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BUILDING THE SPACE WORKFORCE OF THE FUTURE: STEM ENGAGEMENT FOR A 21ST CENTURY EDUCATION

HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

NOVEMBER 5, 2019

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

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FIRST SESSION

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BUILDING THE SPACE WORKFORCE OF THE FUTURE: STEM ENGAGEMENT FOR A 21ST CENTURY EDUCATION

TUESDAY, NOVEMBER 5, 2019

U.S. SENATE,
SUBCOMMITTEE ON AVIATION AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:30 p.m. in room SD–562, Dirksen Senate Office Building, Hon. Ted Cruz, Chairman of the Subcommittee, presiding.

Present: Senators Cruz [presiding], Wicker, Thune, Moran, Gardner, Capito, Sinema, Cantwell, and Rosen.

OPENING STATEMENT OF HON. TED CRUZ, U.S. SENATOR FROM TEXAS

Senator CRUZ. Good afternoon. This hearing is called to order.

I am very pleased to see a hearing on STEM and math and science and precision is starting precisely at 2:30 and 0 seconds. That is an auspicious way to begin this discussion.

Earlier this year on one of the hottest nights of the summer, nearly a half million people crowded onto the National Mall. They were not there for a protest or to celebrate a national holiday, and they were not there for a concert or to watch a fireworks show. No. Instead, a half million people went there drenched in sweat to watch the story of the Apollo 11 mission as it was projected onto the Washington Monument, commemorating the moment 50 years ago when Neil Armstrong and Buzz Aldrin took that giant leap for mankind.

As everyone in D.C. knows, if there are a half million people on the Mall and it ain't a protest, something big is going on. And landing the first humans on the Moon and returning them safely to Earth marks as one of the epochal moments in the history of mankind.

As we look out over our space landscape today, what we see is very different from the landscape of 1969. Indeed, not only did we succeed in going to the Moon and back again, but we have gone on to put robotic rovers on distant planets, celestial observatories in orbit that can literally peer into the beginnings of the universe, and we have established an enduring human presence in low-Earth orbit. In the span of a single lifetime, we have seen space fundamentally transformed from an uninhabited void or a scientific

novelty to an integral part of our daily lives and the world economy.

Space is often referred to as the last frontier. And rightfully so. Much like the first frontiers of exploration, space is hard. It takes meticulous planning and extraordinary determination, and even then nothing is guaranteed. It is dangerous, but the last frontier shares a critical aspect with the first frontiers through its power now and tomorrow to inspire us.

The space race of the 1960s inspired Americans to aim higher, to dream bigger than they ever had before, to literally shoot for the Moon. And I believe the burgeoning space sector of today can do the same for an even bigger and broader swath of the United States and the world.

Just a few weeks ago, we witnessed the historic all-female space walk on the International Space Station, the first ever. And when the United States returns to the Moon as a part of the Artemis program—Artemis, of course, being the twin sister of Apollo—well, NASA has committed that we will land the first woman ever on the surface of the Moon and it will be an American astronaut who steps forth on the Moon. As the father of two young daughters, that makes me very proud, indeed.

As we return to bold space exploration, we do so not only with a much more diverse astronaut corps, but also a much more diverse set of commercial and nongovernmental partners. As we move out on these plans, it is worth remembering the success of Apollo 11 and our national space program as a whole was due in no small part to the contributions of a diverse work force, including countless women who were working behind the scenes and whose stories have only recently become household names.

One of those women, Dr. Christine Darden, testified before this Subcommittee earlier this year. Dr. Darden was one of the famed human computers at NASA, and without her work and the work of many other so-called computers, many of them African American women, we never could have sent astronauts into space, let alone brought them back safely.

Unfortunately, for far too long, Dr. Darden and the other human computers' contributions were hidden, relegated to the background for a time. Her story and the story of others like her serves as a reminder of the lessons we need to learn to ensure that we are cultivating and elevating talent and leadership not based on race or gender, but based on merit, based on skill, based on hard work, and based on passion.

Today's hearing is about building the kind of workforce that ensures NASA and the diverse group of partners we return to space exploration has the skilled base of people it needs to be successful now and in the future, that ensures the space economy can continue to grow, and that we will be successful in establishing the United States of America as the leader and a true space-faring nation.

To accomplish this, we can and should leverage the inspiration of space and space exploration to get kids of all ages, of all backgrounds, resources engaged, excited about science and technology and engineering and math.

But that alone is not enough. Creating the space workforce for the future will require us to take a serious look at the road ahead, to explore unconventional partnerships and roles of responsibility and to take other decisive actions as needed to maintain U.S. leadership in space. Getting it right will be a complex and challenging undertaking. After all, space is hard.

But I am reminded and encouraged by something Gene Kranz, the Apollo 11 flight director, said of that mission when he testified before this subcommittee in July of this year: what America will dare, America will do.

I look forward to hearing from our witnesses today about their work in STEM education and what suggestions they might have for how we in Congress can act. And I want to thank, in particular, the Ranking Member for her initiative in proposing that we hold this hearing and for her leadership, bipartisan leadership, that has strengthened this Committee, and I look forward to continuing working alongside her many years to come.

With that, I recognize the Ranking Member.

STATEMENT OF HON. KYRSTEN SINEMA,
U.S. SENATOR FROM ARIZONA

Senator SINEMA. Well, thank you, Chairman Cruz, for holding this hearing. I am excited about today.

Our STEM workforce is at a critical juncture. The U.S. space economy is booming, but if we do not build a strong STEM education pipeline, we will face a deficit of millions of workers over the next decade, putting our economy and national security at risk.

Congress, Federal agencies like NASA, industry partners, and most importantly, educational institutions must work together to develop and prepare a 21st century workforce so we continue to lead in space and so our economy remains innovative and strong.

So thank you today to Dr. Elkins-Tanton, Mr. Manber, Dr. Gladden, and Ms. Condino for joining us today to discuss this important issue.

Since it was established in 1958, NASA has had productive partnerships with universities across the country, including a few in Arizona. As we develop more advanced space technologies, set large goals for the country's space program, and grow our aerospace industry, we must continue these partnerships to ensure we have a strong work force. This starts with educating students and giving them hands-on research opportunities to excel in STEM fields.

Universities and students across the country currently work with NASA on important projects such as mission monitoring, research and analysis. In my home State of Arizona, Arizona State University, University of Arizona, and Northern Arizona University all work with NASA to further its mission both big and small. The talented faculty across the state propose innovative ideas and bring new opportunities to students.

When Administrator Bridenstine testified in front of the full Commerce Committee earlier this year, he said, quote, NASA has had amazing success with university partnerships. Arizona universities are leading the world when it comes to university engagement with NASA and developing these programs and projects.

For example, at ASU, Dr. Elkins-Tanton's mission, Psyche, marks the first time a university has led a deep space NASA mission. She and her team will be the first scientists to study an asteroid, which is remarkably similar to a planetary core, once the spacecraft launches in 2023 and arrives at the asteroid in 2030.

University of Arizona is also paving the way for future missions with its work on OSIRIS REx. Dr. Dante Lauretta leads the science team and the mission's science observation planning and data processing. The team at University of Arizona is critical to the success of this mission that will bring the first asteroid sample to Earth.

All three of Arizona's public universities also participate in the Arizona Space Grant Consortium, which is jointly funded by NASA and the three universities. This Space Grant works to attract and retain students in STEM fields. In Arizona, the Space Grant Consortium partners awarded 175 paid internships and fellowships to Arizona students in 2018 alone, which allows students to work alongside principal investigators on a mission like Psyche or OSIRIS REx, actively building Arizona's STEM workforce.

These mission and research advancements offer us critical insights into space, and they also spark interest and passion in our next generation of scientists, mathematicians, and engineers.

But students are not the only ones benefiting because NASA gains innovative ideas which, when paired with their expertise and resources, can push the boundaries of what we thought was possible.

When the Administrator testified, he also stated that university projects typically meet both cost and schedule. At an agency like NASA where money and time are both limited and projects are sometimes over budget and behind schedule, these partnerships are key to maximizing science and discovery across the universe.

As we look ahead, we must grow these partnerships, retain the knowledge that is gained from them and train the next generation. That is the only way we can ensure we have a workforce ready to keep America at the forefront of space.

This week, we are introducing legislation to help address the STEM workforce concerns that are raised today. The National Aeronautics and Space Administration Authorization Act of 2019, which I am looking forward to introducing with Chairman Cruz, Chairman Wicker, and Ranking Member Cantwell, includes provisions that require NASA to establish an outreach program to encourage high school students to pursue careers in technical education and gives NASA the ability to establish and grow lasting partnerships between itself and universities through research centers.

I am also proud to work with Senator Capito on legislation which will modernize the space grant program for the first time since 1988. Our bill will streamline the program and ensure that State consortia have the resources to recruit and retrain the next generation of scientists, engineers, and mathematicians.

I look forward to hearing from our witnesses on ways we can address these issues and the other issues we face as a country.

Thank you so much, Mr. Chairman. I yield back.

Senator CRUZ. Thank you.

I now recognize the Chairman of the Full Committee for his opening statement.

STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Well, I want to congratulate my two colleagues on their excellent opening statements.

Senator Cruz described the crowd witnessing the 50th anniversary in dramatic, vivid, almost poetic words. I could almost sense the pungent fragrance of that sweaty throng gathered on the Mall.

[Laughter.]

Senator CRUZ. Almost like a Senate hearing.

[Laughter.]

Senator WICKER. The clerk will note crosstalk and just say "crosstalk."

[Laughter.]

Senator WICKER. In the 50 years since the Apollo 11, NASA has continued to achieve incredible feats. None of these missions would have been possible without the support and partnership of America's educational system, in particular the talent and expertise found in our universities. And that is why we are here today.

University researchers continue to lead groundbreaking projects in space technology and scientific discovery. In doing so, they involve students, some of whom become scientists, some of whom become engineers, others mathematicians for NASA and in the private sector. Maintaining this pipeline is vital to maintain America's preeminence in outer space. And I am glad to be a cosponsor of the legislation Senator Sinema mentioned.

Today's panel represents a cross section of the NASA STEM education ecosystem. I would like to extend a particular welcome to Dr. Josh Gladden, Vice Chancellor for Research at my alma mater, the University of Mississippi. Ole Miss' work with NASA includes on graphene, a material with transformative potential for many applications, including space flight. In fact, this past weekend, NASA launched a graphene research payload to the International Space Station.

So thank you all for being here today. Thank you, Mr. Chairman, and I look forward to a great discussion on improving STEM engagement to help build the space work force.

Senator CRUZ. Thank you, Mr. Chairman. And I will say your remarks reminded me—growing up, both my parents were mathematicians, and an old engineer's joke about the Washington Monument is a mathematician and physicist and an engineer go to the Washington Monument. And they are each discussing how to figure out how tall it is.

And the mathematician says it is very simple. All I need is a length of string and a transit. I can measure the distance through the transit. I can measure the angle to the top of the monument. It is a simple matter of trigonometry to figure out the height of the monument.

The physicist says, no, no, no, it is much simpler than that. I will take the elevator to the top of the monument. I will tie the string around the transit. I will lower it down to the bottom of the monument and I will measure the length of the string.

The engineer looks at both of them, looks at the tour guide, and says, how tall is the damn thing.

[Laughter.]

Senator CRUZ. With that, I am happy to introduce our witnesses.

