serving Institutions, Asian American and Native American Pacific Islander-Serving Institutions, Alaska Native and Native Hawaiian-Serving Institutions, American Indian Tribal Colleges and Universities, Native American-Serving Nontribal Institutions, and other Minority Serving Institutions (MSI).

In September 2022, some of the nation's brightest college and university students flexed their entrepreneurial muscles to develop ideas to bring NASA technology to the commercial marketplace through the "Mini MITTIC" pitch competition – which became a permanent part of the annual White House HBCU Scholar Recognition Program. A small-scale version of the agency's **MUREP Innovation and Tech Transfer Idea Competition (MITTIC)**, Mini MITTIC brings together scholars from a variety of disciplines to develop and pitch their ideas at the National HBCU Week Conference in Washington, D.C. Read more about Mini MITTIC on page 14.

MUREP representatives also traveled the nation during the fiscal year to share information about current and upcoming NASA opportunities with MSIs, university administrators, faculty, and students. The **HBCU/MSI Technology Infusion Road Tour** was hosted by MUREP in partnership with NASA's Office of Procurement, Office of Small Business Programs, and the Small Business Innovation Research and Small Business Technology Transfer (SBIR / STTR) program. During three Road Tour events – one virtual, and two in a hybrid format at the University of Illinois at Chicago and at Texas Southern University



MUREP Precollege Summer Institute students do hands-on research at NASA's Glenn Research Center in Cleveland while exploring the different ways STEM professionals conduct groundbreaking work in industry. Credits: NASA

in Houston — dynamic presenters from NASA's mission directorates, prime contractors, and other federal agencies shared opportunities for MSI funding, partnership, and participation. A total of 126 MSIs were represented, connected, and engaged in the Road Tour. MUREP also showcased STEM careers and participated in career fairs at prominent national conferences such as the National Society of Black Engineers, the Society of Women Engineers, and the Central Intercollegiate Athletic Association for member schools and other MSIs.

MUREP reaches the unique population of community college students through **NASA Community College Aerospace Scholars (NCAS)**. NCAS offers three "mission opportunities" progressing from an introductory, self-paced online course to an engineering design challenge on-site at one of the agency's field centers. More than 1,280 community college students from 250 colleges in 35 states and Puerto Rico participated in NCAS.

MUREP obligated a total of \$20.8M to MSIs nationwide to help address challenges facing the agency's exploration goals and the need for a diverse future workforce. Through **MUREP Aerospace High-Volume Manufacturing and Supply Chain Management Cooperative (MUREP High Volume)**, NASA invested in universities developing diverse networks capable of supporting high-volume manufacturing and supply chain ecosystem in the aerospace industry. The agency also sought projects connecting students to NASA STEM. The **MUREP Precollege Summer Institute** and **MUREP Aerospace Academy** awards both invested in colleges and universities to develop new ways to support and inspire local high school students to get involved in STEM, and the **MUREP American Indian and Alaska Native STEM Engagement (MAIANSE) CONNECTing** activity funded MSIs' projects designed to foster connections between NASA missions and indigenous culture. MUREP also provided short-term planning grant opportunities to MSIs through the **MUREP-Small Business Technology Transfer**

**Research (M-STTR)** activity in partnership with **NASA's Space Technology Mission Directorate's SBIR/STTR program**. The planning grants are designed to enable MSIs to partner with NASA researchers to develop their capabilities with the possibility of competing for longer-term agency funding. The goals of the planning grant are to stimulate creative engagements between NASA and MSI researchers in areas of mutual interest and develop mutually beneficial relationships supporting NASA missions.



**127**  
active  
awards  
totaling



**\$20.8M**  
obligated  
to



**76**  
MSIs,  
which  
represent



**27**  
states and  
territories



Learn more about MUREP at  
[nasa.gov/stem/murep](https://nasa.gov/stem/murep)



# MINI MORE IDEAS

Some of the nation’s brightest college and university students flexed their entrepreneurial muscles to develop ideas to bring NASA technology to the commercial marketplace through the “Mini MITTIC” pitch competition – which became a permanent part of the annual White House HBCU Scholar Recognition Program in FY 2022.

Students from Historically Black Colleges and Universities (HBCUs) participated in the 2022 HBCU Week National Conference held Sept. 20-23 in Washington, D.C. The 2022 White House HBCU Scholars delivered impressive pitches to NASA and industry experts showcasing their ideas to transform NASA concepts into commercial success through a competition known as “Mini MITTIC”.

The “Shark Tank”-style challenge requires teams of students from a variety of disciplines, such as STEM fields, business, and communications, to develop a viable commercialization concept for a NASA intellectual property (IP). The competition is a small-scale version of NASA’s MITTIC.

For the past two years, NASA and the Department of Education have collaborated to bring Mini MITTIC to the HBCU Scholar Recognition Program, which is part of the White House Initiative on Advancing Educational Equity, Excellence, and Economic Opportunity. This year, Mini MITTIC officially became a permanent part of the program.

The Mini MITTIC experience is an invaluable component of the program

because of the networking opportunities it creates between scholars, their mentors, and NASA leaders. According to Elyse Jones, a management and program analyst who serves as the outreach and engagement coordinator, Mini MITTIC fosters diversity, creativity, and teamwork for the HBCU Scholars Program.

Shelita Hall is a Ph.D. student at Norfolk State University in Hampton, Virginia. In addition to being named a 2022 White House HBCU Scholar, she’s a NASA Pathways intern and MUREP GEM doctoral fellow.

“I wanted to be part of [the HBCU Scholar Recognition Program] in order to witness the excellence of the other HBCU scholars and be a part of this initiative to highlight HBCUs and figure out ways to make us more competitive in the workplace,” she said.

She was excited to learn that NASA had officially joined the program. “It’s everything that I want to do in one place: to be part of the competition and just to be able to experience all the professional development workshops and network with other NASA personnel at the conference,” she said.

This year’s 86 White House Scholars, representing 52 HBCUs, were divided into 10 teams for Mini MITTIC. The teams presented five-minute pitches to a panel of four judges from NASA, the U.S. Patent Office, and industry partners. The top three presented during the next day’s luncheon in front of conference attendees, who voted along with the judges to select a winner: Team 2, “Carbon Dioxide Team of Change,” which pitched a solar-powered carbon dioxide converter. Hall’s team, Team 3, “Perishense,” and Team 9, “SpiroCheck,” rounded out the top three.



Student teams in the 2022 cohort of White House HBCU Scholars pitched their commercialization ideas and listened to other teams’ pitches during the 2022 HBCU Week National Conference held Sept. 20-23, 2022, in Washington, D.C. Secretary of Education, Miguel Cardona, lower left, spoke to the scholars who participated in Mini MITTIC as a part of the federal HBCU Scholar Recognition Program. Credits: Department of Education





# NASA SPACE GRANT

## A national network of colleges and universities

NASA's [National Space Grant College and Fellowship Project \(Space Grant\)](#) brings together partners from across academia, industry, and government to invest in STEM education and research with the goal of expanding opportunities for Americans to understand and participate in NASA's aeronautics and space projects. Space Grant's 52 consortia — one in each state as well as the District of Columbia and the Commonwealth of Puerto Rico — connect more than 850 affiliated universities and colleges, informal education institutions, industry, and others to fund fellowships and scholarships and create enriching STEM opportunities for students and educators.

The project launched a new approach in 2022 with the [Space Grant K-12 Inclusiveness and Diversity in STEM \(SG KIDS\)](#). Through this pilot program, the awarded consortia are reaching beyond state boundaries, creating regional partnerships with new STEM opportunities for middle- and high-school students and educators. SG KIDS also addresses White House Executive Order 13985: Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, as well as NASA Administrator Bill Nelson's focus on providing authentic STEM opportunities to K-12 students. Read more about Space Grant KIDS on page 18.

As NASA continues on the path to send humans back to the Moon through Artemis, Space Grant has an important role in student challenges focusing on critical research and technology for future missions. The 2022 [Breakthrough, Innovative and Game-Changing \(BIG\) Idea Challenge](#) tasked participating teams of college students to come up with alternative ways for rovers to move across extreme terrain. Funded by NASA's [Space Technology Mission Directorate](#)



Students participating in the National Eclipse Ballooning Project prepare to release a research balloon carrying their science payload. Credits: NASA

[\(STMD\)'s Game Changing Development Program](#) and Space Grant, the year-and-a-half-long challenge concluded in November 2022 with technologies that tumbled and slithered to the top of the rankings. Learn more about the BIG Idea Challenge on page 39.

The [Great Lunar Expedition for Everyone \(GLEE\)](#) project is focused on lunar exploration. It will deploy 500 note card-sized LunaSats on the lunar surface to carry out experiments developed by teams of high school or undergraduate students from around the world.

College and university students also get the opportunity to launch experiments on sounding rockets through the RockOn and RockSat programs led by the Colorado and Virginia Space Grant Consortia. Sounding rockets carry payloads on a parabolic trajectory, resulting in

flights that provide up to 20 minutes in space before returning to Earth. Students' payloads flew on two launches in FY 2022: RockOn and RockSat-C in June 2022, followed by RockSat-X in August 2022. Learn more about these and other student payloads flown in space on pages 48 and 49.

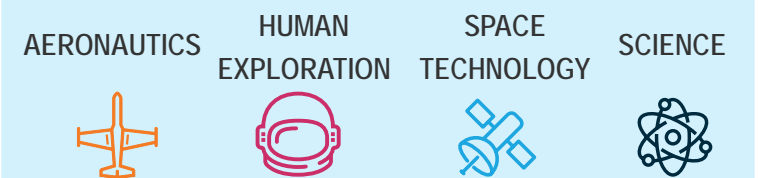
Additionally, Space Grant collaborated with [NASA's Science Mission Directorate \(SMD\)](#) and [Aeronautics Research Mission Directorate \(ARMD\)](#) on projects offering hands-on research and development experiences here on Earth. Through SMD's Science Activation (SciAct) program, Space Grant provided more than \$400,000 in funding toward the Nationwide [Eclipse Ballooning Project \(NEPB\)](#) led by the Montana Space Grant Consortium. Over 55 student teams from higher education institutions across the nation are developing science projects to study atmospheric and other phenomena during the annular solar eclipse in October 2023 and total solar eclipse in April 2024.

For the second year, Space Grant and ARMD also worked together in support of the [University Student Research Challenge \(USRC\)](#), which focuses on advancing design, technology, or capabilities in support of aviation. In FY 2022, Space Grant awarded more than \$370,000 toward supporting multiple teams based at affiliated universities.



To learn more about NASA Space Grant or the consortium for your state, visit: [go.nasa.gov/3ym50oe](https://go.nasa.gov/3ym50oe)

Space Grant Consortia provide state-wide opportunities that contribute to NASA's mission in:



**\$48.1M**  
cooperative agreements  
awarded to institutions

**52**  
Consortia  
(50 states, Puerto Rico  
and District of Columbia)

**\$19M** in financial support to  
significant awardees

**4K+** significant awards to students

**29K+** educator participants

**423K+** student participants

**361** peer-reviewed publications

**3** patents **5** tech transfers

# SPACE GRANT KIDS

NASA SPACEGRANT



Students from Chesterfield Career and Technical Center in Chesterfield, VA calculate plant growth measurements and monitor environmental conditions for their basil plants for the Plant the Moon Challenge. Image credit: NASA's Virginia Space Grant Consortia

## NASA awarded more than \$4 million to institutions across the U.S. through the new Space Grant K-12 Inclusiveness and Diversity in STEM (SG KIDS) opportunity.

The goal of **SG Kids** is to help bring the excitement of authentic NASA experiences to groups of middle and high school students who are traditionally underserved and underrepresented in STEM.

A pilot program made possible through NASA Space Grant, SG KIDS represents a new approach by asking the awarded consortia to reach beyond state boundaries to create regional projects tailored to students in those areas. The projects funded under SG KIDS will provide students with hands-on experiences and lessons that bring NASA's missions to life and boost the STEM ecosystem in these regions.

SG KIDS addresses the White House Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, as well as NASA Administrator Bill Nelson's focus on providing authentic STEM opportunities to K-12 students.