Our first witness, Dr. Linda Tarbox Elkins-Tanton, is the Managing Director of the Interplanetary Initiative and the Principal Investigator of the NASA Psyche Mission at Arizona State University. Her research revolves around terrestrial planetary formation, magma oceans, and subsequent planetary evolution, including magmatism and interactions between rocky planets and their atmospheres. She also promotes and participates in education initiatives such as inquiry and exploration, teaching methodologies, and leadership and team building for scientists and engineers. Dr. Elkins-Tanton also currently serves on the standing review board for the Europa mission and served on the Mars panel of the planetary decadal survey and on the Mars 2020 rover science definition team.

Dr. Elkins-Tanton received her Ph.D. in geology and geophysics from MIT.

Our second witness is Mr. Jeffrey Manber, who is the founder and CEO of Nanoracks. Since 2009, Nanoracks has created products and offered research services for the commercial utilization of space. Today Nanoracks is the single largest private investor on the International Space Station with over $40 million of private capital dedicated to commercial facilities and equipment. Nanoracks employs 70 people in Texas and has launched 250 small satellites and over 800 experiments to the ISS.

Mr. Manber is also Chairman of DreamUp, an educational public benefit corporation that lets students pursue opportunities in space-based research and education.

Mr. Manber is a graduate of Northwestern University.

Our third witness is Dr. Josh Gladden, who is the Vice Chancellor for Research and Sponsored Programs at the University of Mississippi. In this role, Dr. Gladden works to facilitate research and research funding, as well as provide support for all funded projects at the university.

Prior to this role, Dr. Gladden served as Associate Vice Chancellor for Research and as the Director of the National Center for Physical Acoustics. Dr. Gladden also served in elected national leadership positions including as a member of both the executive committee for the National Spectrum Consortium and chair of the Physical Acoustics Technical Committee of the Acoustical Society of America.

Dr. Gladden received a Ph.D. degree in physics from the Pennsylvania State University.

And finally, Ms. Sheila Condino is currently a physics teacher at Oakton High School in Vienna, Virginia, but she is also the founder and still an advisor of the famed Rocketry Club at Presidio High School in Presidio, Texas. For those of you who do not know, Presidio is located along the Rio Grande River, 240 miles south of El Paso, and resides in one of the most remote parts of the continental United States. For most people in Presidio, English is a second language, and many people face tough economic challenges, making it hard for students to focus solely on school.

However, even under those circumstances, Presidio High School's Rocketry Club has consistently placed well in contests across the country, and as a result, they have become a well-respected rocketry team. During her time in Presidio, Ms. Condino and her students excelled qualifying for the national finals at the Team America Rocketry Challenge.

In 2011, Ms. Condino was chosen by the National Aviation Hall of Fame selection committee to receive the Scott Crossfield Aerospace Education Teacher of the Year Award.

Ms. Condino, received her bachelor's degree in physics from Philippine Normal University in Manila, Philippines.

And with that, I welcome each of the witnesses and welcome Dr. Elkins-Tanton to give her testimony.

STATEMENT OF DR. LINDA T. ELKINS-TANTON, MANAGING DIRECTOR, INTERPLANETARY INITIATIVE AND PRINCIPAL INVESTIGATOR, NASA PSYCHE MISSION, ARIZONA STATE UNIVERSITY

Dr. ELKINS-TANTON. Chairman Wicker, Chairman Cruz, Ranking Member Cantwell, Ranking Member Sinema, and members of the Committee, thank you so much for the opportunity to speak today. I am testifying on my own behalf.

I am Managing Director and Co-Chair with University President Michael Crow of ASU's Interplanetary Initiative, which I will talk about a little bit today, and also PI of the NASA Discovery mission Psyche, the 14th in the Discovery portfolio, as mentioned by Chairman Cruz. Thank you.

We have a vision for an optimistic human space future, and by "we" I mean we in this room. We have this vision. We want humans to be an interplanetary species, and we want a situation where our space exploration improves society on Earth and our knowledge and care of the Earth itself. Those are the stakes that we are talking about. These really are huge times for us thinking about us going interplanetary, taking these steps.

Here are three key university-NASA partnership needs.

First is workforce development. We need talent to support the growing aspirations of our Nation and to work with other countries as the world's continuing leader in space. Therefore, education has to be future-facing and workforce-oriented. I think this is a very important thing to stress, that we are in the information age now. The educational style of the industrial era should be behind us. We need to look forward.

Second, returning to the Moon, this time to stay, will require more than just engineers, scientists, and astronauts. We need everyone involved, every aspect of society. We need artists and philosophers. We need sociologists and psychologists. We need business leaders and philosophers. These are the kinds of connections that universities are really good at putting together for a push like the push to become interplanetary.

And third, this full stakeholder triangle of NASA and universities and the private sector is required for our interplanetary future. Nonprofit universities are uniquely placed to create rapid responsive teams and transfer the technological intellectual property produced at universities into the private sector to the benefit of the

space sector and also to the American taxpayer. This transfer has to speed up.

So now is the time to grow our partnerships in these fruitful, more targeted ways. Now is the time to set up university-affiliated research centers and other such mechanisms to speed up the development of specific solutions and accelerate the flow of knowledge and technology to NASA and to the private sector.

ASU is here to meet this challenge with a student population of over 100,000 and as the number one ranked school for university innovation 5 years in a row. It astonishes me coming from the East Coast to see what a big public university can be, and so many of us in this room understand the value of these amazing institutions. And we are lucky in Arizona to have several.

At ASU, our space sector partners include over 70 private sector organizations, over 30 universities, and over 20 government agencies, labs, and centers. We have been working very hard in the interplanetary initiative to develop new ways to put together research teams that are effective, rapid, and interdisciplinary, and include all the sectors. I feel strongly that this triangle of three sectors—we have to figure out how to bring those together to speed up innovation and speed up our path to space. And we have been working on that specifically. We have identified many of the big questions we have to answer to achieve our space future, and we have begun to answer those questions.

On the Psyche mission, we were challenged by NASA to make a bigger student collaboration with greater impact. We pioneered ways to create interdisciplinary capstone teams where students learn real team collaborative skills while working on real NASA mission challenges. We have, for example, student graphic designers, student project managers and marketers working with, for example, student electrical and mechanical engineers. This is where the project managers actually get to help manage a project. We have cohorts of student artists producing inspiration and outreach.

And even though we are only 2 years into this mission, we have a total of over 500 students who have worked with Psyche already at a total of 27 universities from 15 states. And I say this particularly to underscore my personal commitment that this is not, of course, just about my university or just about Arizona. This is about our society at large and our nation, and I believe very strongly in bringing all sectors together. That is what I am trying to work at in my career in every way.

The age of this Prussian style compliant industrial workforce is over. You know what I am talking about. We do not need to train better test takers. We need to change the nature of education from a fixation on the memorization of a specific content, something that I call the sacred content, the content that your advisor taught you and you feel that you need to teach the next person. We need to teach the ability to problem solve, to assess data, and to work effectively in teams both sharing information, criticizing and understanding information, and giving and receiving feedback, things that often we do not really practice until we are in the workforce. This is the education of the future because the future is actually filled with jobs that do not exist today. They do not exist today. So we have to teach the process skills.

In the fall of 2020, the ASU Interplanetary Initiative will launch the most forward-looking workforce-facing undergraduate program to date. It is a part of our answer to education in the information age. The bachelor of science in technological leadership is a scalable three-year degree program using exploration learning techniques in the classroom and having students spend every summer in the workforce in internships. Every student will learn the fundamental content for the future of programming, statistics, calculus, collaborative problem-solving, communication, positive team psychology, and they will also learn team communication, ethical leadership, and critical thinking via a special methodology that we have been working on for years.

We can accelerate space development by connecting universities, NASA, and the private sector for knowledge sharing and rapidly targeted innovation. We can be system integrators, but even more importantly, we can create and deploy the teams with members of all three sectors to solve the greatest challenges.

Together with my sister universities, we are ready to create our future. So let us go to space together.

[The prepared statement of Dr. Elkins-Tanton follows:]

PREPARED STATEMENT OF DR. LINDA T. ELKINS-TANTON, MANAGING DIRECTOR, INTERPLANETARY INITIATIVE AND PRINCIPAL INVESTIGATOR, NASA PSYCHE MISSION, ARIZONA STATE UNIVERSITY

Intensifying and targeting NASA-University partnerships for our space future

Full Committee Chairman Wicker, Full Committee Ranking Member Cantwell, Chairman Cruz, Ranking Member Sinema, and Members of the Committee, thank you for allowing me to speak today. I am testifying in my personal capacity. I am the co-chair, with university President Michael Crow, of the Interplanetary Initiative at ASU, and I am the Principal Investigator of the NASA Psyche mission, the 14th in the Discovery program.

We have a vision an optimistic human space future, we, in this room, have this vision, where we are an interplanetary species, and where our space exploration improves society on Earth and our knowledge and care of Earth itself. Becoming multiplanetary in mind and in reality is essential for the continued growth of civilization.

To achieve this future we need all stakeholders moving fast. Two of the most critical stakeholders in this space future are NASA and American universities. Our partnership, the partnership between universities and NASA, is central and crucial to the future of space exploration and settlement.

NASA partners with universities in many ways, though the most common is through research grants and project contracts. But to speed forward in the way we must to reach the Moon and Mars, we need to focus and hone these partnerships.

Here are three key examples of university-NASA partnership needs:

1. *Workforce development:* we need talent to support the growing aspirations of our nation, and to work with other countries as the world's continued leader in space. Therefore, education has to be future-facing, and workforce-oriented.
2. *Returning to the Moon,* this time to stay, will require more than just engineers, astronauts, and scientists; it will require medical professionals, legal and policy experts, architects, writers, philosophers, and business leaders. Much of the research among these disciplines takes place in universities.
3. *The stakeholder triangle of NASA—universities—private sector* is necessary for our space future requires the full involvement of. Non-profit universities are uniquely placed to communicate the needs, create rapid responsive teams, and transfer the research and technology intellectual property produced at universities through partnership with NASA into the private sector, to the great benefit of both the space industry and the American taxpayer.

Now is the time to grow our partnerships in these more fruitful, targeted ways: Now is the time to set up University Affiliated Research Centers and other such

mechanisms to speed up the development of specific solutions, and accelerate the flow of knowledge and technology to NASA and to the private sector.

ASU is here to meet this challenge with a student population of 100K+ and as the #1 ranked school for innovation, five years in a row. Under president Michael Crow and his vision for the New American University, ASU is redefining the landscape of public higher education. It's a more inclusive and collaborative model than any other university. We are here to solve real-world problems, and educate for the future. Our partners value our ability to meet their needs, and on their schedule.

A vibrant, deep workforce is critical to our future. And the age of the Prussian-style compliant industrial workforce is over. We don't need to train better sitters-still, better passive listeners. We need to change the nature of education from a fixation on a specific content memorization to the ability to problem-solve, assess data, and work effectively in teams, both sharing information and giving and receiving feedback. This is the education of the future: Educating for the processes, the transferrable skills, that every person needs for work and life, and to speed forward the economy of the future, which is filled with jobs that don't exist today.

ASU has created the Interplanetary Initiative to specifically meet the needs of aerospace and execute on the vision of the administration. For three years we have been developing the most innovative ways to build research teams that are effective, rapid, and interdisciplinary, and we've developed really new educational programs that create collaborative problem-solvers for the future workforce. We identified many of the big questions that we will have to answer to achieve our space future. And we've begun the work to answer those questions.

Together with our sister universities ASU can accelerate space development in the following ways:

- Connecting universities, NASA, and the private sector for knowledge sharing and rapid targeted innovation—being system integrators, but even more, creating and deploying the teams to solve the greatest challenges
- Developing core technologies needed to support the mission
- Training the future workforce

We're ready now. Let's go to space together.

Comment on university-led space missions

As you all know, NASA flies both flagship missions, that are organized from NASA Headquarters, and competed missions, which are led by scientists either an universities or at labs or NASA centers. Each has its purpose and place in our exploration of space. Flagship missions are critical for stimulating development of new technology and for fulfilling the most complex of planetary goals.

Flagship missions can engage a broader swath of the community through competed calls for instruments. These calls can bring new groups onto missions, but the project scientist then has the challenge of organizing and uniting disconnected subteams.

Competed missions have the advantage of being conceived of, budgeted, and planned as a whole from the beginning. Flagships, in comparison, are planned in segments and not under a single person's uniting vision.

University-led competed missions, in particular, are regularly coming in on time and on or even under budget. These are sometimes the results of that single uniting leadership. Both the science vision, the results, and the correct scheduling and budgeting make it clear that university-led missions are a critical part of the NASA portfolio.

Senator CRUZ. Thank you.

Mr. Manber.

STATEMENT OF JEFFREY MANBER, CHIEF EXECUTIVE OFFICER, NANORACKS LLC

Mr. MANBER. Thank you. Chairman Cruz, Ranking Member Sinema, Senator Wicker, and other distinguished members of the Aviation and Space Subcommittee, thank you for giving me the opportunity to return to this room to testify.

I am going to talk about something a little different about how we can use and we are using the commercial pathway to space to

ensure we have a workforce for the next generation beyond to keep us in the lead as a space-faring nation.

When we opened the doors at Nanoracks in 2009, we were met with a pleasant surprise. Our first customers were schools, something we never predicted. Our first experiments on Space Station were small nanolabs that were developed by middle school students. The parents literally held bake sales not for their soccer team but to send their very own space science experiments to the ISS via the Nanoracks Space Act Agreement with NASA. This is something that could never have been imagined before the commercial pathway. So there was no direct NASA funding, but there was the public-private partnership with NASA that has only taken off since.

One of our major educational partners is the Student Spaceflight Experiments Program run by Dr. Jeff Goldstein, which has been a flagship program for us at Nanoracks and DreamUp. They are now on their 15th mission to the International Space Station. They have involved over 100,000 students, and they learn about all aspects of the process from designing the payloads to the curriculums, to launching, to sending it to space, and the return. And again, nearly all of this has been done with no direct NASA funding.

And just this weekend, Nanoracks flew the first-ever oven to the International Space Station for our friends in the Zero G Kitchen, and you may have heard that the first customer is the DoubleTree, which is baking cookies. And before you laugh and before you say this has no place at an educational hearing, let me say that DoubleTree and Hilton are working with Scholastic, and they have put a program in place in 50,000 schools across the country involving 1 million students with curriculum to show them how baking is different on the Earth than in microgravity. And this is how we capture the hearts and minds of the younger people. And let me say that these are the students that will one day bring humans to Mars, and yes, they are going to want dessert when they get there.

So these are just two significant examples of hundreds of payloads that I can reference. The commercially funded experiments that we have flown to the ISS include plant growth chambers, fluid chambers, DNA sequencing, all paid for by the parents, the students, the sponsors, but not again direct NASA funding. Of course, we need NASA. We need that public-private partnership, but this is a new model. It is one model for assuring education of our workforce.

And let me add, Chairman Cruz, that Nanoracks and DreamUp have flown by now almost 60 educational payloads from Texas schools from Hawkins, Houston, Burleson, El Paso, San Antonio, Austin, Buda, and more. And I hope my New York twang did not destroy anything there. OK?

Senator Sinema, we have also flown four experiments to the Space Station from Arizona, and just this weekend from Wallops Island, we had 15 students from Arizona State and they deployed commercially a CubeSat satellite. And it was wonderful to meet all the students. And they are great, and it gives us all optimism.

So I am happy to provide the Committee with our full list of statistics for all the districts in which we have flown payloads and what we are doing in the future.

But we can do better, and we can do more to prepare the workforce for the coming space economy.

First off, both DreamUp and Nanoracks know we can do more to bring our under-represented communities to space. We have begun a dedicated effort to involve historically black colleges and universities, and I should have some good news in signing our first historically black college and university in the next couple of weeks.

And second, we must do more than have just engineers, and you have mentioned that. Space is more than satellites and rockets. We have to engage agricultural colleges like Texas A&M or Prairie View A&M. We need to involve biology departments and pharmaceutical students to help find that cure for cancer in the microgravity of space that we have long thought was possible.

And finally, by 2025, as our Nation and industry is focused on the return to the Moon, we are driven to meet an exciting goal. Nanoracks and DreamUp are working to ensure by 2025 we have sent at least one student research project from every congressional district to the International Space Station. This is how we make sure that we have opened the eyes of all the students from all sectors of our society.

We need the excitement, the tools, the cost efficiencies, and the responsiveness of the private sector. It is part of this public-private partnership that my colleagues, mostly from the university sector, are talking about today. We need to assure that the workforce of tomorrow is ready to keep us on the Moon, move us on to Mars, and just as importantly, unlock the new discoveries in the unique environment of space.

Thank you.

[The prepared statement of Mr. Manber follows:]

PREPARED STATEMENT OF JEFFREY MANBER, CHIEF EXECUTIVE OFFICER, NANORACKS LLC

Chairman Cruz, Ranking Member Sinema, and other distinguished members of the Aviation and Space Subcommittee, thank you for giving me the opportunity to return to this room to testify before you. I look forward to discussing how commercial access to the International Space Station has provided an unprecedented educational experience to over a million students across the United States.

Let me begin today by explaining that I am here in two different capacities. I am, of course, representing Nanoracks as the CEO, but I am also Chairman of the Board for DreamUp, Nanoracks' educational sister company. Once just a division in Nanoracks, we spun DreamUp out to be a standalone public benefit corporation because the business of providing educational access to space was, and remains today, strong and important. DreamUp's sole focus is bringing space to the classroom, and the classroom to space.

We opened the doors at Nanoracks in 2009 with the goal to make space accessible to everyone. I am proud to say today that the very first customers that brought Nanoracks into business were in fact, schools. Our very first experiments were small projects that were developed by middle school students. These kids quite literally held bake sales—not to sponsor their soccer team, or raise money for the school dance, but to send their very own science experiment to the International Space Station via a Nanoracks Space Act Agreement with NASA. This is something that could never be imagined before the commercial pathway. Nanoracks standardized and miniaturized technologies as well has created programs that made something as complicated and expensive as space, into something that was both affordable and doable within one school year.

One of our major educational partners is the Student Spaceflight Experiments Program, run by Dr. Jeff Goldstein, which has been a flagship program for Nanoracks and DreamUp since our first flights on the Space Shuttle. Dr. Goldstein's program is now on their 15th mission to the Space Station, and he has engaged nearly 100,000 students across the country in the spaceflight process—from creating and hypothesizing an experiment, submitting a proposal for review, building an experiment, flying it to space, and receiving the experiment back on the ground for analysis. Of course, not every proposal is selected—but even those which aren't are provided a unique classroom experience where they think critically, collaborate, and build a proposal strategy, just as they would as future NASA or industry employees.

Notably, all of this has been done with no direct NASA funding.

Dr. Goldstein's program is one of many incredible programs that was built on commercial access to the Space Station. Just this weekend, Nanoracks flew the first-ever oven to the Space Station, set to bake DoubleTree cookies on orbit. Never before has something been baked from raw ingredients in microgravity. This provides not only for a fascinating microgravity experiment contributing to how we endure long-duration space travel, but also allowed a private enterprise to build an educational program, in partnership with Scholastic, that was delivered to *one million students* in 50,000 classrooms across the United States. Using a symbol of hospitality, this experiment shows what will happen to one of the most relatable items on Earth—a chocolate chip cookie—in the complex environment of microgravity. Students who have never been engaged in space before, now have a tangible object they recognize, and can think critically about what would happen when gravity is taken away, and are learning how the International Space Station and NASA are trying to best understand the science behind human exploration. These are the students that may one day bring humans to Mars—and yes, they are going to want desert when they get there.

These are just two significant examples of hundreds that I can reference. To date, Nanoracks has flown nearly 600 educational experiments to the Space Station—experiments which include building plant growth chambers and fluid chambers, materials aggregation, DNA sequencing, and so much more.

If I might add, Chairman Cruz, that Nanoracks and DreamUp have flown nearly 60 educational payloads to the Space Station from Texas schools—from Hawkins, Houston, Burleson, El Paso, San Antonio, Austin, Buda, and more.

Senator Sinema, we have also flown four experiments to the Space Station from Arizona—including a university small satellite that launched just this past Saturday! Over 15 students from Arizona State University joined my team in Wallops Island to watch their hard work take flight.

I am beyond proud of the educational outreach done by both Nanoracks and DreamUp, but I would be remiss if I didn't use this platform to share that we as a nation have so much more work to do.

These 600 payloads represent so much hard work done by students, teachers, parents, and community leaders across the country—but the strong majority come from well-off communities. Let's do more to bring our underrepresented communities to space.

So today, Nanoracks and DreamUp have begun a dedicated effort to engage Historically Black Colleges and Universities—and I hope to share in the coming weeks some exciting news about these efforts. Additionally, we will show that it's more than just engineers we are looking for in the aerospace industry. We need to better engage agricultural colleges like Texas A&M or Prairie View A&M, we need involve biology departments and pharmaceutical colleges to find that cure for Cancer. . Space is more than engineering today, and we are dedicated to assuring we are fueled by more than a handful of schools.

Just last week, the 2019 National Assessment of Educational Progress showed that average scores of fourth and eighth grade students have declined since 2017. The Secretary of Education was quoted as saying that America's 'antiquated approach' to education fails too many children.

This means that the model in which an educator, who holds all the knowledge, stands in front of his or her classroom and imparts knowledge to their students does not work anymore. The world is changing too quickly, innovation happens too fast, and we must give students real, hands-on experiences that teach them 21st Century Skills, particularly the ability to think on their feet, adapt, and persevere (even when they "fail").

We can do better by engaging the full spectrum of students in space exploration as a clear path to make our next generations bolder and brighter than my generation.

Since we're talking about education, let me provide the committee a report card.

America has been doing great work in building up the next workforce in STEM fields. The commercial pathway has provided unprecedented access to students both in America and across the world, and created job opportunities once never imagined. We have quite literally changed the lives of students, and opened their eyes to the wonders of space. But let's together cast a wider net. Funding for NASA's educational division has long been debated. Let's not tie NASA's hands behind their backs when it comes to educational outreach. Let's allow NASA the freedom as other agencies have to have robust STEM programs. NASA is likely one of the only government agencies that can inspire both a 5 year old and a 50 year old—something no other government agency can boast. If we want to maintain American leadership in space, it's by investing in the kids today that will be the future NASA Administrator, or the future Chairman of this Subcommittee.

Today, I am announcing that Nanoracks and DreamUp are assuring that every Congressional district in the United States has sent at least one student research project to the International Space Station by 2025. We will work with industry and educational organizations to assure that the workforce taking us to Mars will be strong, world-class and inclusive of all Americans.