**“Creating a sustainable and diverse workforce pipeline in the area of ML/AI (machine learning/artificial intelligence) for robotic systems is necessary to achieving NASA’s future exploration goals for the Moon, Mars, and beyond. The curriculum and collaboration established by this NASA support will have lasting impact in K-12 educator capabilities and student skills for years to come.”**

- Dr. Steven Ruffin  
Director, Georgia Space Grant Consortium through the Georgia Institute of Technology

Each of the four grantees was awarded approximately \$1,050,000 in cooperative agreements to put their proposals into action during the next three years. The grantees and their proposed projects are:

### Old Dominion University Research Foundation

Norfolk, Virginia

NASA Space Grant Plant the Moon Challenge

Student teams will get hands-on planetary science experience as they design experiments to grow plants in a simulated version of lunar soil, called regolith, through the NASA Space Grant Plant the Moon Challenge. Partners are the Virginia, West Virginia, North Carolina, South Carolina, Florida, and Puerto Rico Space Grant Consortia, as well as the Institute for Competition Sciences.

### Georgia Institute of Technology

Atlanta, Georgia

Inspiring NASA's Next Generation through Building, Coding, and Machine Learning Missions (NASA ML-Bots)

NASA ML-Bots will teach the fundamentals of coding, artificial intelligence, and machine learning to middle- and high-school students in Georgia, Alabama, Louisiana, and Tennessee. Partners are the Alabama Space Grant Consortium; LaSTEM (an affiliate of the Louisiana Space Grant Consortium); University of Tennessee Chattanooga (an affiliate of the Tennessee Space Grant Consortium); Morehouse College and the Atlanta University Center; Mercer University in Macon, Georgia; and the Hines Family Foundation.

### University of Texas at Austin Texas

Space Teams Labs: Engaging, Inspiring, and Training a Diverse and Inclusive Future STEM Workforce

Space Teams Labs will immerse students in interactive space mission activities through virtual reality (VR) technology. The project aims to provide and install hardware and software for at least 50 Space Team Labs in schools, informal education settings, university partner spaces, and other locations reaching underserved students. The Texas, New Mexico, and Louisiana Space Grant Consortia are working together on the project.

### Ohio Aerospace Institute

Cleveland, Ohio

Stepping Stars: A Multi-State Middle and High School Space Grant STEM Engagement Project

Stepping Stars will introduce middle and high school students to the concepts of biomimicry, an approach that takes inspiration from success in the natural world and applies it to engineering and problem-solving. Partners are the Ohio, New York, and Nebraska Space Grant Consortia, as well as Akron Zoo, Girl Scouts of North East Ohio, Ithaca Sciencenter, the Nebraska Department of Education, and Nebraska's 21st Century Community Learning Centers.



Learn more about Space Grant Kids at <https://go.nasa.gov/3YL6Hrh>

# NASA NEXT GEN STEM

## Spark and sustain interest in STEM for K-12 students

NASA's Next Gen STEM project offers a wide array of unique experiences designed to engage K-12 students nationwide in the agency's missions, people, and resources. Whether students are in the classroom, at home, in afterschool programs or in informal education settings, Next Gen STEM aims to reach them through networks of partners and educators, fun activities, educational products, and exciting learning opportunities. This includes expanding the agency's reach into communities that are traditionally underserved and underrepresented in STEM.

Through Next Gen STEM, NASA is broadening participation and building literacy in STEM to inspire the next generation of explorers. Over 2,262 educators at more than 1,000 U.S. museums, science centers, planetariums, NASA Visitor Centers, Challenger Centers, observatories, parks, libraries, camps, and youth-serving organizations were partners in the [Museum & Informal Education Alliance](#).

One highlight of FY 2022 is a new, online community of practice connecting educators and other STEM education professionals with each other and the NASA team. Called the [Connecting Our NASA Network of Educators for Collaborating Together in STEM \(CONNECTS\)](#), the platform fosters discussions, shares materials, and hosts virtual events. CONNECTS hosted several such events during its first year, enabling teachers and K-12 students to talk to NASA experts about topics such as the Artemis program, the Commercial Crew Program, the Quesst supersonic aircraft, and the James Webb Space Telescope in both large scale and smaller settings. The CONNECTS community brings together more than 1,200 educators and NASA team



NASA's SpaceX Crew-2 NASA astronaut Megan McArthur speaks to students during a visit to Arlington Science Focus Elementary School, Friday, June 10, 2022, in Arlington, Virginia. Credits: NASA/Aubrey Gemignani

members. Next Gen STEM also launched the pilot of NASA Sparking Participation And Real-world eXperiences in STEM (SPARX), a new framework for challenges and competitions for K-12 students. SPARX allows participants to select challenges according to their perceived STEM identity, capabilities, and prior experiences. The overarching objectives of SPARX are to utilize evidence-based practices to meet K-12 educators where they are to lower the STEM activity barrier to entry, improve STEM literacy, and show students representation in STEM careers, since studies have shown that most minorities in STEM fields knew someone of their same gender or ethnicity who served as a role model. During the FY22 pilot, six awards were made to facilitate the participation of 145 educators and over 25,000 students from 25 states and Washington, D.C.

Next Gen STEM's [STEM on Station](#) initiative connects students and educators with the International Space Station through educational downlinks and the [Student Payload Opportunity with Citizen Science \(SPOCS\)](#). (Read more about SPOCS on page 48.)

Next Gen STEM produced a variety of resources to help educators excite the Artemis Generation about humanity's return to the Moon. The Artemis Camp Experience Guide, a set of hands-on activities telling the story of the Artemis missions, reached more than 100K people. Through the Artemis Generation Spacesuits and Build, Launch, Recover educator guides, students will learn all about the development of spacesuits and find out how NASA prepares for launch and recovers the spacecraft when its mission successfully ends.

Next Gen STEM continues to invest in partnerships with informal education organizations that develop and share their own NASA STEM activities with students in their communities. These institutions are uniquely positioned to reach those who are historically overlooked for such opportunities. [NASA's Teams Engaging Affiliated Museums and Informal Institutions \(TEAM II\)](#) program selected four organizations in FY 2022, awarding approximately \$800,000 to each organization to put its proposal into action during the next two to four years.

The project also kicked off the new TEAM II Community Anchor Award, selecting an inaugural cohort of 21 institutions to serve as NASA Informal Education Community Anchors. This designation recognizes the organization as an important local hub for space and STEM learning, establishing a NASA presence and nurturing connections between NASA and students in the community. The agency awarded a total of approximately \$520,000 for one- to two-year projects that will serve diverse populations. Read more about the Community Anchor Award on page 22.

Next Gen STEM's collective participation in FY2022

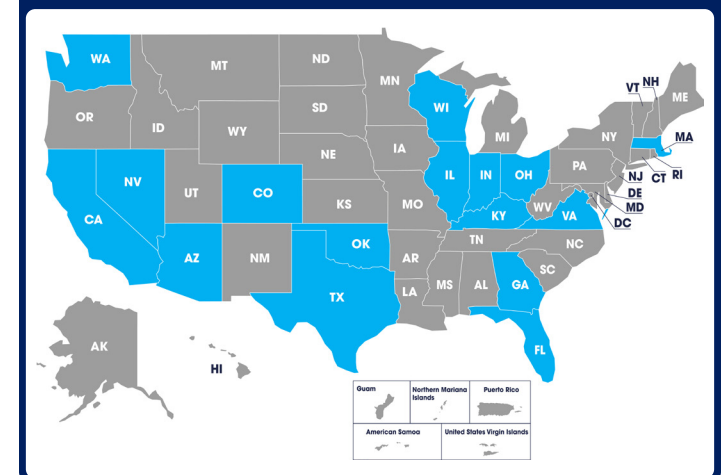
**240K+** student participants      **39K+** educator participants

### NGS Educator Guides and Camp Experiences

Next Gen STEM creates publications for formal and informal education. These resources offer engaging content for grade levels K-12. Three of this year's publications connect students to the Artemis missions and human exploration of the Moon: the [Artemis Camp Experience](#), [Artemis Generation Spacesuits](#), and [Build, Launch, Recover](#).

### Educational Downlinks with NASA Astronauts

K-12 students asked questions of the crew aboard the International Space Station through 26 educational downlinks with U.S. schools, including one U.S. Department of Defense Education Activity school in the United Kingdom.



Learn more about Next Gen STEM at [www.nasa.gov/stem/nextgenstem/index.html](http://www.nasa.gov/stem/nextgenstem/index.html)

# COMMUNITY ANCHORS

The TEAM II Community Anchor designation enables awardee institutions to establish themselves as a NASA STEM resource for local students and families.

NASA's Next Gen STEM developed the **Teams Engaging Affiliated Museums and Informal Institutions (TEAM II)** program to inspire the next generation of explorers by helping museums, science centers, and other informal education institutions and their partners bring NASA STEM content to their communities. The inaugural cohort of Community Anchors launched in early 2022 with 21 projects awarded \$25K each and selected to share authentic STEM experiences with diverse audiences in 16 states.

Students who participated in NASA STEM events hosted by the Long Island Explorium in Port Jefferson, New York, became "community anchors" themselves. The project, "Seeking the Wisdom of the Stars to Understand Planet Earth," included 12 workshops focusing on Earth and space science with emphasis on food security, the availability of fresh water, and natural disasters. During these workshops, staff members trained and recruited teen students to help create and run a NASA activity booth at the annual Maker Faire Long Island in June 2022. In addition to the workshops and Maker Faire engagement, the Long Island Explorium also hosted a professional development seminar for area librarians, which was recorded and made available to the library system's 56 libraries and 1.5 million residents.

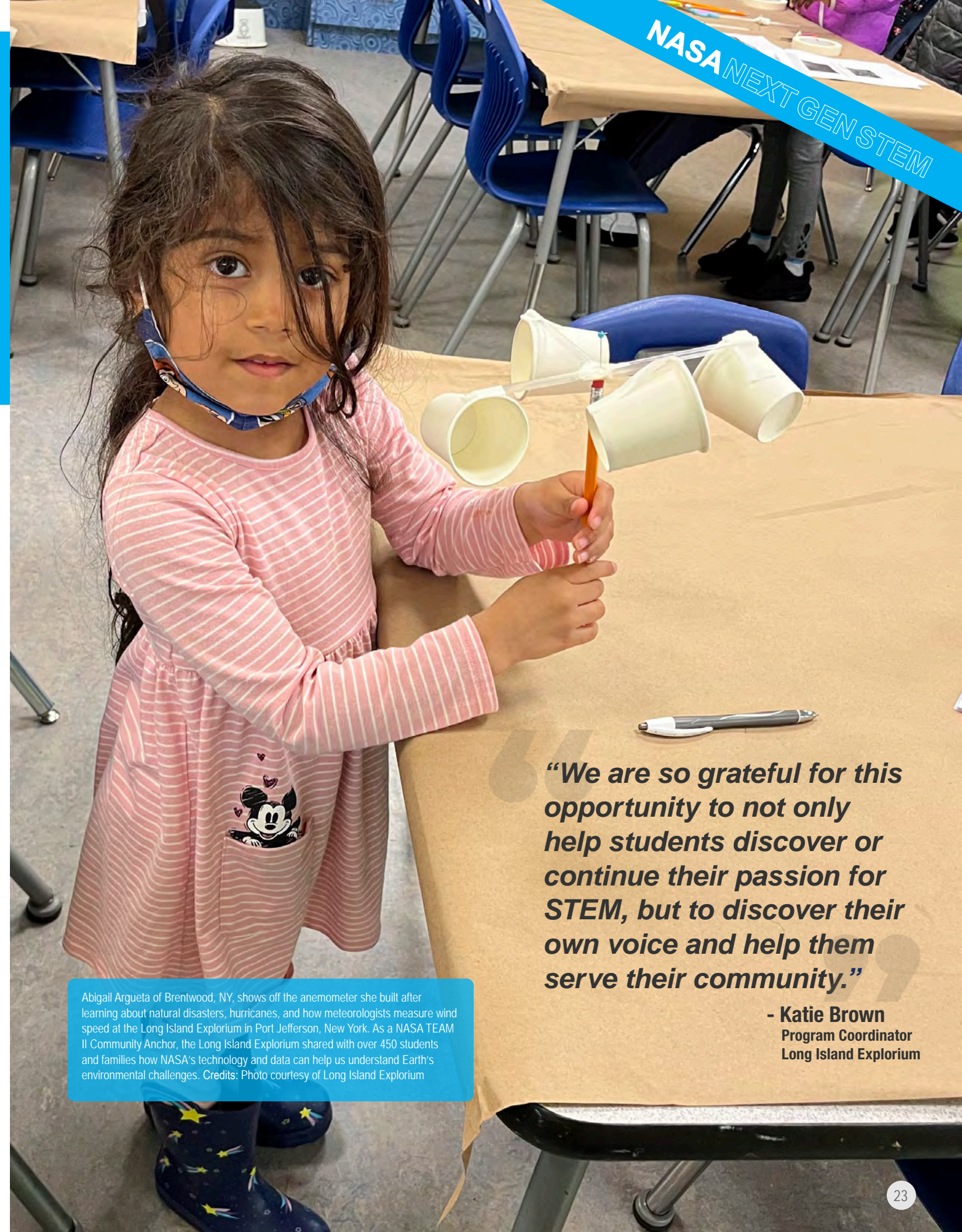
More than 2,000 miles away, elementary and middle school students in the border city of El Paso, Texas, learned about innovations in space, citizen science, astronautics, and more through six workshops hosted by Fab Lab El Paso. The year-long program was called "PASOFinders," a nod to the Spanish word for "path" and the meaning of "pathfinder" as someone who discovers the unknown. Through the PASOFinders series

of workshops, students in grades 3-8 engaged in hands-on activities to learn about the engineering process of iterative design, data collection, and virtual reality, and explore the scientific achievements of Hispanics, indigenous peoples, and women.