I ask the Committee to join me and my team as we ensure America's leadership in space via these ambitious but critical goals.

I am happy to provide the Committee with our full list of statistics for all of the districts in which we've flown payloads, and further information on our educational outreach products both on the ground and on-orbit.

Thank you.

Senator CRUZ. Thank you.

Dr. Gladden.

STATEMENT OF J.R. (JOSH) GLADDEN, PH.D., VICE CHANCELLOR FOR RESEARCH, PROFESSOR OF PHYSICS, UNIVERSITY OF MISSISSIPPI

Dr. GLADDEN. Mr. Chairman, members of the Subcommittee, let me first thank you for the opportunity to provide my perspective on the role that universities can and should play in the development of the nation's STEM workforce to provide NASA with the engineers and scientists needed to keep accomplishing its mission into the next generation.

Chairman Cruz, you did a fantastic job of introducing me. One little bit, if you go back a little deeper, I was a physics teacher for about 5 years. So Ms. Condino and I can talk shop afterwards.

As with many technical objectives and challenges we will face in the next generation, the complexity of missions at NASA will only increase. It is incumbent upon higher education to prepare a workforce ready to meet those challenges.

One critical element in preparing this unique workforce is the necessity to ingrain in them a predilection and a passion for lifelong learning. Transformative technologies are no longer coming once a generation. They are coming once a decade. We have several programs and initiatives at the University of Mississippi to address these educational challenges.

We have designed and are in the process of building a unique 200,000 square foot STEM education facility. What makes this space unique is that it is designed from the ground up around collaboration across disciplines and active-learning teaching methods that focus on small-group project work and interactive technologies. These instruction methods have been shown to both improve the comprehension of the science and engineering principles, as well as promote group problem-solving skills.

Another unique program at UM is our Center for Manufacturing Excellence. All CME students major in engineering, business, or ac-

counting, but they also share a body of coursework across all of these disciplines. CME students focus on group projects, communications skills, and understanding a holistic view of a particular problem, from the technical all the way to the financial. We cannot predict the technologies that these graduates will engage during their careers, but we do know that they will always need to work in teams and understand the bigger picture.

Universities also play a key role in developing and disseminating next generation engineering principles. Lean engineering, design thinking, additive manufacturing and additive construction are important examples. Design thinking helps break down complex, multidimensional design problems into a manageable framework while lean engineering realizes those designs through highly efficient production and manufacturing. A challenge here, however, is not to sacrifice the technical foundations upon which all of these concepts are built.

Additive manufacturing and additive construction will play vital roles in any long-term space mission. Whether the mission is a base on the Moon or a manned mission to Mars, replacement parts cannot be stocked. They will need to be printed as they are needed. Any larger-scale structures on the surface of a Moon or a planet will require using native materials and reliable additive construction technologies.

The role of advanced materials will also be increasingly important in the next generation of space systems design. Nanophase materials such as graphene have been studied for several decades, but are now emerging as useful technologies. Our Center for Graphene Research and Innovation designed a graphene-enhanced polymer material that just was launched this Saturday from Wallops Flight Facility in Virginia to be tested on the International Space Station for protection. It will spend about a year in space and is designed to protect against hyper-velocity impacts. So in a year, we will be able to bring that down and see how the experiment went. We and others are exploring graphene enhancements on many technologies relevant to NASA missions from microfiltration to high-efficiency solar panels. And let me be clear. Both graduate and undergraduate students play critical roles in all of these research experiments.

Perhaps less obvious but an increasingly important skill set is around space activities are legal and regulatory issues. UM is home to the National Air and Space Law Center, along with the Journal for Space Law since 1973. As space activities in the private sector continually grow, appropriate light-touch legal frameworks need to be developed and studied to best inform decision-makers. UM is preparing this workforce with the first Air and Space Law Masters Program in the Nation.

Let me take a moment to emphasize here, along with some others who have already spoken on it, the importance of the NASA Space Grant program. This program provides incredible space science and engineering research opportunities to graduate and undergraduate students from a wide swath of the country. I can tell you from personal experience that nothing can hook a young college student into a NASA career faster than working on a real-world problem with NASA engineers.

I thank the Subcommittee for your attention and welcome questions when it is time.

[The prepared statement of Dr. Gladden follows:]

PREPARED STATEMENT OF J.R. (JOSH) GLADDEN, PH.D., VICE CHANCELLOR FOR RESEARCH, PROFESSOR OF PHYSICS, UNIVERSITY OF MISSISSIPPI

Mr. Chairman and members of the subcommittee, let me first thank you for the opportunity to provide my perspective on the role universities can and should play in the development of the Nation's STEM workforce to provide NASA with the engineers and scientists needed to keep accomplishing its mission into the next generation.

My name is Josh Gladden and I have the privilege of serving as the Vice Chancellor for Research and Sponsored Programs and Professor of Physics at the University of Mississippi. Before this role, I served as the Director for the National Center for Physical Acoustics and Group Lead for the Materials Physics Lab at the NCPA.

As with many technical objectives and challenges we will face in the next generation, the complexity of the missions at NASA will only increase. It is incumbent on higher education to prepare a workforce ready to meet these challenges.

One critical element in preparing this unique workforce is the necessity that they are ingrained with a predilection and passion for life-long learning. Transformative technologies are no longer coming once in a generation—they are coming every decade. We have several programs and initiatives at the University of Mississippi to address these educational challenges.

We have designed and are in the process of building a unique 200,000 square foot STEM education facility. What makes this space unique is that it is designed from the ground up around collaboration across disciplines and active-learning teaching methods that focus on small-group project work and interactive technologies. These instruction methods have been shown to both improve comprehension of science and engineering principles and promote group problem-solving skills.

Another unique program at UM is our Center for Manufacturing Excellence. All CME students major in engineering, business or accounting, but also share coursework across each of the three disciplines. CME students focus on group projects, communications skills and understanding a holistic view of a particular problem—from technical to financial aspects. We cannot predict the technologies these graduates will engage with during their careers, but we do know they will always need to work in teams and understand the bigger picture.

Along with other universities in the nation, we are expanding our professional student options—students who are re-engaging with the university to update their skills while remaining on the job. These programs might range from a professional master's program with an accelerated time frame to a certificate program to get up to speed on an emerging technology. Another area we are looking to expand is what one might call "deep collaboration" where technical professionals from the government come spend extended time with research labs and groups at the university. Such programs are highly mutually beneficial to both the university researchers as well as the professional engineers. These sorts of programs I believe will be become increasingly important to our technical professional workforce.

Universities also play a key role in developing and disseminating next-generation engineering principles. Lean engineering, design thinking, additive manufacturing and additive construction are important examples. Design thinking helps break down complex, multidimensional design problems into a manageable framework while lean engineering realizes those designs through highly efficient production and manufacturing. A challenge here, however, is not to sacrifice the technical foundations upon which all these concepts are built.

Additive manufacturing and additive construction will play vital roles in any long-term space missions. Whether the mission is a base on the moon or a manned mission to Mars, replacements parts cannot be stocked—they will need to be printed as they are needed. Any larger-scale structures on the surface of a moon or planet will require using native materials and reliable additive construction technologies.

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ciency solar panels. Let me be clear: Undergraduate and graduate students play a key role in the development of such technologies.

Perhaps a less obvious, but increasingly important, skill set around space activities are legal and regulatory issues. UM is home to the National Center of Air and Space Law along with Journal of Space Law since 1973. As space activities in the private sector continually grow, appropriate light-touch legal frameworks need to be developed and studied to best inform decision makers. UM is preparing this workforce with the first Air and Space Law Masters Program in the Nation.

Let me also take a moment to emphasize the importance of the NASA Space Grant program which provides incredible space science and engineering research opportunities to graduate and undergraduate students across a wide swath of the country. I can tell you from personal experience that nothing can hook a young college student into a NASA career faster than working with a team on a real-world problem.

I thank the subcommittee for your attention and would welcome any questions.

Senator CRUZ. Thank you.

Ms. Condino.

STATEMENT OF SHELLA RIVANO CONDINO, PHYSICS TEACHER, OAKTON HIGH SCHOOL

Ms. CONDINO. First, I thank God for allowing me to be part of this STEM endeavor.

Second, thanks to you all for giving me this opportunity today to share and give testimony about the impact of STEM engagement, especially to the underserved, under-represented minorities, women, and our rural communities.

I have been a physics educator for 27 years. I hope it does not show the age.

[Laughter.]

Ms. CONDINO. And I have been an advocate of interdisciplinary and applied approach to learning even before I heard the acronym, STEM, in the late 1990s. I strongly believe in practical and experiential learning as I myself learn best by doing. Who does not enjoy hands-on and minds-on activities, or the adventure of putting theory into practice, or bringing knowledge to life, much more solving real-world problems? The power of this method of learning gives students a sense of responsibility, accountability, and ownership in their own learning.

Every day before I start teaching, I always try reminding myself of this quote: tell me and I forget, teach me and I may remember, but involve me and I learn. Honestly, I have always wanted to tell my former teachers about that quote because then they will have a better understanding of what type of student I was when I was young, but I never got the chance or the courage to tell them anyway. So now as a teacher, this became my quote, a daily reminder, that as a teacher I need to create a learning environment that is transformative, engaging, fun, and where learning remains implicitly.

Teaching in Presidio High School in Texas, which is a border town, rural geographically isolated like what you said—to be exact, it is 251 miles away from El Paso, which is about 4 hours away from the nearest Walmart, an economically disadvantaged school that is one of the highlights of my teaching career. I had my most meaningful and fulfilling experiences as an educator in that school district. It is the most challenging, yet it is the most rewarding. With more than 60 percent of the students identified as English

language learners, 95 percent Hispanic, 100 percent participating in the reduced—no, not even reduced—free lunch program, it truly challenged my creativity in teaching.

Thus, what I did was use my passion for aviation and aerospace and began incorporating basic rocketry in my physics teaching. I also created a free summer enrichment program in rocketry and robotics to provide students activities that will make their minds engaged.

This idea came to mind when I attended the first graduation I had in that school where there were four empty seats placed in remembrance of the four students who died due to drug-related events, drag racing accidents, and even suicide. I felt the urgent need for my intervention, a sense of responsibility to this community by keeping these children away from bad elements such as drugs, alcohol, teenage pregnancy, and street racing.

Hence, I founded the Presidio Rocketry and Robotics Club in 2007 and created teams competing at The American Rocketry Challenge, or TARC, which is a STEM initiative and the world's largest model rocketry contest. The program grew. The membership started with three young girls and then it has grown to more than 30 students. With the support of my co-sponsor, Ms. Adelina Portillo, who is an ESL teacher, because I do not speak Spanish, and that was the hardest thing for me to do, to be able to teach to a group of kids where we do not have any communication that would be common for both of us, but we tried to do English. We tried. The administrators, the staff and teachers, the community of Presidio, even some of the companies that are outside of Presidio helped sponsor our program, and it became really popular amongst the middle school and high school students. Even our neighboring rural schools—they were encouraged and inspired to do the same initiative for their own students.

Presidio gained national recognition because of its consistent placement in the top 100 teams in the Nation at the TARC contest in 2009 up to present. And in 2012, we got invited to the White House Science Fair, and our team presented their rockets to President Obama.

Because we mostly finish in the top 25 in the national finals, Presidio teams got the chance to participate at the NASA Student Launch Initiative Project, which is an advanced, high-power rocketry program where students design, build, and launch rockets which carries scientific and engineering payloads. These aerospace STEM initiatives allowed our students to enhance their critical thinking, analytical and metacognition skills, conduct scientific research, improve their communication skills both oral and written, develop time management and organization, utilize technology through software and simulations, problem-solve and troubleshoot, and collaborate to make wise decisions. Through these programs, my students developed STEM skills and soft skills employers are looking for in the future workplace.

Our students also became involved in the NASA Texas High School Aerospace Scholars program, Texas Alliance for Minorities in Engineering statewide contest, the Texas Tech STEM academic competition, even in botball robotics both in-state and world championships, TCEA robotics, VEX robotics, even in the prestigious

Zero Robotics Virtual Contest held at MIT. It sounds impossible to believe, but this is the records of what my students in Presidio has done.

And, Dr. Manber, Presidio also participated in the Student Spaceflight Experiment Program, SSEP, mission to the ISS where we sent a microgravity flight experiment to the International Space Station on SpaceX Falcon 9 rocket and Dragon spacecraft, and compared results or our own ground earth experimentations. This achievement is truly special because students collaborated and communicated with astronauts on board the ISS, and the community of Presidio developed awareness and exposure to STEM literacy.

I know I left Presidio in 2014 and relocated here in northern Virginia. However, I continue to mentor the Presidio Rocketry team and communicate with them virtually through Skype every Friday from 3 to 5 p.m. Eastern time, after school. I review their rocket simulations and give them feedback on their designs. I also virtually demonstrate strategies and techniques on how to build stable and robust rockets.

I currently teach AP physics courses at Oakton High School in Vienna, and I continued my goal of encouraging student participation and interest in STEM. I am one of the teacher sponsors of the Cougar Robotics, Rocketry, and Physics Clubs. Our rocketry team won first place at the Battle of the Rockets last year, became a national finalist at TARC, and currently we are working with NASA on our SLI project. Our robotics FRC team made it to the first Robotics World Finals in Detroit, Michigan last year. Last Monday, our physics club members participated at the STEM outreach program of the Association of Old Crows in the International Symposium and Convention on Electronic Warfare and we won the Cybersecurity Codebreaking Challenge. Last Friday, I took my students to the Project Aviation Career Education and Expo in Leesburg, Virginia, and we bagged $22,500 worth of scholarships on flight trainings.

[Applause.]

Ms. CONDINO. Thank you.

Because of my experiences in teaching in the third poorest school district in the State of Texas and right now in one of the richest counties in the entire country, I became more certain. I am more determined and passionate about contributing to the future workforce. This is my way of giving back to this country. I hope that you too will continue to invest in our youth's education for it will surely guarantee great returns.

Thank you very much and may God continue to bless us all and God bless the United States of America.

[The prepared statement of Ms. Condino follows:]

PREPARED STATEMENT OF SHELLA RIVANO CONDINO, PHYSICS TEACHER, OAKTON HIGH SCHOOL

First, I thank God for allowing me to be part of this STEM endeavor. Second, thanks to all of you for giving me this opportunity today to share and give my testimony about the impact of STEM Engagement especially to the underrepresented, minorities, and rural communities.

I have been a physics educator for 27 years, and I have been an advocate of interdisciplinary and applied approach to learning even before I've heard of the acronym

STEM in the late 1990s. I strongly believe in practical and experiential learning, as I myself learn best BY DOING. Who does not enjoy hands-on and minds-on activities? or the adventure of putting theory into practice? or bringing knowledge to life? much more solving real-world problems? The power of this method of learning gives students a sense of responsibility, accountability and ownership in their own learning.

Everyday before I start teaching, I always try reminding myself of this quote: *Tell* me and I *forget, teach* me and *I may remember,* ***involve*** me and ***I learn.*** Honestly, I've always wanted to tell my former teachers about this quote so that they can understand me better when I was a student, but I never got the courage to tell them anyway. So now, this quote has become my daily reminder that as a teacher I need to create a learning environment that is transformative, engaging, fun and where learning remains implicitly.

Teaching in Presidio High School in Presidio, Texas, a border town, rural, geographically isolated and economically disadvantage school, is one of the highlights of my teaching career. I've had my most meaningful and fulfilling experiences as an educator in that school district. The most *challenging,* yet the most *rewarding.* With more than 60 percent of the students identified as English Language Learners, it truly challenged my creativity in teaching. I used my passion for aviation and aerospace and began incorporating basic rocketry in my physics teaching. I also created a free summer enrichment program in rocketry and robotics to provide students activities that will make their minds engaged. This idea came to mind when I attended a graduation one year, where 4 empty seats were placed in remembrance of the 4 students who died due to drug related events, drag racing accident and suicide. I felt the urgent need for intervention, a sense of responsibility to the community by keeping these children away from bad elements such drugs, alcohol, teenage pregnancy, and street racing. Hence, I founded the Presidio Rocketry and Robotics Club in 2007 and created teams competing at The American Rocketry Challenge, a STEM initiative, the world's largest model rocketry competition. The program grew membership starting from 3 young girls to more than 30 students! With the support of my co-sponsor Ms. Adelina Portillo, the administrators, staff and teachers, community of Presidio and companies who helped sponsor our program it became popular amongst high school and middle school students. Neighboring rural schools were encouraged and inspired to do the same initiative for their students. Also, Presidio rocketry gained national recognition due to its consistent placement in the top 100 in the Nation at TARC since 2009 to present! In 2012, we got invited to the Whitehouse Science Fair and our team presented their rockets to former President Obama. Because we mostly finished in the top 25 in the national finals, Presidio team got the chance to participate at the NASA Student Launch Initiative project, an advanced-high-power rocketry program where students design, build, and launch a rocket which carries scientific or engineering payloads. These aerospace STEM initiatives allowed our students to enhance their critical thinking, analytical and metacognition skills; conduct scientific research, improve their communication skills both oral and written, develop time management and organization, utilize technology through software and simulations, problem-solve and trouble shoot, and collaborate to make wise decisions. Through these programs, my students developed STEM skills and soft skills employers are looking for in the future workplace.

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team made it to the FIRST Robotics World Finals in Detroit, Michigan last year. Last Monday our physics club members participated at the STEM outreach program of the Association of Old Crows in the International Symposium and Convention on Electronic Warfare and won the Cybersecurity Codebreaking Challenge. Last Friday, I took my students to the Projet Aviation Career Education and EXPO in Leesburg, VA and bagged $22500 worth of scholarship on flight trainings.

Because of my experiences in teaching in the 3rd poorest school district in the State of Texas and in the one of the richest counties in the entire country, I became more certain, determine and passionate about contributing to the future workforce. This is my way of giving back to this country. I hope that you too will continue to invest in our youth's education for it will surely guarantee great returns. Thank you very much and may God continue to bless us all and this great country. God bless the United States of America!

Here is a list of a few students who became part of the STEM programs and their current STEM related careers.

1. Ana Nieto—mechanical engineer, Aurora Flight Sciences, a subsidiary of Boeing Company in Manassas, VA
2. Itza Rodriguez—structural design engineer, The Boeing Company in Seattle, WA
3. Antonio Bujanda—mechanical engineer, assistant professor at Texas Tech University in Lubbock, TX
4. Janet Nieto—chemist at Reliable Analysis in Michigan
5. Daniella Barraza—environmental scientist, Bureau of Land Management in Las Cruces, NM
6. Aida and Ana Luevanos—directors, Alumni Relations at Sul Ross University in Alpine, Texas
7. Taylor Galliete—mechanical engineer, Sandia National Laboratories in Albuquerque, NM
8. Helena Cardona—architect, CAS Architects in Mountainview, CA
9. Miguel Nieto—Legislative Assistant, Texas State Capitol House of Representatives in Austin, TX
10. Mextli Delgado—mathematics teacher in Odessa, TX
11. Tatum Galliete—film, Warner Brothers in Los Angeles, CA
12. Roxanne Hernandez—business analyst, Select Energy Services in Austin, TX
13. Matthew LaRosa—physicist, Lockheed Martin Corp Missile Division in Orlando, FL

Senator CRUZ. Thank you very much, Ms. Condino, for that very powerful testimony. And let me say to each of you, thank you for your testimony. That was illuminating. That was important and particularly for those of you who are or have been educators, thank you for the time you have spent helping inspire, helping shape the next generation of scientists and innovators and leaders.

Ms. Condino, let me say as well, you are Skyping every week with the students in Presidio High School, and if you would, please convey for me to the students at the Presidio Rocketry Club how proud we are of the hard work they are doing.

And in fact, one story that I wanted to ask you to elaborate on is a story that a spokesman for the Aerospace Industry Association recounted in a "Texas Monthly" article, which is that the Presidio team, in order to be able to afford their first trip to Virginia for the Team America Rocketry Challenge had to auction off a goat. And according to the article, your team auctioned off a goat in Presidio every year for the next 5 years. And in 2014, the team placed its highest ranking yet, fourth place at the competition. Could you elaborate on that please?

Ms. CONDINO. Like what I said, it is an economically disadvantaged school, and so we do not have much of a budget. But it is very difficult to convince the school board to allow us to go outside

of Presidio. So what I decided was, together with the teacher that I worked with, you know, my co-sponsor, we have to raise funds in order for us to show that we wanted these kids to move forward.

And one of the initiatives that we did was a suggestion from a parent to auction a goat because at that time when we tried to compete in the TARC, and we made it to the top 100, we have to fly out of Texas. But we have to go to the airport 4 hours away first. It was the transportation that was the most difficult and then the budget on how to build the rockets as well.

So I always tell the kids we cannot waste money. We cannot waste time. We have to do everything through simulation first, and through that simulation, build from scratch. And we decided let us show to the school board that we are willing to put in time and effort.

There were a group of companies, particularly Lockheed Martin Corporation, because at that time when we learned that we made it to the national finals, we were already told we are not moving on because we do not have the budget, there is liability, and all of those things. But when I mentioned it to Mr. Steve DeLeon, who used to work at Lockheed Martin at that time, he felt like he wanted to help. And so he was able to gather about $3,000, and he told me put pressure to your board and tell them we are willing to support this initiative. And so we went.

But we have to do it every year. We cannot just rely on other people's money every single time. We have to show them that we also are putting in some of our efforts. And yes, we first raffled the goats. In that particular area, goat is a common thing to eat. So they would pay money in order to eat the goat. But there are winners where they do not want the goat. So I auctioned it. After I raffle, we auction it at night because we have this arts festival. And with one little goat, we could make $2,000. But it is all about hard work. It is about your initiative. We sell donuts. I burned my fingers by barbecuing in front of church every Sunday because I wanted to show the community that we are not just traveling out of town for pleasure. We wanted to compete and bring back that glory to that little town of Presidio.

Senator CRUZ. Well, thank you for your creativity and your passion, and perhaps in honor of that story at our next subcommittee hearing we may have to serve cabrito tacos.

[Laughter.]

Senator CRUZ. Mr. Manber, you mentioned in your testimony that Nanoracks and DreamUp have flown roughly 60 educational payloads to the ISS from Texas schools in Hawkins and Houston, Burleson, El Paso, San Antonio, Austin, Buda. What is the impact on those schools of being able to participate? And how can we expand it so that more schools have that opportunity?