"We were once young students, looking up to the stars and dreaming of becoming astronauts," said Michael Nelson, director of operations at Fab Lab El Paso. "Now we work alongside NASA to inspire and shape future generations of explorers – a dream come true."



Lucca Soto works on his water filtration experiment using a variety of materials such as sand, rock, coffee filters, and more during a World Water Day event in March 2022 at Fab Lab El Paso. Credits: Fab Lab El Paso



NASA NEXT GEN STEM

*"We are so grateful for this opportunity to not only help students discover or continue their passion for STEM, but to discover their own voice and help them serve their community."*

**- Katie Brown**  
Program Coordinator  
Long Island Explorium

Abigail Argueta of Brentwood, NY, shows off the anemometer she built after learning about natural disasters, hurricanes, and how meteorologists measure wind speed at the Long Island Explorium in Port Jefferson, New York. As a NASA TEAM II Community Anchor, the Long Island Explorium shared with over 450 students and families how NASA's technology and data can help us understand Earth's environmental challenges. Credits: Photo courtesy of Long Island Explorium

# FY 2022 NASA STEM Program Awards By State or Territory



## Next Gen STEM

NASA reaches diverse groups of K-12 students and educators through Next Gen STEM. The project's grantees and affiliates help bring the excitement of spaceflight into classrooms and communities nationwide, broadening participation in STEM and igniting a passion for exploration.



## Space Grant

Space Grant consists of a national network of colleges and universities, informal education institutions, and industry affiliates to expand opportunities for students to participate in NASA's aeronautics and space projects. Connecting these organizations are the 52 Space Grant consortia, (one in each state as well as Washington, D.C., and Puerto Rico).



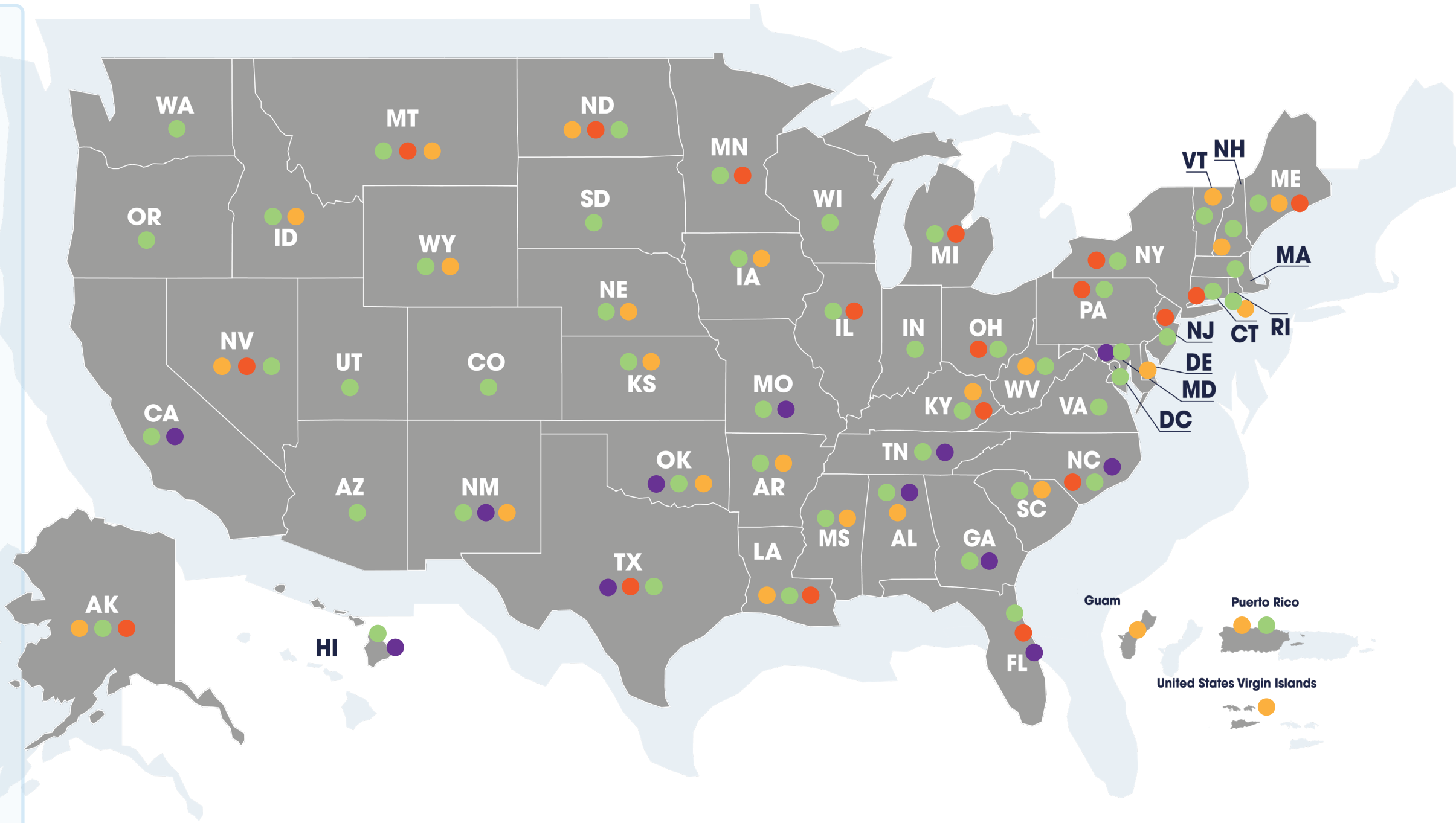
## EPSCoR

NASA is one of six federal agencies with an EPSCoR program, which exists to strengthen STEM capabilities and research infrastructure in U.S. regions that historically have had less involvement in research and development activities. NASA EPSCoR funds projects in 28 jurisdictions, enabling researchers in those areas to participate in competitive R&D.



## MUREP

Through MUREP, NASA invests in the advancement of research capacity at Minority Serving Institutions, and opportunities for MSI students to contribute to the agency's missions and goals.





# STUDENT WORK EXPERIENCES

NASA makes stellar work experiences available to high school and higher education students. Through internships and fellowships, students work to find solutions to technological challenges and have a role in NASA's mission. Agency interns and fellows are an integral part of the future STEM workforce.

Internships are available for high school, undergraduate, and graduate students, as well as educators. Under the professional guidance of an agency mentor, interns contribute to NASA projects, gain workplace experience, develop their expertise, and learn how to put their own knowledge and skills to work in the aerospace industry.

NASA's Fellowship activity engages graduate students from traditionally underrepresented groups in research that's critical for the agency's current and future exploration goals. The National GEM Consortium recruits top students pursuing advanced degrees in applied science and engineering, then matches their skills to the technical needs of GEM employer members, including NASA.

These valuable work experience opportunities launch students' careers on an exciting trajectory. Read on for this year's NASA internship and fellowship highlights.

NASA intern Shayne Tyrell inside the Vehicle Assembly Building at Kennedy Space Center. Credits: NASA



NASA intern Jada Jennings. Credits: NASA



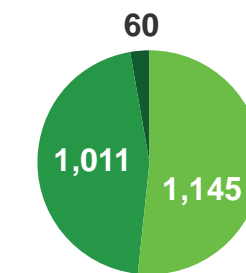
## NASA hosted more than 2,200 interns representing a range of academic levels, races, and ethnicities in 2022.

Through NASA Internships, students in high school and higher education contribute to NASA's space exploration goals while adding authentic STEM workplace experience and hands-on skills to their own resume.

NASA Internships are competitive awards to support educational opportunities that provide unique research and operational experiences for high school, undergraduate, and graduate students, as well as educators. Interns work side-by-side with NASA professionals throughout the agency, working on projects such as the Artemis missions, technology development for future human spaceflight, space science, Earth science, computer science and software, communications, and more. NASA mentors provide workplace and career guidance while helping interns grow their expertise.

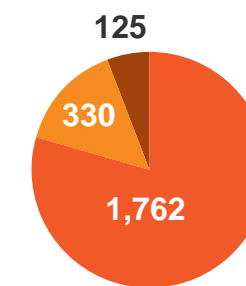
### Total Internships FY 2022

FALL '21	SPRING '22	SUMMER '22
527	467	1,224
<b>2,218 Total</b>		



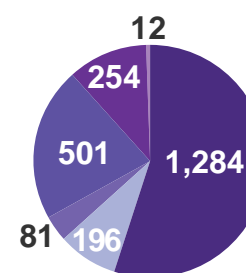
#### Gender

- Did Not Report
- Female
- Male



#### Ethnicity

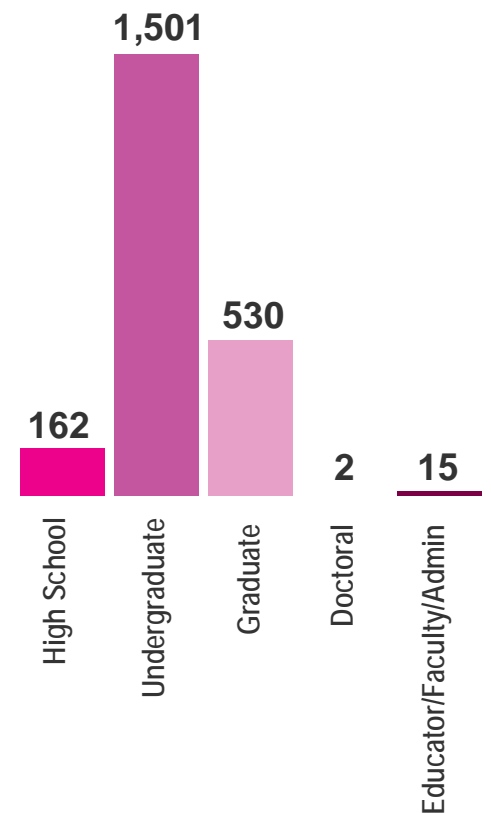
- Did Not Report
- Hispanic or Latino
- Non-Hispanic or Latino



#### Race

- Did Not Report
- White
- Native Hawaiian or Other Pacific Islander
- Black or African American
- Asian
- American Indian or Alaska Native

#### Academic Level



Participants could select multiple categories when reporting race. Respondents were not required to report across all categories.

# AMAZING INTERNS

## Through authentic work experiences, NASA interns have been participating in the ultimate STEM project: NASA's exploration of the Moon with Artemis.

The uncrewed Artemis I mission was the first integrated flight of the Space Launch System (SLS) rocket and Orion spacecraft. This first in a series of increasingly complex missions will carry Orion around the Moon, paving the way for astronauts — including the first woman and person of color — to step onto the lunar surface.

This new era in human exploration has had the help of NASA interns who lend their efforts to make future lunar exploration a reality.

NASA intern Katrina "Kat" Ternus, an aerospace engineering major at Embry Riddle Aeronautical University in Florida, helped establish protocols for monitoring the SLS for potentially hazardous ice development during fueling. Ternus also got the unique experience of monitoring segments of the rocket's twin solid rocket boosters as they came together in Kennedy's Vehicle Assembly Building.

NASA interns Shayne Tyrell and Aidan Fleming, computer science undergrads at the University of Central Florida, spent their summer internship working together on a diagnostic program developed to help engineers monitor the health of servers and computers running critical software in the Launch Control Center. While Fleming focused on pulling computer data into the program, Tyrell developed the graphical user interface that displays that data for users.

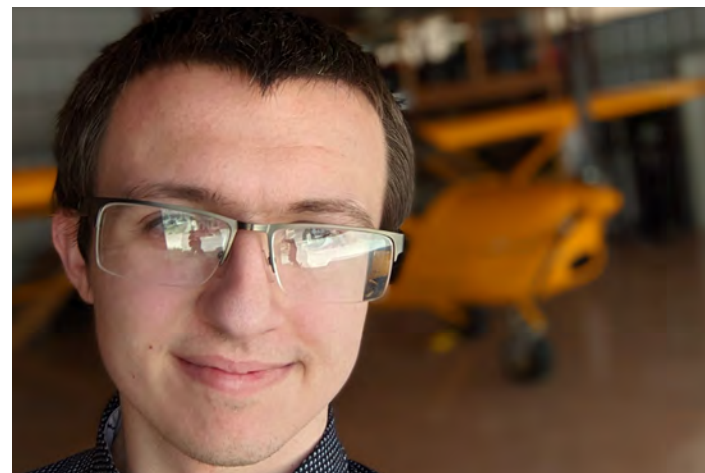
Like space enthusiasts worldwide, these interns eagerly waited to see their contributions take flight as the SLS rocket and Orion spacecraft launched a new era in spaceflight.



NASA intern Katrina "Kat" Ternus in front of the Vehicle Assembly Building at NASA's Kennedy Space Center. Credits: NASA




NASA intern Shayne Tyrell inside the Vehicle Assembly Building at NASA's Kennedy Space Center. Credits: NASA



NASA intern Aidan Fleming inside a hangar at NASA's Kennedy Space Center. Credits: NASA

*"One great thing about Artemis is that we are taking what we knew from [earlier programs] and now we're kind of pushing it toward the future."*

**-Kat Ternus**



Learn more about  
NASA Internships at  
[intern.nasa.gov](https://intern.nasa.gov)

NASA intern Katrina "Kat" Ternus in front of Artemis I on launch pad 39B at NASA's Kennedy Space Center. Credits: NASA





## The NASA Fellowship Activity awards are designed to support NASA STEM Engagement objectives and to provide academic institutions the ability to enhance graduate-level learning and development.

Each year, the NASA Fellowship Activity awards training grants to Minority Serving Institutions (MSIs) using Minority University Research Education Project (MUREP) funds. The NASA Fellowship Activity aligns with the Office of STEM Engagement's goal to establish a well-trained STEM workforce.

In partnership with the NASA Fellowship Activity, the National Consortium of Graduate Degrees for Minorities in Engineering and Science (GEM) engages underrepresented and underserved minorities in STEM graduate academic programs, and has graduated over 4,000 researchers, professors, and entrepreneurs around the nation. GEM provides highly qualified faculty, undergraduate, and graduate students, in disciplines needed to help advance NASA's missions, thus affording them the opportunity to directly contribute to advancements in STEM-related areas of study. Fellowship opportunities are focused on innovation and generate measurable research results that contribute to NASA's current and future science and technology goals.

### FY2022 New and Total Active Fellows

**21** new fellows      **86** total active fellows

**13** new Ph.D.      **76** total active Ph.D.

**8** new Masters      **10** total active Masters

**8** new fellows from MSIs      **52** active fellows from MSIs



Above: Rayshaun Wheeler, a first-year Ph.D. student majoring in systems engineering at the University of Virginia, worked at Kennedy Space Center's Granular Mechanics and Regolith Operations Lab in the center's Swamp Works facility. Wheeler's focus was on foundational work, including the Lunar Rockyard Project, where he built an outdoor bin that simulates the Moon's craters and rocks.

Opposite: Angie Huerta, a first-year Ph.D. student studying particle physics at the University of Notre Dame, worked at Kennedy Space Center on a project testing hydrogen plasma on lunar regolith simulant, which is similar to returned lunar soil samples, to explore the plasma's reliability and efficiency potential for Artemis.



Learn more about  
NASA Fellowships at  
<https://go.nasa.gov/3Jg3Bpq>

# NASA FELLOWS

# FEATURED

# FELLOWS



**Myckieala Cooper**

**Langley Research Center**  
**Graduate student at Texas A&M University**  
**Majoring in biotechnology**

"I am working towards developing plasmon-enabled sensors for the detection of foodborne pathogens. During my time at NASA, I worked on the ash analysis for closing the loop on space waste and implementing into in situ resource utilization (ISRU) applications. I specifically contributed with the characterization of ash materials from different space waste-processing technologies by scanning electron microscopy, energy dispersive spectroscopy and X-ray photoelectron spectroscopy for ISRU applications. With the characterization of these materials, we were able to discover high-value products that can be extracted from trash conversion systems and assist future space missions."



**Natalia Farquarson**

**Ames Research Center**  
**Graduate student at Johns Hopkins University**  
**Majoring in electrical and computer engineering**

"The first phase of my project was to build a model that can test and train audio data which would allow Astrobees to identify each sound in the space. In the final phase of the research, I hope to provide Astrobees the capabilities to assess acoustic noise on the International Space Station (ISS). Ultimately, this would add an additional level of efficacy when it comes to Astrobees' ability to carry out maintenance tasks on the ISS. My time at NASA has helped in my future educational and career goals because it has allowed me to learn about machine learning as well as signal processing."



**Mahmoud Matar Abed**

**Kennedy Space Center**  
**PhD candidate at the University of Minnesota**  
**Majoring in chemistry**

"During my time at NASA, I have worked on fostering artificial intelligence and machine learning (AIML) transformation communication and workforce development. Majoring in biotechnology at Texas A&M University with a background in pharmacy and business, my career goal is to pursue computational medicine with an emphasis on analyzing datasets to improve translational medicine and health outcomes in diverse patient populations. Working with the Langley Data Science team supported my career pivot and is helping me work on interdisciplinary teams to creatively solve problems using innovative AIML enhanced approaches."



**Sianji Brown**

**Kennedy Space Center**  
**Graduate student at Columbia University**  
**Majoring in sustainability science**

"My research project was on a capacitive deionization (CDI) reactor that selectively removed sodium ions from wastewater to produce fertilization water. As NASA continues its mission to return to the Moon and Mars, the CDI reactor will contribute to the closed loop water treatment system that will allow for in-situ access to potable water for crop production in space. My time and research have contributed tremendously to my career path by providing me with hands-on laboratory experience and introducing me to a sustainable water system solution that can be applied in terrestrial spaces to improve more people's access to clean water."

# STUDENT LEARNING OPPORTUNITIES

Authentic, hands-on learning experiences give students a chance to test out their ideas and gain a whole new perspective on their own abilities. These student challenges and competitions are designed to spark the curiosity and determination of the Artemis Generation as they take on the challenges of space exploration. This year, challenges were available for students in middle school all the way through graduate school.

**Students flexed their design and engineering skills as they built and launched high-powered rockets, designed robots capable of mining the Moon's surface or traversing difficult**

**lunar terrain, created human-powered rovers, and tested technologies and tools to assist future astronauts working on the Moon. They innovated new ways to commercialize the agency's intellectual properties by developing technologies for the marketplace, and developed science and technology payloads for flight on high-altitude balloons and sounding rockets, and to the International Space Station.**

There are so many out-of-this-world opportunities for students to learn about NASA's missions. Read about this year's student challenge highlights on the following pages.

SUITS team testing their augmented reality device at the rock yard at Johnson Space Center during the NASA Spacesuit User Interface Technologies for Students (NASA SUITS) Onsite Test Week. Credit: NASA

# ARTEMIS

## STUDENT CHALLENGES

**As NASA embarks on a new era of lunar exploration through the Artemis missions, it's more important than ever that today's students – the Artemis Generation – get opportunities to flex their STEM skills and tackle some of the most critical technological challenges ahead.**



The Student Launch team from Victory Christian Center School in Charlotte, North Carolina, pose with their rocket prior to launch. Credits: NASA/Danielle Burlison.

Students can gain experience designing and testing rockets, robots, exploration tools, software, and more through the agency's [Artemis Student Challenges](#).

[Student Launch](#) competition returned to in-person launches in the field near the agency's Marshall Space Flight Center in Huntsville, Alabama, for the first time in three years in April 2022. Sixty student teams from 23 states and Puerto Rico participated in the 2022 challenge, which asked middle-school, high-school, and college and university teams to build and launch a high-powered amateur rocket, fly it to an altitude between 4,000 and 6,000 feet, and make a successful landing — all while carrying a payload capable of autonomously determining its landing location and transmitting it back to the ground station without the use of GPS or Earth-based technologies. This requirement simulated a challenge inherent in communicating with spacecraft on other planetary bodies where GPS is not an option. Twenty-seven teams attended the on-site launch event, while teams that were unable to travel conducted their flight tests at a home launch field. Student Launch is funded by Next Gen STEM and NASA's Human Spaceflight Mission Directorates.

The [First Nations Launch](#) challenge also provides students the opportunity to demonstrate engineering and design skills through rocketry. Managed and funded by MUREP and facilitated by the

Wisconsin Space Grant Consortium, First Nations Launch is focused on student teams from Tribal Colleges and Universities, Native American-Serving Nontribal Institutions, and schools with American Indian Science and Engineering Society (AISES) chapters. In 2022, 57 students from 13 schools representing 25 tribal organizations designed, built, and flew high-powered rockets for the challenge's first launch weekend since 2019 at Carthage College in Kenosha, Wisconsin.



A member of the University of California Davis First Nations Launch team discusses the group's rocket with a NASA judge.



The Milwaukee School of Engineering's robotic miner is ready for its turn to dig in the mining arena during NASA's LUNABOTICS competition on May 24, 2022, at the Center for Space Education near the Kennedy Space Center Visitor Complex in Florida. Credits: NASA/Kim Shiflett.

Also returning to in-person competition for the first time since 2019 was the [Lunabotics](#) robotic mining challenge, made possible through the Human Spaceflight Mission Directorates. Robotic excavators designed by 38 college and university teams faced off in a new mining arena at NASA's Kennedy Space Center in Florida, where they mined simulated lunar soil, or regolith, to collect as many rocks as possible and deposit them in a collection bin. Each year, the competition challenges teams to use the same systems engineering process used by NASA to design, build, and operate robots capable of excavating and moving across a simulated lunar surface — critical capabilities robots will need to extract building materials, water, or fuel during future Artemis missions.

The excitement of Lunabotics also was offered to K-12 students in FY 2022 through the Lunabotics Junior Contest. For Lunabotics Junior, students designed a robot that could move regolith from one place to another on the lunar South Pole. Learn more about Lunabotics Junior on page 46.

[NASA's Human Exploration Rover Challenge \(HERC\)](#) is funded by Next Gen STEM and the Human Spaceflight Mission Directorates. In 2022, 91 teams of U.S. and international high school and college/university students were challenged to design, build, and test human-powered rovers and scientific task tools that would be used on a

challenging half-mile course that simulates the terrain of the Moon and other rocky bodies in our solar system. Throughout the challenge year, teams submitted a series of technical reports that detailed rover and task tool design specifications for dimensioning, material properties,



Students competing in NASA's 2022 Human Exploration Rover Challenge work on building their rover. Credits: NASA

performance demands, and safety constraints, along with information about team budgets, scheduling, and STEM outreach activities.

Due to lingering safety concerns regarding COVID-19 the 2022 challenge was held virtually, and competing teams submitted rover demonstration videos to satisfy requirements.

What about areas on the Moon that can't be reached by a wheeled rover? This is what the **Breakthrough, Innovative and Game-changing (BIG) Idea Challenge** sought to explore in 2022. University-level teams were asked to design unique, cost-effective robots that could hop, slither, crawl, tumble, leap, or otherwise move without rolling on wheels. The agency awarded nearly \$1.2 million to seven university teams in early 2022, and the teams used these funds to create their technologies and tested them in an analog environment in November 2022. The BIG Idea Challenge is sponsored by NASA through a collaboration between the agency's Space Technology Mission Directorate and Space Grant, and is managed by the National Institute of Aerospace.