Mr. MANBER. Well, I think Ms. Condino has just told us the impact. It is incredible the impact. We have students coming to us now who are asking us for help on their thesis, their university thesis, Ph.D. thesis. They started with us 5, 6, 7 years ago. Teachers tell us every week that the students never forget participating in a project that actually goes to space. And so with a great deal of humbleness, we see how many lives that we have changed, having these students decide to go into STEM and go into engineering

or biology because of space. So it has had an extraordinary impact on the lives of the students and the teachers and the parents when they see that this is something real and something that can be done within an academic year or almost an academic year.

You ask an excellent question, how do we expand it? We are sometimes that awful thing of a business, and we are investing. We are investing to expand to reach out to the disadvantaged. We have to reach out to more communities. We are working with——

Senator CRUZ. What does it cost for a school to——

Mr. MANBER. OK. The smallest price we have is $15,000 U.S. for a month on the Space Station. And so it is test tubes. And I will be honest with you. I do not mean to do this here at a hearing, but we do not make money on that. I mean, we also work with NASA and the German Space Agency and others. And on this educational at $15,000 you can do a test tube that goes up.

Senator CRUZ. Let me repeat that for anyone at C-SPAN watching. You are saying any school in America——

Mr. MANBER. Yes, $15,000 will put you up for 30 days on the station.

Senator CRUZ. Wow.

Mr. MANBER. And we have lists of all of the payloads that have flown previously. So you can see the research that has been done. We work with partners like Dr. Goldstein who can provide a curriculum. DreamUp has a curriculum. And we are expanding. That program is growing rapidly. It is also growing, as I said, into more disadvantaged locations.

We still have trouble with NASA. We have trouble because we do not quite fit, but we are picking up the first of our NASA funding for disadvantaged communities.

And we are also going overseas now. And I think it is a great story in American leadership. Both DreamUp and Nanoracks—we have done work with the UAE on contests and in Germany. And so this is a great story of all working together, the students, the community, NASA, and the private sector. So it is a good story.

Senator CRUZ. So $15,000. If I am doing my math right, that is about seven and a half goats.

[Laughter.]

Senator CRUZ. And you may think of an alternative price.

Mr. MANBER. Well, I can think of alternative things we could auction off in Texas.

[Laughter.]

Senator CRUZ. Senator Capito.

STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM WEST VIRGINIA

Senator CAPITO. Thank you, Mr. Chairman, and thank all of you for being here today.

I am from West Virginia and we have a great relationship with NASA in West Virginia. We have the Katherine Johnson IV&V Center that we just renamed in her honor, our proud West Virginian.

I would like to ask really anybody on the panel. But in my observations there, I think one of the most enlightening thing that I have seen and really I think the way to get our students is the col-

laborative efforts they do with Fairmont and also with West Virginia University.

So how do you see that expanding? I do not know. Dr. Gladden, you might be more involved with that at your school. How do you see that expanding and is there any pushback from NASA to continue those kinds of internships and availabilities? Because a lot of them end up working there in the end.

Dr. GLADDEN. Well, thank you for the question.

I certainly do not see any pushback from NASA. I think that NASA has been a very good partner too with the higher ed community providing those internships, those opportunities for our students, and also as we have talked about before, the research projects. Students are always involved in every research project. And so those are golden opportunities for those students to get involved in a real project of interest to NASA but also to engage with the professionals at NASA. And that engagement, even over and above the technical parts, is really quite valuable.

So, no, I certainly do not see any pushback. And I think that all of us in higher ed are always looking for more and more experiential opportunities for our students.

Senator CAPITO. So that would be like the Space Grant program.

Dr. GLADDEN. Exactly. Yes, Space Grant is a great example of a vehicle to make those sorts of things happen.

Senator CAPITO. Ms. Condino, you talked about your robotics team. Another observation I have had—I have seen a lot of robotics teams. We live in a rural State. And one of the things that I have noticed that I think is kind of lost on people when they think about the STEM education that comes from being a part of a robotics team, whether it is an elementary, middle school, or high school, but the skill sets that you are developing are not just your science and technology skill sets. You are learning how to present. You are learning how to work collaboratively. You are learning how to share knowledge with other teams from other States or other schools. And I think that part of the robotics team, for that person that may not have the highest technological skills or maybe cannot work the controllers as well as somebody else, to have a member and the concept of teamwork is something that I think is incredibly important and certainly NASA is a team.

So how do you see that with your experience as a teacher?

Ms. CONDINO. In our robotics program, we divide our group into subcommittees or committees, you know, little committees. We actually right now we even have the business committee, the marketing group. We have kids that are involved in just documentation alone, even the scouting group because they have to pair up with some other schools. So it is important for them to have good relationships with the opponents so that in the end, if you do not actually make it to the top finals, the top teams will get the chance to select you. So having good relationships with them.

So it is not at all just the build skill or the coding skill and the programming skill. It is all types of skills that actually is being honed and enhanced in these kinds of programs.

Senator CAPITO. And I think that really fleshes it out.

Dr. Elkins-Tanton, it is great that Senator Rosen is here with me today. I joke that we are the STEM times two because we just re-

cently got a bill passed, the Building Blocks of STEM Act. Part of our mission has been to draw in more women into STEM at a younger age.

What is your experience with this, and how do you think we can increase the participation not just of women but other minority groups that are not well represented in the STEM fields?

Dr. ELKINS-TANTON. Thank you for this question. This is something I am so passionate about and I think about deeply. And anyone who is listening, I want to work with you on this. I think it is for anyone who feels that their voice cannot be heard either because of their gender or their socioeconomic background or their race or any of the reasons there could be implicit bias against a person.

And to me the really key step in advancing equity is culture. I think that you need a culture of the organization where people can rise on their merits, where they are not bullied out, where they are not harassed out. Sociologists say that until there are about 30 percent of people who you feel like are like you on the team, you feel like you are alone, and therefore you are the most vulnerable person. It does not matter what the hiring rubric is. If you do not have a good culture, you will not have diversity.

And I would just add to that also the experiential learning, the inquiry learning of things that we are working on—you can create any kind of miracle with one fabulous teacher and 30 kids or with a perfect internship. But if we cannot do this at scale, we have lost. We need to be able to do this at scale.

And so that is the purpose of so much of what I have been working on personally, trying to make sure that these experiential inquiry experiences can be done at scale. I think it is critical to equity and diversity as well.

Thank you.

Senator CAPITO. Thank you.

Thank you, Mr. Chair.

Senator CRUZ. Thank you.

Senator Rosen.

STATEMENT OF HON. JACKY ROSEN,
U.S. SENATOR FROM NEVADA

Senator ROSEN. Thank you.

Well, I have to tell you that all of you are so inspiring. And oh, my goodness, I can tell you I have so many friends who are teachers that find the creative ways to inspire their students through music, through physics, through all kinds of things. And it is the art and passion of teaching that will really move our country forward because when you grab those young minds—you have grabbed me. I am like ready take your class. And there you go. So thank you, and all of your passion is infectious. You need to go around the country talking about this.

And Senator Capito and I did introduce a bill, Building Blocks of STEM to help get young girls, pre-K through 12, involved in STEM education. It should hopefully be passing the House and the President will sign that into law. We will get some things moving.

But we do, in Nevada, have a wonderful woman, Dr. Elisabeth Hausrath, who is a research geoscience professor at UNLV. So she

got the bug early. And so we know that currently half the states in the United States, including Nevada, only receive less than 10 percent of Federal R&D funding. The NASA EPSCoR is a joint Federal/State program designed to allow more states to participate in space and aeronautics research, building upon what the kids learn in the younger grades.

So we received $100,000 at UNLV to study minerals found on Mars. Like I said, geoscience professor, Dr. Elisabeth Hausrath—she is a role model for so many. We have been featuring her. She is leading this research project and she was selected by NASA as one of 10 scientists who is going to choose which rock and soil samples from Mars that are going to be brought back to Earth.

So the President's budget proposal—it terminates this NASA's office of STEM engagement and significantly is going to cut NASA EPSCoR. So we are going to do Building Blocks of STEM. We are going to try to provide grants and help for teachers and schools and bring this up to scale, we hope, around the country. But what do we do if we terminate this project? Where do we go from here?

Dr. ELKINS-TANTON. One very practical thing I might say, as the PI of the mission, Psyche—and by the way, speaking of gender, I believe I am the second woman to ever win a competed deep space mission. I really feel strongly about that.

Senator ROSEN. Congratulations.

Dr. ELKINS-TANTON. And the first was Maria Zuber, who I am sure many of us in this room know, my friend and mentor.

We are allowed to take a percentage of our PI-led mission money and use it for undergraduate education and outreach. And so that was something that I mentioned in my testimony. But that could be expanded beyond the undergraduate. If the missions could also then reach K through 12, could reach out to communities with that money. If that money was just allowed to be used in a broader sense, that would immediately be perhaps a simple way that we could help with the potential tightening of the NASA budget.

Senator ROSEN. So maybe offering internships and scholarships for people who are going to graduate school or undergraduate, that they can come down and help teachers like this do some great things in their classroom, give them those extra skills.

Dr. ELKINS-TANTON. That is exactly right. You know, our 550 undergraduates we have had involved in two years—that could have been 550 undergraduates and 550 high school students or middle school students. That would begin to make a difference.

Senator ROSEN. Thank you.

And so I guess what I want to ask each one of you in all the different areas that you work in, how can we here in Congress help you get the next generation inspired to reach for the stars, if you will? Right? Because that is what NASA is all about. And thinking about that, using that imagination. So we are the policymakers. We are the lawmakers. You cannot legislate everything, but what can we do to help you inspire that next gen? Please.

Mr. MANBER. Thank you for your enthusiasm, Senator.

Senator ROSEN. I am a former computer programmer. I like the STEM stuff.

Mr. MANBER. We have found at both Nanoracks and DreamUp that first off, NASA opens doors. I have unfortunate news that not

all of the American public likes all of the American government. OK. This is news for you. But NASA still opens doors, and NASA must be there. It is a wonderful brand. It is a wonderful history. And no matter where we are when we say we are working with NASA to go to the International Space Station, people smile. I mean, there is just this trust of what NASA has been, is, and will be.

So what I would say from your vantage point is I do not want to see NASA go away in STEM. I mean, so many governmental organizations have STEM outreaches, which is wonderful. But NASA is a special part of our government, and they have such a proud history.

So we have found that contests inspire when it is something real of going to space. This is just from our vantage point.

Senator ROSEN. I watched the moon landing, and so I know what it inspires.

Mr. MANBER. When a student can be part of something that involves a launch of a rocket or whatever, a satellite, or whatever it is, that is inspiring, and we need that the history of NASA to be there to continue to make them motivated.

Senator ROSEN. Please, yes.

Dr. GLADDEN. So I just want to tee off of that because I think that is really truly important. You know, NASA is uniquely positioned of really any Federal agency to capture hearts and minds of students at a very young age. And I think this also connects back to the gender gap discussion we were having a few minutes ago that even before the students get to Ms. Condino, reaching back into the middle school, that is where you begin to see some differentiation happening based on gender. And I think trying to reach back into the middle school or even elementary school through NASA and the allure of NASA, that might be a powerful thing for our country.

Senator ROSEN. Ms. Condino, what do you think?

Ms. CONDINO. From a teacher's standpoint, I think it is reduction of all of those tests, and instead of focusing so much in the classroom and teaching to the test because it is mandated by the State or the government, why not allow us teachers to create all of those STEM initiatives and projects and have the kids put their minds and participating and doing activities that are like that?