While traversing across the Moon will pose challenges for future crews, working on the lunar surface also will require specialized tools. Two challenges, the NASA **Spacesuit User Interface Technologies for Students (SUITS)** and **Micro-g Neutral Buoyancy Experiment Design Teams (Micro-g NExT)**, offer opportunities for college and university teams to address these needs in different ways.

NASA SUITS challenges students to design and create information displays for use in spacesuits. These displays are developed to help astronauts work within an augmented reality environment. Funded by the Exploration Systems Development Mission Directorate's xEVA and Human Surface Mobility Program and managed by OSTEM at Johnson Space Center, NASA SUITS hosted 10 teams from 15 institutions in 2022, inviting them to test their software designs at Johnson's Rock Yard facility.

Teams participating in Micro-g NExT are asked to address a genuine challenge in space exploration by developing and testing a new tool or device identified as necessary for Artemis missions. For the 2022 challenge, teams could choose to design a sample marker for astronauts to deploy on the Moon's surface, a bag and dispenser for crew members to use when collecting geological lunar samples, or create an anchoring mechanism capable of holding onto a variety of surfaces. Nineteen teams brought their prototypes to Johnson Space Center's Neutral Buoyancy Lab for testing by NASA divers in the simulated lunar surface environment. Micro-g NExT is funded by the Human Spaceflight Mission Directorates. Read about a featured Micro-g NExT team on page 43.



Students from the University of Maryland's 2022 BIG Idea Challenge team test their wheeled rover, TRAVELS (Terrapin Rover Allows Versatile Exploration of the Lunar Surface).



SUITS team testing their augmented reality devices at the rock yard at Johnson Space Center during the NASA Spacesuit User Interface Technologies for Students (NASA SUITS) Onsite Test Week. Credit: NASA



A NASA diver testing a student created tool in the Neutral Buoyancy Lab at Johnson Space Center as part of the 2022 Micro-G NExT challenge. Credit: NASA



NASA Spacesuit User Interface Technologies for Students (NASA SUITS) Onsite Test Week at the Johnson Space Center Rock Yard, May 20, 2022. Credits: NASA/Josh Valcarcel.



Learn more about  
Artemis Student Challenges at  
[stem.nasa.gov/artemis/](https://stem.nasa.gov/artemis/)

# PIVOT PATENT

Lone Star College Receives  
Patent After Success in NASA's  
Micro-g NExT Challenge

A NASA diver testing the Lone Star College-Cy Fair (CRATER) Dust Tolerant Pivot Mechanism during the NASA Micro-g NExT challenge at Johnson Space Center. Credits: NASA

After NASA's adoption of their zip-tie cutter, a tool designed to assist spacewalking astronauts, Lone Star College-CyFair in Houston has continued finding success through the agency's Micro-g Neutral Buoyancy Experiment Design Teams, or Micro-g NExT, experience. Recently, the college's CRATER team received a patent for a dust-tolerant pivot device they designed during a 2020 Micro-g NExT challenge in support of NASA's Artemis program.



A NASA dive team testing the Lone Star College-Cy Fair (CRATER) Dust Tolerant Pivot Mechanism during the NASA Micro-g NExT challenge at Johnson Space Center. Credits: NASA

Micro-g NExT challenges colleges from across the country to design, build, and test a tool or device that addresses an authentic, current space exploration need. The "micro-g" element comes from these concepts being tested in a simulated microgravity environment — NASA Johnson Space Center's Neutral Buoyancy Laboratory (NBL), better known as the behemoth pool where astronauts prepare for upcoming spacewalks.

The dust-tolerant pivot device's patent, U.S. Patent US 11,219,995 B1, denotes why this invention is so inherently useful: The inventors have found a new and improved pivoting assembly that overcomes the deficiencies of conventional geological and landscaping tools when collecting lunar samples such as rocks, pebbles, and sand. The pivoting assembly has a high level of lunar dust tolerance, increasing the life, reliability, and durability of the pivoting assembly. Incorporating the assembly makes lunar sample collection tools more effective.

The six-person CRATER team was advised by Dr. Yiheng Wang, a professor of engineering at Lone Star College. Two students, Kary Meadows and Humberto Andres Leal Acosta, were named as inventors on the patent.

A major part of the process for the team was learning and practicing

the engineering design model, which Wang said is exemplified within the team. Wang described the team's process as being design-focused, including extensive research, prototyping their top design, and fine-tuning through multiple tests.

"When I started working with all my new student teams, I let them know from the beginning that if their designs showed potential, our college

***"It feels great — it feels like a sense of accomplishment [for] all the hours we put into it, It feels like you're a professional engineer now."***

**— Humberto Andres Leal Acosta  
CRATER Team Member**

would consider sponsoring patent applications," Wang said. "After [our team] successfully [virtually] directed tests of their design prototypes at NASA's NBL in September 2020, our college decided to proceed with filing a patent application on Team CRATER's design."

Wang saw the potential for the device and understood that time was of the essence in applying for the patent. Previously, Team CERO of Lone Star College was not able to receive a patent for their zip-tie cutter, as they only started the application process a year after it had already been unveiled to the public, deeming it ineligible.

"We realized that this is something that can be useful outside of the space exploration market," Leal Acosta said. "It can be used for agriculture, it [can] be used for mining, it can be used in an environment that isn't space."

Team CRATER applied for the patent after receiving support from Lone Star College and seeing its promise for real-world applications. The patent was officially received Jan. 11, 2022, and shows the students' creativity and hard work.



Learn more about  
Artemis Student Challenges at  
[stem.nasa.gov/artemis/](https://stem.nasa.gov/artemis/)

# MIRO

## RESEARCH

NASA's [MUREP Institutional Research Opportunity \(MIRO\)](#) supports students and faculty at Minority-Serving Institutions participating in research that aligns with the agency's top priorities. Since its inception 30 years ago, MIRO has inspired the next generation while attracting, engaging, and preparing the future STEM workforce.

Jenny Gil Acevedo is a doctorate student in environmental science at University of Puerto Rico, Río Piedras. Acevedo is studying how future space crews could employ microalgae for waste management. Microalgae could be used to remove nitrogen and phosphorous from urine, leaving water to be filtered and algae to be utilized for other purposes, such as plant fertilizer or even 3D printing. "I can see the huge potential algae have in long-duration missions," Acevedo said. "We have to think about how to make things sustainable, on Earth and in space."

Justin Borrero, a recent graduate of the University of Puerto Rico, studied carbon dioxide removal and conversion. Through a concept called the Sabatier reaction, carbon dioxide exhaled by astronauts in a closed system could be combined with hydrogen to create both water and methane — a potential propellant. This method could be used in a spacecraft, on the Moon, or even on Mars.

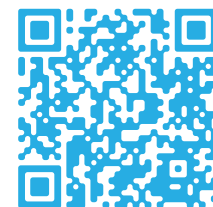
A thousand miles northwest of Río Piedras, Melissa Venedicto, a doctorate student in materials science and engineering at Florida International University in Miami, is focused on discovering the best materials for lightweight microelectronic devices. Through her project, she's identifying ways to apply and mass-produce these materials for use in future human spaceflight.



Melissa Venedicto studies materials for potential future spaceflight at Florida International University in Miami.

"Optoelectronics can be embedded into spacesuits as blood pressure or temperature sensors or used inside a spacecraft to monitor temperature and humidity levels, and they're safe, reliable, and stable in space environments," Venedicto said.

These projects and many more made possible through MIRO will help pave the way as NASA continues to expand the boundaries of exploration.



Learn more about MIRO research opportunities at [nasa.gov/stem/murep/miro/index.html](https://nasa.gov/stem/murep/miro/index.html)

Justin Borrero inside a laboratory at the University of Puerto Rico, where he studied carbon dioxide removal and conversion.

# CHALLENGES ACCEPTED

As NASA continues to expand its horizons in space, aviation, science, and technology, the Office of STEM Engagement provides opportunities for students to engage in these areas through an array of challenges ranging from middle school through graduate school.



Lucia Grisanti, national winner in the K-5 category of the 2022 Lunabotics Junior Contest. Credits: Future Engineers

## Lunabotics Jr.

For the first time, the excitement of Lunabotics was offered to K-12 students in FY 2022 through the [Lunabotics Junior Contest](#), an opportunity funded by NASA's Human Spaceflight Mission Directorates and facilitated by Future Engineers. For Lunabotics Junior, students designed a robot that could move regolith from one place to another on the lunar South Pole. The two designers who emerged victorious in their respective age categories were Shriya Sawant, 15, of Cumming, Georgia, and Lucia Grisanti, 9, from Toms River, New Jersey. As grand prize winners, Sawant and Grisanti got to have a virtual chat with Kennedy Space Center Director Janet Petro.



Community college students participating in the job shadowing portion of an NCAS on-site visit at NASA's Langley Research Center. Credits: NASA

## NCAS

Each [NASA Community College Aerospace Scholars \(NCAS\)](#) mission builds students' aerospace knowledge and skills by focusing on the agency's specific science and mission goals, collaboration, competition, and career pathways.

- Mission 1: Discover is a five-week, self-paced online course in which students learn about NASA missions, research, and goals.
- Mission 2: Explore allows students to choose either an exploration or career simulation experience.
- Mission 3: Innovate is an engineering challenge to design a mission to the Moon or Mars under the mentorship of a NASA scientist or engineer. Scholars worked at Ames Research Center, Armstrong Flight Research Center, or Langley Research Center.

Of the 1,287 community college students NCAS served in FY 2022, 85% hailed from Minority Serving Institutions (MSIs). Scholars self-reported as 41.9% female, 71.9% minority, and 3.9% veteran.



Texas State University's Bobcat CaerusCrete team, left to right, Solomon Debbarna, Anthony Torres, Rodolfo Castillo Hernandez, Damini Gopal, and Xijun "Jeff" Shi. Credits: Texas State University

## NASA MINDS

Undergraduate students attending MSIs have the opportunity to contribute to the Artemis missions through [MUREP Innovative New Designs for Space \(NASA MINDS\)](#), an annual competition that completed its second year in FY 2022. NASA MINDS asks students to design a project that will help solve a technological problem facing the Artemis team. A total of 33 teams representing 32 institutions from 15 states completed the challenge, and in May 2022, former NASA astronaut Winston Scott virtually presented awards to participating teams.

Team SenseAid from the University of Central Florida in Orlando, the Grand Champion at the senior level, built a prototype 3D printer intended to be capable of printing in gravity and microgravity across a wide range of engineered materials. The Bobcat CaerusCrete team from Texas State University, the Grand Champion at the underclassman level, used lunar regolith simulants to synthesize geopolymers for future 3D construction on the Moon. In addition to monetary awards, these winning teams will receive a complimentary trip to NASA's Kennedy Space Center for a recognition ceremony, behind-the-scenes facility tours with subject matter experts, and access to the Kennedy Visitor Complex.



Students presented their concepts during the MITTIC poster session at Johnson Space Center. Credits: NASA

## MITTIC

The [MUREP Innovation Tech Transfer Idea Competition \(MITTIC\)](#), encourages MSI students from a variety of academic disciplines to form teams focused on developing a business concept to commercialize a specific NASA intellectual property. In April 2022, participants from nine MSIs took part virtually in the MITTIC immersion experience at NASA's Johnson Space Center, meeting business leaders and agency subject matter experts and touring the center's spacesuit lab before presenting their pitches in the "Space Tank" competition. Judges selected HydroPONDS, a combined MSI team from Santa Monica College, San José State University, and Pasadena City College, as the winner of MITTIC 2022 for their spinoff design to implement user-friendly, water recycling gardens into new apartment and high-rise infrastructure. While all competing MITTIC teams received incentives of up to \$5,000, team HydroPONDS received an additional \$10,000 to begin building their prototype. Team HydroPONDS virtually toured and engaged with leadership at NASA's Ames Research Center and the Silicon Valley Leadership Group.

Great things are on the horizon for MITTIC as the competition returns to on-site experiences for selected teams. Through the continued support of the STMD Tech Transfer program, the activity is expanding MITTIC's NASA Intellectual Property offering for teams to choose from in designing their spinoff proposal.



# PAYLOAD PAYOFF

## Several payloads developed by university student teams were put to the test during FY 2022

Several opportunities offered through OSTEM's projects allowed student payloads to be tested by NASA during FY 2022. While some of the experiments flew to the International Space Station, others completed suborbital missions launched aboard sounding rockets. Read on to learn about a few of the innovative investigations created by the Artemis Generation.



University of Idaho SPOCS student participants Ashley Keeley and Kaitlyn Harvey work in the Space Station Processing Facility (SSPF) lab to secure the initial layer of their payload contamination level prior to launch. Credits: NASA

Four experiments focusing on bacteria resistance or sustainability research flew to the space station through the [Student Payload Opportunity with Citizen Science \(SPOCS\)](#) offered by NASA's STEM on Station, part of the Next Gen STEM project. As a part of the project, student teams also included K-12 students as citizen scientists with a role in the experiment.

In December 2021, the first two SPOCS payloads — an antibiotic resistance experiment developed by Columbia University and an experiment testing bacteria-resistant polymers developed by the University of Idaho — flew to the station aboard the uncrewed cargo resupply mission SpaceX CRS-24. Two additional SPOCS payloads



Inside a laboratory at Kennedy Space Center, Arkansas State University students — one in a waxworm costume — prepare their payload for flight to the International Space Station to study how waxworms degrade plastics in microgravity. Part of Next Gen STEM's Student Payload Opportunity With Citizen Science (SPOCS), the payload flew aboard the SpaceX cargo Dragon spacecraft launched July 14 on the company's 25th uncrewed cargo resupply mission to the station. Credits: NASA

followed in July 2022 aboard SpaceX CRS-25: a biopolymer experiment developed by Stanford University, and a study of waxworms' ability to biodegrade plastic in microgravity developed by Arkansas State University.

Also aboard SpaceX CRS-25 was a payload designed to help advance water-recycling capabilities in spaceflight. Water must be transported into space and efficiently recycled in order to continue using it for crew health and other needs. A team of researchers from the University of Puerto Rico, Río Piedras created a novel water recycling method which launched aboard SpaceX CRS-25 so it could be put to the test in orbit. The research was supported by [NASA's MUREP Institutional Research Opportunity \(MIRO\)](#), which awards funds aimed at enhancing and sustaining institutions' capability to perform NASA-related research and education.



Alondra Rodriguez-Rolon, professor Eduardo Nicolau, and Liz Santiago-Martoral work on one of their water recycling experiments. Their work is among the projects funded over the last 30 years through NASA's MUREP Institutional Research Opportunity (MIRO) program. Credits: University of Puerto Rico-Río Piedras

Not every student payload was tested in the microgravity environment of the space station. The University of Kentucky developed its Kentucky Re-Entry Probe Experiment (KREPE) to evaluate the performance and behavior of heat shields on hypersonic vehicles entering the atmosphere. Using funds from [EPSCoR's Rapid Response Research](#) award, the University of Kentucky team built a numerical simulation code for modeling heat shields, but the only way to validate that code was to build — and fly — capsules that could collect vital data as they returned to Earth.

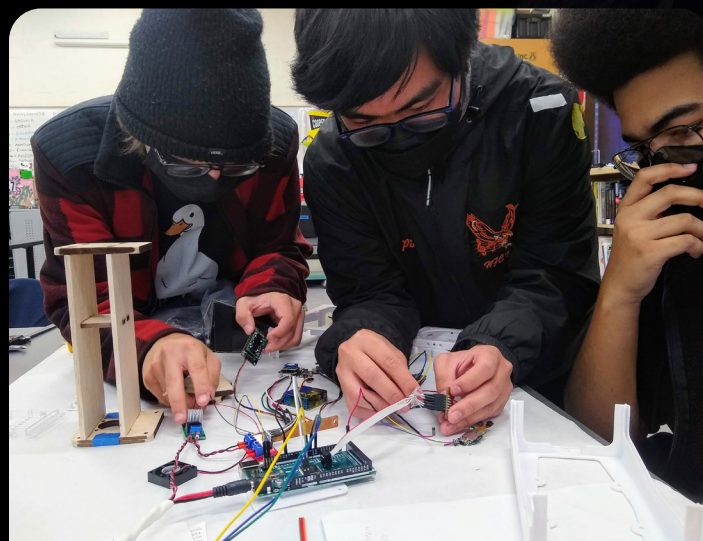
Three football-sized KREPE capsules launched to the station on Northrop Grumman's 16th cargo resupply mission in August 2021, but the real test began three months later, when astronauts installed and activated the capsules inside the uncrewed Cygnus spacecraft before its return to Earth. As the Cygnus disintegrated as planned, the KREPE capsules were ejected for their re-entry test. Two of the three were successful in capturing and transmitting data — more than enough information for the team to analyze the heat shields' performance.

In addition to orbital payloads, experiments flown in suborbital space can also return valuable information for student researchers. [RockOn](#), [RockSat-C](#), and [RockSat-X](#) are suborbital flight opportunities made possible to college and university student teams through the Colorado and Virginia Space Grant Consortia and enabled through a collaboration with the Wallops Flight Facility Suborbital and Special Orbital Directorate. In June 2022, a two-stage Terrier-Improved Orion rocket launched from NASA's facility on Wallops Island, Virginia, carrying 39 experiments from the RockOn program and seven from the RockSat-C program to an altitude of nearly 70.5 miles.

RockSat-X payloads, which contain more complex experiments than RockOn and RockSat-C, are flown approximately 20 miles higher to provide more flight time. Six student experiments designed and built by community college and university students launched through RockSat-X aboard a Terrier-Improved Malemute sounding rocket from Wallops in August 2022, carrying the payloads to an altitude of about 91 miles.

# MISSION FOCUSED

NASA's five mission directorates create STEM based opportunities and resources centered on their focus areas: Aeronautics Research, Science, Space Technology, Exploration Systems Development, and Space Operations.



Students from a winning team for the 2021-2022 TechRise challenge work together at Sewanhaka High School in Floral Park, New York, to wire the electronics of their experiment payload for their upcoming suborbital test flight. Credits: Sewanhaka High School, Jack Chen

## TechRise

Students in grades 6-12 gained the opportunity to design, build, and launch science and technology experiments on high-altitude balloons or suborbital rockets in the inaugural year of NASA's **TechRise Student Challenge**. Managed by the Space Technology Mission Directorate and NASA's Flight Opportunities program, in partnership with NASA's Tournament Lab and administered by Future Engineers, the first iteration of TechRise challenged students to develop experiments that will have approximately four hours of flight time if assigned to balloon flights or around three minutes of testing in microgravity if launched on a suborbital rocket. In January 2022, 57 teams comprising more than 600 students were awarded a NASA-funded slot on an upcoming flight and \$1,500 per team to build their experiments. These payloads are slated to fly in 2023 on suborbital rocket flights operated by Blue Origin or UP Aerospace, or on a high-altitude balloon flight from Aerostar.



Students presenting their research during a GLOBE Student Research Symposium. Credits: GLOBE

## GLOBE

NASA's Science Mission Directorate sponsors the **Global Learning and Observations to Benefit the Environment (GLOBE)** program. GLOBE encourages and supports participants to understand, sustain, and improve Earth's environment. In 2022, more than 200 students across the United States presented 68 scientific research projects during a series of seven GLOBE Student Research Symposia (SRS). The annual SRS are opportunities for students grades 5-12 to discuss and share their scientific research with one another and with STEM professionals. Projects ranged from monitoring reports about ice and snow up north in Fairbanks, Alaska, to insights about the impacts of cloud formations on humidity down south in Kenner, Louisiana. Read the **2022 highlights** here! Learn more about the annual SRS and register for a 2023 SRS in one of six U.S. regions. To get involved internationally, learn more about the **GLOBE International Virtual Science Symposium**.



A public program in the Hayden Planetarium at the American Museum of Natural History (AMNH) in spring 2022 using SciAct-supported OpenSpace software to describe the movement of stars and galaxies over the eons. Credits: AMNH

## Science Activation

The **NASA Science Mission Directorate Science Activation (SciAct) program** connects NASA Science with diverse learners of all ages in ways that activate minds and promote a deeper understanding of our world and beyond, with the ultimate goal of increasing active participation in the advancement of human knowledge. In 2022, SciAct facilitated more than 50 million learner interactions across all 50 states, four territories and 153 countries. SciAct operates through a cooperative, nationwide network of three dozen competitively selected and community-based teams, and several activities at NASA centers. More than half of the teams focus on specific, underserved communities, while the rest attend to aspects of broadening participation. SciAct teams work together across a shared set of NASA values and SciAct group norms to connect diverse learners of all ages with more than 800 NASA subject matter experts, exciting and timely science content, and authentic experiences. The efforts are amplified through a network of more than 500 project partners.



AirVenture participants taking part in hands-on NASA STEM activities. Credits: AirVenture

## AirVenture

Members of NASA's ARMD STEM team joined forces with Next Gen STEM to engage approximately 60,000 attendees in an array of aeronautics and space exploration topics during the annual **Experimental Aircraft Association AirVenture** event held in July 2022 in Oshkosh, Wisconsin. Participants of all ages visited the NASA exhibit tent for fun, hands-on activities highlighting NASA's Quesst supersonic mission, astronomy, the Mars Ingenuity helicopter, and more. Additionally, the NASA team supported an educator professional development day, the GirlVenture summer camp, and subject matter talks focused on STEM. Industry provided free admission to all students 18 and younger for AirVenture, allowing a wide range of attendees the chance to be up close to aviation, NASA experts, and interactive activities.



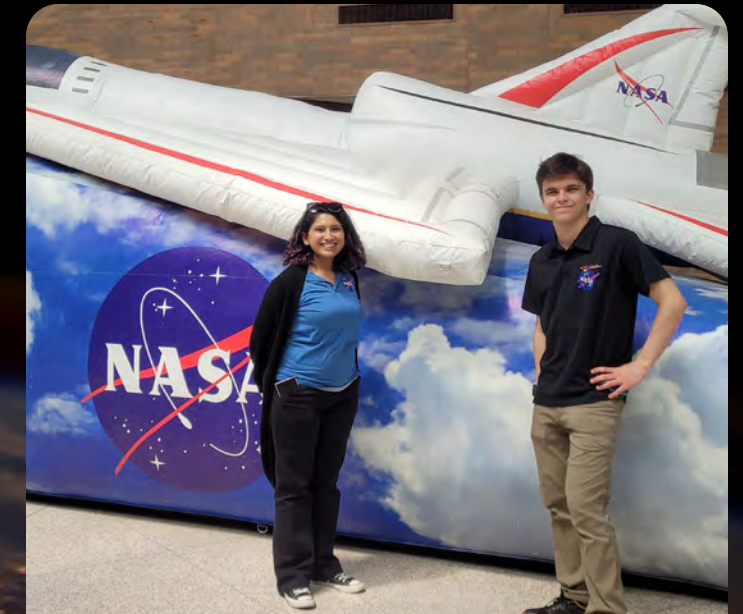
2nd Place Winner – University of Illinois at Urbana-Champaign with Honeybee Robotics. Credits: NASA



Carnegie Mellon University won first place in the 2022 Blue Skies Competition, with project Sustainability and Connected Autonomy: A New Era for Aviation. Credits: Blue Skies



In addition to the ARISS scheduled contacts, Astronaut Kjell Lindgren made hundreds of random contacts with amateur radio operators, youth and the ARISS NASA interns. Credits: NASA



NASA representatives standing in front of an inflatable X-59 during the NASA in your Neighborhood STEM engagement event. Credits: NASA

## RASC-AL

Through the **Revolutionary Aerospace Systems Concepts – Academic Linkage (RASC-AL)** Competition, university-level students design projects based on real NASA engineering challenges while providing NASA access to new research and design ideas by top collegiate talent. The 2022 RASC-AL teams designed and proposed innovative solutions in response to one of the following four themes:

- Suitport Logistics Carrier
- Portable Utility Pallet
- Mars Water-Based ISRU Architecture
- Universal Sample Containment System

Over 270 students and faculty actively participated in the competition on finalist teams throughout the academic year. The competition's culminating event was the 2022 RASC-AL Forum, held in June 2022 in Cocoa Beach, Florida, in which 15 finalist teams from 13 universities presented their concepts to a panel of NASA and industry judges in a competitive design review. RASC-AL celebrated its 20th anniversary in 2022. One of NASA's longest running higher education competitions, RASC-AL encourages students to move the needle on concept development and trade space analysis and bring fresh ideas compatible with NASA's space exploration efforts. RASC-AL is sponsored by NASA's Moon to Mars Architecture Development Office within the Exploration Systems Development Mission Directorate and the Space Mission Analysis Branch at NASA Langley. It is administered by the National Institute of Aerospace.