Senator ROSEN. Experience-based learning. I like it. Thank you. I yield back.

Senator CRUZ. Thank you.

Senator Thune.

STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA

Senator THUNE. Thank you, Mr. Chairman.

As the demand for jobs in STEM fields continues to grow, it is critical that we have students from all over the country who have those skills and are competitive on graduation regardless of where they choose to receive their education.

NASA's Established Program to Stimulate Competitive Research, or EPSCoR, provided, as you know, funding to areas of the country that are typically unrepresented in Federal space and aeronautics

research funding. South Dakota's universities continue to produce high quality students in STEM fields, and EPSCOR funding has been essential in making a broader base of STEM expertise available to NASA.

So could you just, as a general question, sort of speak to the importance of building a nationwide STEM workforce that draws from every state across the country?

Dr. ELKINS-TANTON. Thank you for that question.

I see the effects of the tightening our STEM workforce every day working on this mission. I see it at Jet Propulsion Laboratory. It see it at Maxar, our industry partners. Everyone is feeling it. It is a real problem on the ground right now, which I imagine Mr. Manber can relate to.

So to me showing students early that you are not a special kind of person if you go into STEM, that anyone who is interested can do it. There is not this differentiator between the STEM people and the non-STEM people. You can love art and you can love philosophy and you can love sports and you can also love math. And you can work with people who love all those things.

If we could make it more of a connector instead of necessarily a differentiator, if we could work on the culture of not judging girls in fifth grade and telling them they are not good at math, work on that culture, give the teachers the freedom to connect not just STEM, but all the fields together, to me that would be a great impetus for bringing people into this world of STEM.

Mr. MANBER. In Houston, we just hired our first in-company recruiter, and we have done it because we are having trouble filling jobs. We are very, very hungry to find the right level of young engineers that have space experience, and we have picked up some new programs lately. And my head of engineering is frantically, you know, where do we find the people? This is a serious problem for us, and in the space community, we cannot do non-U.S. citizens. We cannot do the visas. So we have a problem in this country today. We are growing 30 to 40 percent a year, and I am worried about getting the right people. I am just having trouble with it.

Dr. GLADDEN. So I think all of that is exactly right.

I might touch on one element of that question that I think was in your question, Senator Thune, about the demographic diversity across the country, so making sure we are drawing engineering talent not just from the East Coast and the West Coast but all through the country. And I do think that is critically important because we are culturally different. We have different experiences as young children. And so that little girl who grew up fixing her tractor on her farm could make an amazing engineer, but she has got to have the opportunity to see that path forward.

And so I think that is where programs like NASA EPSCoR and others can be so invaluable to making sure that all of those students in South Dakota and Mississippi and everywhere in between can see that path forward because there is talent out there. It is not that we do not have the talent. I think we have a pipeline problem.

Senator THUNE. Ms. Condino, you mentioned in your testimony some of your experience teaching in a rural community in Texas. And I am curious. We obviously work very hard in South Dakota.

We have got some exceptional students, and that is thanks to the dedication of the faculty and the administrators and State officials who work very hard to make sure that they have to tools they need. But one of the challenges that we face is recruiting teachers and retaining STEM teachers.

And I am just wondering, based on your experience in Texas, if you could share any ideas that might help schools in South Dakota and other rural states recruit and retain teachers who are equipped to teach STEM-related courses.

Ms. CONDINO. I remember moving from teaching in El Paso to Presidio, Texas where my salary was cut more than $10,000. But I think that is one thing that would attract teachers in those rural areas because there are gems in the rural areas. The kids could do much because they have nothing to lose. And that is one thing that I have noticed. If I would present the students something that is new to them, they will grab it in a heartbeat. They will do whatever I want.

But it is very difficult to keep the teachers because one would be either pay scale, obviously, and the lack of proper training. I am very resourceful in my own way. I tried to use technology and all the other resources inside and outside, and that is what I promise my students every day that if I cannot get the resource from right here, I will bring it to you.

Like for career day, I remember how every year we have a career day in November. But the first career day I attended in Presidio, we only had plumbers. And I have nothing against those kinds of jobs, plumbers and people who work in the salon. The most popular were the border patrol and the military. But I felt like these kids have to be exposed. So I told the teachers and administrators, hey, I want to do a virtual career so that I could have people from the outside, professors in the universities from the outside that I know, and even those in other countries, former students of mine are already in—that are professional, have the kids get exposed to that.

Answering what you asked about keeping the teachers, it is the individual. I can only speak for myself. It does not matter where I go. It does not matter how much I get paid for teaching. This is my passion. And so I will just give 100 percent of what I have. And I really hope that those other teachers would stay in that teaching profession because we are losing the majority of them.

But I am proud to tell you that Presidio High School or even the elementary has now faculty members that were my former students. So they are going back. And that is what I told the students. When you leave Presidio, you have to come back and help your community to flourish.

Senator THUNE. You have to be able to handle the 40 below wind chills in South Dakota too on top of it.

[Laughter.]

Senator THUNE. But I just want one last question, if I can, Mr. Chairman.

In addition to the achievements of NASA and its partners, maintaining American leadership in space is also going to depend on continuing improvements in our cybersecurity capabilities. We have a little university in South Dakota, Dakota State University, which

has been a real leader in training qualified cybersecurity professionals.

How important are sophisticated cybersecurity capabilities and a large network of cybersecurity professionals to maintaining American scientific and technological leadership in space, would you say?

Mr. MANBER. Thank you for the question, Senator.

Growing up in our software capabilities and cybersecurity, we are spending more and more money, and we think it is well spent on protecting our internal and external communications. It is something none of us here know the moment it is going to be a crisis or whether it will be a crisis, but it is a threat. And so even a small company like mine is investing more and more to ensure confidentiality and security in our communication systems. We are hit all the time. We are hit all, all the time.

Dr. GLADDEN. Ditto for universities.

Dr. ELKINS-TANTON. Just to add briefly onto that, the team of people working on the Psyche mission is now above 800. We are at so many different organizations. The openings for cyber-attacks through those many, many organizations is vast, and for a project like this, the catastrophe could only be imagined. And so it is beyond critical to add to everything that is said at the table.

Senator THUNE. I am glad to hear that Dakota State is very much on the right track I think. Thank you.

Thank you, Mr. Chairman.

Senator CRUZ. Thank you, Senator Thune.

Mr. Manber, you spoke compellingly about the challenge of finding qualified employees who are trained engineers and able to fill the demands of the modern workforce.

A question I want to ask all four of the panel members, in your opinion, how important is space? How important is the mission?

You know, I think back to when John F. Kennedy came to Houston and came to Rice University and laid out a vision that within a decade, we will take a man to the Moon and bring him home. And I have always liked the fact that President Kennedy said at the time—he was at Rice, and he said why does Rice play Texas. Not because it is easy. Because it is hard.

[Laughter.]

Senator CRUZ. That inspired a whole generation.

My question to you is how important is space for inspiring a new generation of students, a new generation of teachers? How important is going back to the moon? How important is building a sustainable habitat for ongoing research on the Moon? How important is going to Mars and perhaps finding the first signs of life in the universe? How important is that for inspiring the next Nobel laureate in physics? Share the importance of space for inspiration.

Dr. ELKINS-TANTON. In our world today, a lot of the narratives we hear are narratives of fear and narratives of guilt. But the only way you really get people to stand up and do the miracles that we are capable of is when you have a narrative of optimism and a narrative of hope.

And that is what space is. Space is the opportunity to be who we could be as human kind, that we do not always see ourselves being every day here. It is the inspiration that if we can create these

things that you are listing, these beautiful ideas we have, then we can be bolder and better in our lives here at home. It is the inspiration for students to go into STEM fields for something that they find could make them a bigger and a better human being.

And so I think it is incumbent upon us. If we turn away, it is a failure of our species. We have to do this.

Mr. MANBER. We just opened an office in the UAE in Abu Dhabi, and we have been doing work on the Emirates astronaut who went to the Space Station. We did their educational payloads, which is pretty cool.

Why are they looking at space, and why did we open an office in Abu Dhabi? It is funny how we take things for granted in this country and we do not realize. They have studied the last 50–100 years, and they said the best way to ensure that we as a society in the UAE stay together as the oil revenue goes down is to get into space. And to them, they have announced a 100-year program to go to Mars. And so they have looked and studied us, and they said what you did during this Apollo era and what you continue to do in space is the best way that we as a government can inspire our kids not to leave our country and to get meaningful jobs.

The same in Australia. The same in Mexico. The same in the UK. All have opened space programs in the last 2 to 3 years, all looking to the United States as the role model.

And here we do not even see it. Here we have to be reminded only when someone gets in front of us for a brief period of time. And it just frustrates me that we see every day how kids are encouraged by and motivated by space, and of course, there are strategic advantages, commercial advantages.

But to answer the question, the world has looked around and said, you know, what you guys did during Apollo, hey, that is the best way to motivate our next generation. So space is important for a whole bunch of reasons, but one of them we know already. It inspires.

Dr. GLADDEN. That was all very well said.

The only thing I would add to that I think is that if you just look from a straight up return on investment, direct return on investment, it is probably not a great thing to do. But the intangible power of the space exploration is—it is intangible. It is immeasurable. I do not think I can pinpoint any single initiative or program in this country's history that we could all collectively be more proud of and more inspired by than the Apollo program. I mean, it really kind of took this country to a whole different level. And the inspiration that it delivered to the country then got leveraged into all kinds of other technical advances. So that is when you sort of look at our return on investment, you got to pull all that into it as well. So I think that the power of space exploration—it goes way beyond just the direct dollars and return.

Ms. CONDINO. I think it is a reminder that we really are not alone, and we have to go out there. Either to protect ourselves in the future, and explore what is beyond and how can we use that to make our planet even better. So it is a testimony where this is where we could put all the skills that we have developed. Why is it not inspiring to be able to be the first person on Mars? I myself wanted to travel and go to space. That is my lifelong dream.

Senator CRUZ. You know, one of the things we have heard as well is the enormous demands in the STEM fields and that these are only going to keep growing, whether cybersecurity, whether space, whether computers, whether programming. The world is getting more and more complicated, more and more technological, and people lacking those STEM skills have a much higher chance of being locked out of their best chances of the future.

At the same time, we are facing a shortage of graduates with the skills necessary, and one of the things that all of you all have testified to is to address that, we have got to expand the pool. We have got to expand the graduates who are coming out. And in particular, minorities, African Americans, and Hispanics continue to be underrepresented in STEM fields, and women continue to be under-represented in STEM fields.

Both of those are realities I personally have considerable familiarity with. My mom was one of those human computers. She came out of Rice in 1956 and got hired at Shell as a computer programmer at the dawn of the computer age. And my dad was a Cuban immigrant who came out of Texas in 1961 and became a computer programmer at IBM with a heavy Spanish accent and an amazed wonder to be in America.

I want to ask each of you, how do we expand the ability of minorities, the ability of women to see that they can achieve in the STEM fields, to gain the skills they need, and to get the tools to pursue careers if that is their passion and their aptitude and their dreams? And I want to open it up to anyone.

Ms. CONDINO. Well, especially the women, when I used to teach in Presidio, it was very difficult at the beginning to kind of like to have them speak up for themselves. So I always tell the kids self-advocacy is very, very important. And I ask your teacher will be here as your second mom. And after they have already gained all the skills and those exposures that we provided for them, they need that full support in the end as well until they continue.