## Gateways to Blue Skies

As aviation technologies and markets change, new airport designs will be needed to support them. Through the **Gateways to Blue Skies Competition**, undergraduate and graduate student teams designed a 2050s airport — focusing on the exterior of the airport – that can support the climate-friendly planes and aviation markets of the future. The competition is sponsored by NASA's ARMD and administered by the National Institute of Aerospace. The 2050s aviation landscape will incorporate new technologies and designs, enabling safer, faster, cleaner, and quieter aircraft. This future landscape includes the use of alternative fuels, increased efficiency in the use of existing fuels, and changes to the shapes and designs of commercial aircraft. These advancements will require new airports or infrastructure updates and design overhauls to existing ones. Blue Skies challenges teams to evaluate the future landscape and propose designs to accommodate the new technology in an “airports of tomorrow” concept.

Based on the review of research paper submissions, eight teams were chosen to present their findings in a competitive design review during the Gateways to Blue Skies Forum at NASA's Langley Research Center in Hampton, Virginia in June 2022. Each finalist team received a monetary award to facilitate full participation in the forum. Members from the winning teams earn internship opportunities with ARMD.

## ARISS

**Amateur Radio on the International Space Station (ARISS)**, a Space Operations Mission Directorate (SOMD) STEM education outreach program, provides opportunities for students to speak with the crew aboard the International Space Station via amateur radio. These 10-minute contacts allow students, educators, and the public to ask astronauts questions about life in space, space research, and a myriad of other space topics. Formal and informal education organizations submit education proposals that are competitively selected by educational peer judges. Sponsored by NASA, the ISS National Laboratory, and national amateur radio organizations, ARISS supports 60-80 crew radio connections each year with educational organizations around the world. Worldwide participation in 2022 included amateur radio contacts in formal education settings, scout groups, observatories, libraries, children's hospitals, and seven Challenger Centers. ARISS also conducted six international youth contacts for two Axiom-1 private astronauts and mentored three NASA student interns to mature the development of a radio kit and telerobotic experience to extend ARISS future educational outcomes. Established in December 2000, this program continues to inspire, engage, and educate our next generation of space explorers.

## NASA in Your Neighborhood

**NASA in Your Neighborhood** was a collaborative 3-day STEM engagement series that was held April 22-24, 2022. Held in connection NASA's Quesst mission and its creation of the X-59 supersonic aircraft that will be used for the mission, the X-59 aircraft's temporary move from Palmdale, CA to Ft. Worth, TX for testing, the objective of the event series was to exposed students of all ages, K-12, higher education post-secondary, and the general public, to the work NASA aeronautics does often in collaboration with industry and academia—formal and informal. The event secondary objective is to allowed students and the public the opportunity to see the many STEM opportunities right around them, in their own neighborhood. Supported with the help of Texas Space Grant, the STEM series included educator professional development, an post-secondary event for university, community college, and trade and technical students and staff, and a final event for the public at a local museum. NASA ARMD Aeronautics and OSTEM's NGS team worked with UT University of Texas Arlington, Dallas College, and Frontiers of Flight Museum to make the event a success.



Whether they are inspiring young minds, helping students to recognize their own abilities, or providing career guidance, educators play an extraordinary role in students' lives. NASA recognizes the impact of educators on today's students and tomorrow's workforce, and offers programs, resources, and platforms designed to help teachers reach students where they are — whether in the classroom, at home, or in informal education settings.

# EDUCATOR OPPORTUNITIES

# Making

# Connections

Educators are a significant part of students' lives and play a key role in connecting NASA to the Artemis Generation. NASA's Next Gen STEM fully supports formal educators in classrooms and informal educators in museums, science centers, afterschool programs, and similar organizations, all of whom bring the excitement of the agency's missions to students.



Educators learn new STEM teaching tools and resources during the annual Space Exploration Educators Conference held virtually and in person at Space Center Houston. Credits: NASA

NASA's newest online community of practice for STEM educators debuted May 1, 2022. NASA CONNECTS (Connecting Our NASA Network of Educators for Collaborating Together in STEM) is a digital platform and online gathering space where educators can share best practices, learn about upcoming opportunities, and engage in events with one another and experts from across the agency.

Through Virtual Classroom Connection experiences, a small number of schools are selected to ask questions to a NASA subject matter expert, while more schools are invited to listen to the discussion. CONNECTS hosted 13 of these events during the fiscal year, engaging 168 classrooms and 5,462 K-12 students, as well as 44 administrators, 299 educators, and five parents/guardians. Additionally, two large-scale

virtual events gave students the opportunity to ask questions to NASA astronaut Ricky Arnold and former NASA astronaut José Hernández. Combined, these two events reached 3,452 students. Educators also meet virtually and share ideas about teaching, NASA STEM resources, and more through CONNECT-ing, the CONNECTS informal networking group.

The Museum & Informal Education Alliance (MIE Alliance) is an active community of practice within CONNECTS that provides informal educators access to NASA resources as well as support in using these materials. Through MIE Alliance, OSTEM provides diverse groups of students learning opportunities designed to spark their interest and feel a connection to NASA's mission and work.

More than 2,000 educators are partnered with NASA through MIE Alliance, which also manages the "Informal Education Learning Cohort" comprising TEAM II Community Anchors. MIE Alliance hosts webinars with NASA experts and provides a member website, newsletter, and other direct assistance. However, this fiscal year also marked a transition as content and activity moved to the CONNECTS platform.

The NASA STEM Engagement & Educator Professional Development Collaborative (EPDC) at Texas State University hosted 767 online and face-to-face events serving 25,049 educators and 72,729 students nationwide. Topics included a variety of STEM fields, such as human spaceflight hazards, the Artemis missions, aeronautics, and many more.



Learn more about NASA CONNECTS at [stemgateway.nasa.gov/connects/s/](https://stemgateway.nasa.gov/connects/s/)

# SUPPORTING EDUCATORS



Astronaut Tracy Caldwell Dyson on a surprise video call with teacher Charisse Heine. Credits: NASA

## Astronaut Surprises Teacher With Virtual Visit

To celebrate Teacher Appreciation Week 2022, NASA astronaut Tracy Caldwell Dyson made a [surprise video call](#) to help honor Charisse Heine, a science teacher at the Ohio School for the Deaf in Columbus. Ms. Heine has brought the excitement of NASA's missions to her students for more than 25 years.

"Science and technology, engineering, and math are very important to us. You give [your students] the knowledge to use that, and it helps. So we want to thank you, me and all the astronauts here, for all that you do."  
- NASA astronaut Tracy Caldwell Dyson



Teachers touring the model shop at NASA's Langley Research Center. Credits: NASA

## Langley Welcomes Teachers as Part of 2022 MODSIM Program

Middle- and high-school math educators from across Virginia visited Langley Research Center after a year of virtual work to learn about modeling and simulation-based engineering. Approximately 40 Virginia math teachers have participated in the yearlong Simulation-Based Math (MODSIM) Teacher Ambassadors Program over the past two years. The in-person session informally introduced the teachers to Langley's 14-by-22-foot Subsonic Tunnel, the Model Shop, and more.



Teachers from the Houston Independent School District during their externship at NASA's Johnson Space Center. Credits: NASA

## NASA Instructional Coaches Host Teachers at Johnson for an Aerospace Externship Experience

NASA instructional coaches hosted a group of teachers from Houston Independent School District at Johnson Space Center for a two-day externship experience in June 2022. The externship provided teachers with in-person opportunities to experience the work done at NASA and encourage teacher participants to utilize NASA resources in their classrooms.



## Next Gen STEM Educator Resources

Next Gen STEM produced a variety of resources to help educators excite the Artemis Generation about humanity's return to the Moon. The Artemis Camp Experience Guide, a set of hands-on activities telling the story of the Artemis missions, reached more than 100K people. Through the Artemis Generation Spacesuits and Build, Launch, Recover educator guides, students will learn all about the development of spacesuits and find out how NASA prepares for launch and recovers the spacecraft when its mission successfully ends.

The camp guide can be found at [nasa.gov/stem-ed-resources/artemis-camp-experience.html](https://nasa.gov/stem-ed-resources/artemis-camp-experience.html)

# STRATEGIC PARTNERSHIPS

**As NASA advances toward a new era of human exploration of the Moon through the Artemis missions, the agency is working with several strategic partners on new and exciting ways to reach and engage the Artemis Generation.**

Three groups of Florida students were the first to visit Kennedy Space Center in Florida through **Students To Launch (S2L)**, a new initiative designed to inform and inspire learners through STEM experiences. Students to Launch is a collaborative effort between the American Institute for Aeronautics and Astronautics (AIAA) and NASA's Office of STEM Engagement. In August 2022, as NASA prepared for the first Artemis I launch attempt, 47 students and chaperones from the Boys and Girls Club of Jacksonville, Girls Inc. of Panama City, and Girl Scouts from Miami toured the Kennedy Space Center Visitor Complex and met with Pamela Melroy, NASA's deputy administrator and a former astronaut, as well as Kathy Lueders, the agency's associate administrator for space operations.

During the launch attempt, students and the public had the opportunity to put their engineering skills to the test at the interactive **LEGO Education Build to Launch** exhibit at the Kennedy Space Center Visitor's Complex. In 2021, NASA and partner LEGO released a series of Artemis-based STEM learning activities to bring the excitement of launch to students. Although no human astronauts flew on the Artemis I mission, four LEGO astronaut minifigures from the series journeyed to the Moon aboard the Orion spacecraft during the pioneering flight. This tiny crew was among several items selected by the agency to pique the interest of the Artemis Generation. Also on board were space science



NASA Associate Administrator for Space Operations, Kathy Lueders, assists middle school students with a STEM based activity as part of a Students To Launch experience at NASA's Kennedy Space Center in Florida.

badges for **Girl Scouts of the USA**, which hosted an Artemis-themed essay contest, "To the Moon and Back," giving scouts a chance to win a flown badge. Girl Scouts awarded more than 80 students for their essays, which asked girls to imagine their own role in space exploration.

Snoopy, the beloved beagle from **Peanuts Worldwide**, had a special job during Artemis I — a plush, spacesuited Snoopy served as the zero-gravity indicator aboard Orion. To help strengthen student engagement with NASA's newest adventure, Peanuts introduced NASA-focused lesson plans for students ages four to 13. Available in 11 languages, these lesson plans include "Snoopy in Space: The Search for Life," "Snoopy's Zero Gravity Mission," and many more. Snoopy also starred in a series of 12 animated episodes of "Snoopy in Space," a TV series on Apple+, in which he became a NASA astronaut.

In a nod to the legacy of Apollo 14, Next Gen STEM and the **USDA Forest Service** partnered to fly a new generation of Moon Tree seeds on Artemis I to connect the mission to Earth science, data literacy, and citizen science. The Forest Service will germinate the flown seeds — a mix of loblolly pine, American sycamore, sweetgum, giant sequoia, and Douglas fir — and share the seedlings with public and education institutions around the country.



Middle school students with Students To Launch visit the Kennedy Space Center Visitor Complex during a trip to NASA's Kennedy Space Center in Florida.

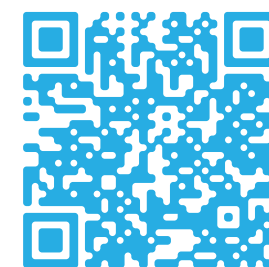
NASA and **Crayola Education** signed a Space Act Agreement in April 2022 to formalize their ongoing relationship, which brings creativity and color to STEM activities. In May 2022, Crayola Education hosted a "Read Along, Draw Along," in which NASA astronaut Tom Marshburn read the classic children's book, "Goodnight Moon," from aboard the International Space Station. Held on Facebook Live, the event included a message from Pam Melroy and a Q&A about Artemis and spaceflight with Marshburn and fellow NASA astronaut Mark Vande Hei.

NASA and Google teamed up to share the world's largest and most complex space science observatory, the James Webb Space Telescope (JWST), in 3D with **Google Arts & Culture**. "The James Webb Space Telescope and the Hubble Space Telescope" interactive webpage examines the differences between the two space-based telescopes and the breathtaking first images taken by JWST, while the

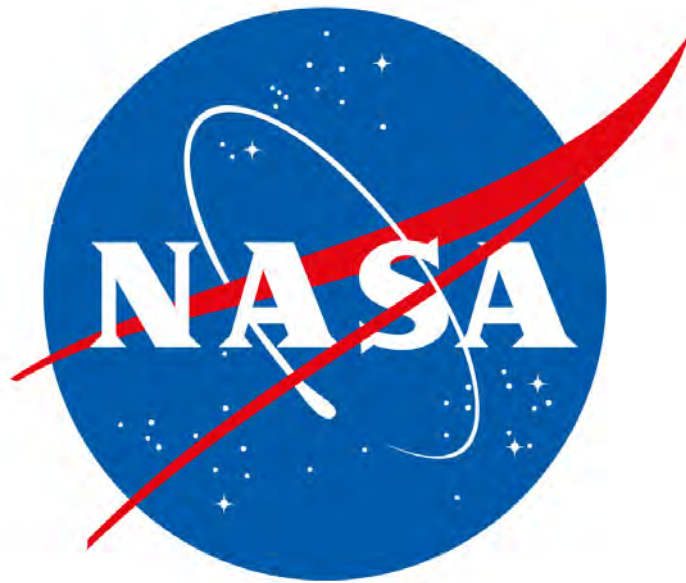
page, "The James Webb Space Telescope Explained," takes viewers behind the scenes into its development and capabilities.

Through **LabXchange**, students can venture to Mars to learn about the Red Planet through "Mission to Mars," a collection of learning resources that focus on Martian geology, personal stories of the team that launched the Perseverance rover, and more.

The agency also partnered with **Discovery Education** in celebration of Earth Day in April 2022. In "Going to the Moon with NASA," on-demand content developed for students in grades 6 through 12, Erica Alvarez, NASA systems engineering and integration manager for advanced exploration systems, explained the agency's lunar exploration plans and how those plans will help us understand and protect our home planet.



Learn more about partnering  
with NASA STEM at  
<https://go.nasa.gov/3JlpfJZ>



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NP-2023-03-3114-HQ

# Addendum

6/12/24 - FY 2022 Office of STEM Engagement performance metrics and information from the STEM Engagement Impacts web pages have been added to the posted 2022 Highlights Report PDF to archive the metrics and information which were not included in the original released document. This also allows the STEM Engagement Impacts web pages to be updated annually to display the most current verified and validated performance metrics and information online.



## FY 2022 OFFICE OF STEM ENGEEMENT (OSTEM) PERFORMANCE METRICS - ARCHIVE

In Fiscal Year 2022 (October 1, 2021 – September 30, 2022), NASA Office of STEM Engagement (OSTEM) projects provided 314 awards to lead institutions across 50 states plus the District of Columbia, Guam, Puerto Rico, and U.S. Virgin Islands; engaging 78K+ educator, 798K+ student, and 333K+ other participants in NASA STEM engagement activities and educational content.

NASA's Organizational Health & Performance Reach of STEM Engagement Metric (FY 2022)	EPSCoR	NGS	MUREP	Space Grant
<b>Institutional Award Data</b>				
Total # of Institutional Awards	90	31	127	66
Total # of Institutional Awards to MSIs	12	0	76	12
Total # of States and U.S. Territories	28	19	27	52
Total Institutional Awards Funding Amount	\$22.7M	\$4.0M	\$20.8M	\$48.1M

### Institutional Award Data Definitions:

- **Institutional Awards** represent STEM Engagement investments awarded to lead/primary award institutions (both formal and informal), via a grant/cooperative agreement solicitation process
- **Institutional Awards to MSIs** represents the classification of lead/primary award institutions that received awards (NOTE: EPSCoR and Space Grant lead/primary award institutions make sub-awards which are not reflected in this data)
- **States and U.S. Territories** represents where Institutional Awards were made
- **Institutional Awards Funding Amount** represents the amount of funding awarded to Institutional Awards

**NASA's Organizational Health & Performance  
Reach of STEM Engagement Metric  
(FY 2022)**

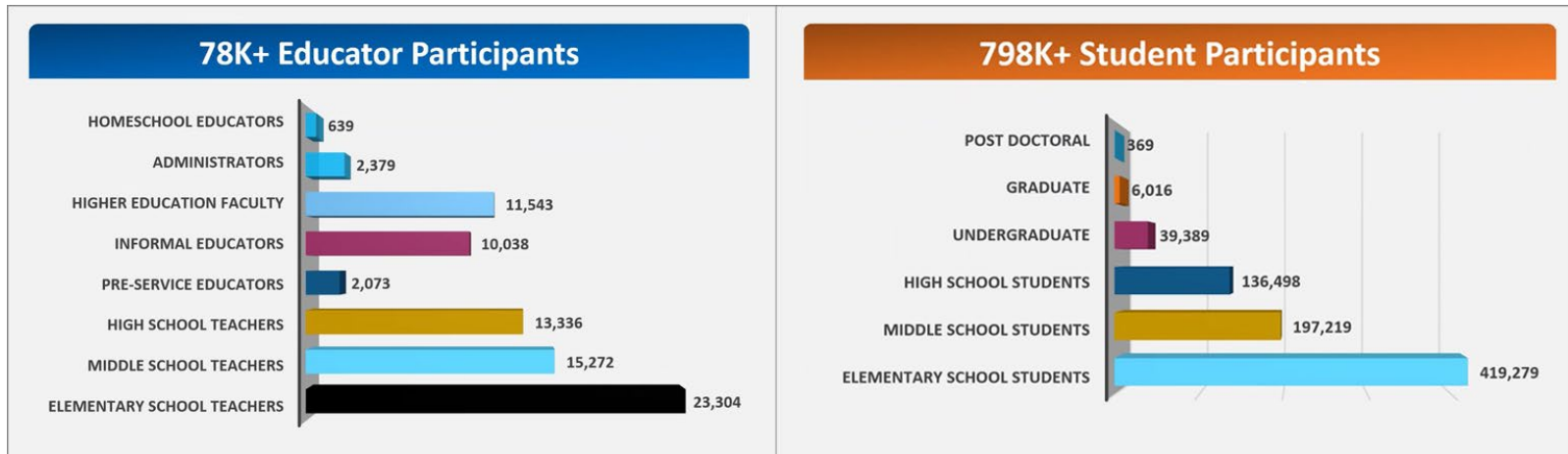
**EPSCoR    NGS    MUREP    Space Grant    Other STEM Engagements    Totals**

**Participant Data**

Total # of Student Participants	685	244281	21131	450865	81808	798770
Total # of Educator Participants	444	35305	7468	30459	4908	78584
Total # of Other Participants	0	178166	26840	127307	1058	333371

**Participant Data Definitions:**

- **Student Participants** represent all students reached through STEM Engagement investments
- **Educator Participants** represent all educators reached through STEM Engagement investments
- **Other Participants** represent all others (non-students and non-educators) reached through STEM Engagement investments



NOTE: Over 333K "Other" Participants reported

### **Additional FY 2022 Key Data Points:**

- Space Grant, MUREP, and EPSCoR grantee and awardee institutions reported 3,613 peer-reviewed publications, technical papers and presentations representing opportunities for learners to contribute to NASA's aeronautics, space and science missions and work
- Notably, 47.0 percent of the peer-reviewed and other technical publications were authored or coauthored by students. Over 9K students received internships, fellowships, and other sustained engagement opportunities (e.g., engineering design challenges, and competitions)
- Over \$43.0M in direct financial support to higher education participants
- 15.9 percent of participants identified as racially underrepresented\*
- 17.6 percent of participants identified as ethnically underrepresented\*\*
- 41.5 percent of the Agency's internship and fellowship positions were filled by women

NOTE, underrepresented statistics for race and ethnicity exceeded the national averages for underrepresented students enrolled in STEM degree programs (per the National Center for Educational Statistics – <https://nces.ed.gov>)

### **Office of STEM Engagement Internships:**

- NASA engaged 1870 unique interns in the OSTEM Internship program
- These significant awards provided a total of over \$17.8M in direct financial support to students.
- 15.0 percent of participating interns identified as racially underrepresented\*
- 15.5 percent of participating interns identified as ethnically underrepresented\*\*
- 46.0 percent of the OSTEM internship positions were filled by women

### **Office of STEM Engagement Fellowships:**

- 86 Total Active Fellows
- 21 New Awards made in FY 2022
- 52 Active Fellows from Minority Serving Institutions

### **Jet Propulsion Laboratory (JPL ) Internships and Fellowships:**

- 877 Total Interns and Fellows
- 871 Students and 6 Educators

*\*Underrepresented racial categories (American Indian or Alaskan Native; Black or African American; and/or Native Hawaiian or Pacific Islander)*

*\*\*Underrepresented ethnicity (Hispanic or Latino)*

# FY2022 STEM ENGAGEMENT PERFORMANCE (AT-A-GLANCE)



## Significant Awards

In Fiscal Year 2022, NASA provided **10,085** internships, fellowships, research opportunities, educator professional development, challenges, and other college/pre-college STEM engagement opportunities to **9,498** student and educator participants representing K-12 institutions and higher education institutions including 2-year, 4-year institutions and all Minority Serving Institution (MSI) classifications. These significant awards provided **~\$43.9M** in direct financial support to participants and engaged participants in over **2.3M** total contact hours.

In these opportunities, **15.9%** of participants identified as racially underrepresented\* and **17.6%** of participants identified as ethnically underrepresented\*\*. Also, **41.5%** of the Agency's higher education internships and fellowship positions were filled by women. NOTE, all three underrepresented statistics (i.e., race, ethnicity and gender) exceeded the national averages for underrepresented students enrolled in STEM degree programs (per the National Center for Educational Statistics - <https://nces.ed.gov>).

\*Underrepresented racial categories (American Indian or Alaskan Native; Black or African American; and/or Native Hawaiian or Pacific Islander)

\*\* Underrepresented ethnicity (Hispanic or Latino)

## Research and Development

NASA's performance in providing opportunities for learners to contribute to NASA's aeronautics, space, and science missions and work is assessed across peer-reviewed publications, technical papers and presentation directly resulting from research funded by NASA STEM Engagement grants and awards to higher education institutions.



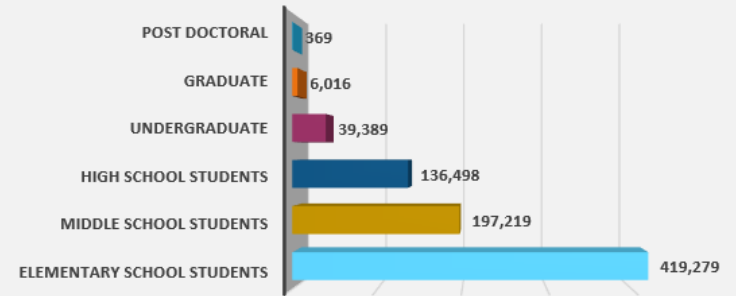
**3,613**

Space Grant, Minority University Research & Education Project (MUREP), and Established Program to Stimulate Competitive Research (EPSCoR) grantee and awardee institutions reported **3,613** peer-reviewed publications, technical papers and presentations in FY 2022.

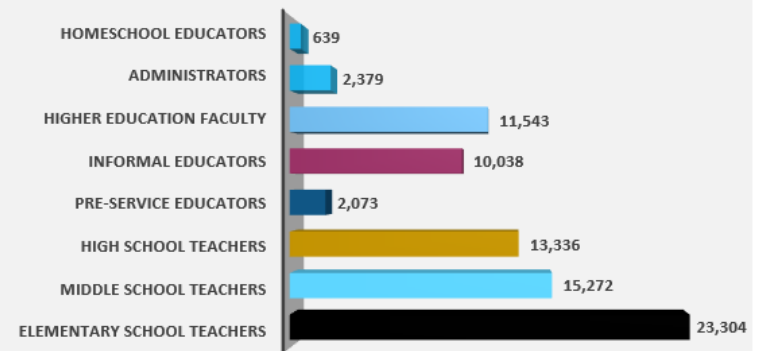
Notably, **47%** percent of the peer-reviewed and other technical publications were authored or coauthored by students.

Additionally, **22** patents and technology transfers were awarded to higher education institutions as a direct result of their NASA STEM Engagement grants or cooperative agreements.

## 798K+ Student Participants



## 78K+ Educator Participants



NOTE: Over 333K "Other" Participants