Like these young girls that I mentored all the way until they finally called me and said, Mrs. Condino, my last question for you is help me decide. Should I accept a job at Lockheed Martin Corporation or should I go to Aurora Flight Sciences, which is owned by Boeing. Things like that.

So it's continuing to mentor these kids whether they are male or female and continuing to provide them that exposure. I am very happy where I am at right now at Fairfax County public schools because especially in my school, they were pioneering these capstone projects where in lieu of having this final exam, these kids are developing projects from ninth grade all the way to senior. And the capstone projects are amazing where they conduct research.

They do presentations at—you know, even at the Department of Education, we have students who published a book. There is a student who actually created a story about her struggle and her way to the United States I believe from Siberia and it ended up being a film. So she was invited to this film festival. So things like that is already starting. And again, it is experiential learning.

And we are now moving on to the middle school where the middle schools are also sort of like being exposed at a young age because these are the skills that we will need for our future work-

force. And I think we have to start really early. And as a teacher, we need to be there and continue our mentorship. Even if they are already graduates, we still continue to communicate with them.

On Thanksgiving, one of my former students at Herndon High School just graduated with a degree in physics, and he is now working at the Missile Division of Lockheed Martin. And he has told me I am coming home on Thanksgiving, and I want to buy you dinner. So things like that where you just give everything that you have because it is not just for me anymore. It is not about me anymore. It is about my kids, the future of my children and their children's children. And I wanted to be able to contribute now.

Senator CRUZ. And the choice you described your former student is facing, I would like to see a lot more students having choices like that.

Dr. GLADDEN. I will be brief. I think the only extra point I would add to that is, as I stated earlier, reaching further back into the grade levels, if we are thinking about trying to grow, which absolutely we need to do, grow the under-represented groups within the STEM fields, the professional ranks, I do think that we will get more bang for the buck if we reach back as early as we possibly can. And whatever the programs are, whether they are NASA programs or Department of Ed programs or wherever they live, I think we need to start early because a lot of those preconceived notions—and some of them are cultural, some of them are implicit bias. I mean, whatever the reasons are, they start very early. And once they start, it is hard to then peel them back, get them back on track at the high school level and certainly at the university level.

Mr. MANBER. A few moments ago, I talked about the extraordinary brand that is NASA. It is almost a disadvantage in the sense of your question. How do we reach out to more disadvantaged communities? We have now made a conscious effort to go reach out to not only African American and Hispanic communities but also first people. And when you go in and when you say you can go to the International Space Station—I will again use a New York analogy—they say, what? Are you selling us the Brooklyn Bridge?

So one of the problems that we face is that NASA sometimes has a love-hate relationship with commercial, but the more that they hear that a small company sent an oven to the Space Station or the more times it comes out instead of it just being NASA and still very often when we do things, it is under NASA.

Now, there are a lot of, let us say, first people who are not going to think that they can go to the Space Station in this way. So to answer you very practically, we have started to just go to some of these conferences, meet with the people, and say either we want to train you or we want to locate something in your community or on the reservation, or you can send something and we will help you.

So it is just hard work, but we cannot wait for the government to do it. But we could have a little bit of emphasis put on NASA that sometimes it is not NASA. Sometimes it is the commercial sector. We say, just laughing, when something goes wrong, suddenly it is us, but when it is right, you know, it is NASA. It is a joke. It is a joke. So it is really trying to get over the brand, over the gravitas that is NASA.

Dr. ELKINS-TANTON. To go back to what Ms. Condino said, so many students are drawn into STEM fields through the team experience of building something together. If you get away from the hero model where it is just that one really smart boy who answers the question and everyone else feels left out, if instead you have everyone at the table working together to solve something, that is where you get real diversity. We can do that at the middle school. We can do that in elementary school. We can do it in high school. That is what our whole new degree is. It is all inquiry and experiential learning. We can do it at scale. We can solve the problem of numbers.

The thing that you can do to help would be to release some of the strictures on K through 12 on teaching to the test so that the teachers feel that they have more freedom to teach in these other ways that we know work.

Senator CRUZ. Well, wonderful. I want to thank each of the witnesses for your hard work, for your passion, your dedication, for your testimony here today.

I am extending because I am being told that Senator Sinema is a minute away. So right as I am in my peroration, getting ready to try to wax eloquent, and instead—all right. Let us ask another question, which is universities.

What should universities be doing better to expand STEM education? And let me ask you in particular. NASA Space Grants. How much of a difference are they making as a practical matter?

Dr. GLADDEN. The Space Grant program is hugely impactful. It not only funds the faculty to do some of their exciting work and partner with NASA to solve a particular problem, but as I said earlier, there are always students involved in those problems. So those are critical.

I would say beyond the NASA Space Grant program, higher ed as a whole is looking pretty deeply—and we certainly are at the University of Mississippi—at the STEM education experience. We have kind of a cookie cutter traditional mold, you know, we have this department and this school, and so on and so forth. But the real problems do not fall like that. And you have to be able to work with folks who do not have an engineering background but they have got an accounting degree or a business or a biology degree, or whatever it is. And the Center for Manufacturing Excellence is an example of this layer that you put on top of those majors that blends and then builds teams of those students. Some are accounting majors. Some are business majors. Some are engineers. But they are all working on a yearlong problem, and they are all taking class work so they understand each other's world.

And so I think the more of that that we can do, get creative about—and, you know, teaching to the test—I am fully onboard with trying to move away from that and get more creative at the secondary level. That is kind of the same at the university. We do not teach them too much to the test, but we teach a lot to the way we have always taught. Can I get an amen on that?

[Laughter.]

Dr. GLADDEN. But I think I am beginning to see more and more willingness in the university and higher ed to think a little bit broader.

Senator CRUZ. And I will say I think that is the first call and response we have had at a subcommittee hearing.

[Laughter.]

Senator CRUZ. That is wonderful.

Senator Sinema.

Senator SINEMA. Well, thank you so much, Mr. Chairman, for allowing me to pop out to another Committee. I am really glad to be back here.

I want to thank you again, all, for being here and testifying on such an important issue.

My first question is for Dr. Elkins-Tanton. In your written testimony, you discussed the difference between NASA-led flagship missions like the Hubble telescope and principal investigator-led missions like Psyche, the mission that you lead. When testifying before the full Commerce Committee in July, NASA Administrator Bridenstine made the same point which you make in your written testimony, that university-led PI missions are more likely to complete it on time and under budget as compared to the NASA flagship missions.

As a principal investigator, what do you see as the differences between how PI-led missions are managed as compared to flagship missions? And what lessons could NASA learn from PI-led missions to keep more of our flagship missions both on time and on budget?

Dr. ELKINS-TANTON. Thank you for the question, and I very much hope not to disappoint you with Psyche mission. We are going to try to be on schedule and under budget. We will see. Doing our best.

The big difference between the way these missions are run—the PI-led missions are conceived of as a whole and the team built from the beginning. And so the schedule and the budget and the instruments that are needed and the plan for the mission are all built as a whole, as a single unit. Whereas, the flagship missions come from the decadal survey. They are trying to answer the really big, really tough space challenges that we have. And they are put together by competition so that the instruments are picked from a pool, and then the leadership is picked. And so once the leadership is in place, what they really have is a whole bunch of separate, I might say, city states that they need to blend into a functional government all together. And that is a big challenge.

And it is not that I think this is wrong. I think that the aspirations of our flagship missions and the new technology developments that they drive, which makes budgeting much harder, are what we should be doing. They are the hard things. But if there is a possibility to create a more united team earlier in the process, I think that will help with the budgeting and scheduling challenges because that is where I see them coming from.

Senator SINEMA. Thank you.

My next question is also for you but I welcome all of our panelists to respond if they are interested as well.

I am really proud of Arizona's universities that we have taken advantage of NASA programs like Discovery and New Frontiers, which provide principal investigators the opportunity to propose and receive funding for a mission that advances NASA's scientific and exploration goals.

What I am concerned about is what happens when one of these missions ends. So after NASA and the university make significant investments to develop expertise in a complex and focused field of air space, astrophysics, or astrobiology, the funding to support the research disappears afterwards. So this can lead both NASA and universities to lose a key source of expertise and it makes some of the follow up research for these missions much harder to complete.

So what opportunities currently exist or should exist to help NASA and universities make continuous or long-term investments in space-related research fields, and what more can we do to help NASA, universities, the private sector, and individual researchers develop these long-term relationships to fuel decades of research?

Dr. ELKINS-TANTON. It is such a constant problem in space research, both on the science and the engineering side, that you buildup an incredible expertise and then the funding and the emphasis goes away. And then those people need to leave for other jobs.

We saw this happen after the Apollo era with lunar science. Our institutional knowledge of lunar science began to drain away because the funding was severely cut.

I envision a kind of world where when we are so lucky, as we have been in Arizona at UofA and at ASU, to win these big competed missions and we get these tremendous teams together, what I would love to see is the opportunity for those people then, waiting for the next possible mission opportunity, rather than vanishing into a different industry, that is a moment when we can bring together university, private sector, NASA to do these kind of triangle sector efforts to hit the next big target that we need. And then we do not lose the people. They are still on the same teams. They are still educating new members, and they are connecting better with the private sector. They are doing tech transfer. They are filling in a gap in Artemis. They are doing whatever the next important thing is. And I would love to see NASA create partnerships like that that would strengthen and grow a workforce.

Senator SINEMA. Yes?

Dr. GLADDEN. So you are absolutely right that when those specific projects end and the funding stops and then you have sort of invested quite a lot of time and energy and money into developing a relationship and a skill set and then it is gone.

So one of the things that we do at the University of Mississippi—and other universities do this very well also—is really work on developing the relationship with the program so that when that funding ends, that we have got a trusting relationship between the scientist and engineers on the Federal side and our faculty members and research staff. And so what that tends to do is the funding may have dried up or shifted in other directions, but once you have the relationship there and you have some flexibility in your skill set—that is another key element is that, as we were talking about sort of changing the way we think about developing on the education side a more flexible curriculum, that is going to lead to a more flexible faculty in the future that are not so narrow that this is what I do and if it does not fit in this box, then I am not involved or I cannot be involved. And so I think those sort of things, having

that flexibility and that long-term relationship, is really key to extending the time that we are collaboratively working.

The one other point I will quickly make is we do have some models with other Federal agencies where we have scientists from the Federal side come and stay on our campus for extended periods of time—it might be 3 months, 6 months, or even longer—and our faculty members also go there for extended periods of time. Those are incredibly valuable. And we even go so far with a particular agency where we have Federal scientists embedded full-time with our faculty in one of our facilities. That is the kind of thing that builds relationships that last decades.

Senator SINEMA. Thank you.

So my next question—sorry, Dr. Elkins-Tanton. I have another question for you.

Since 2015, you have worked as the principal investigator on the Psyche mission, which proposes to send a probe to Psyche, an asteroid with an exposed nickel-iron core. Apparently it resembles the core of a newly formed planet much like the Earth several billion years ago.

As you have developed this mission, how have you worked with both undergraduate and graduate students, as well as other researchers at Arizona State University, and what do you believe that students and researchers gain from the opportunity to work firsthand on a mission like Psyche. And then what more can we do to ensure that students and researchers across the country have the opportunity to participate in NASA missions?

Dr. ELKINS-TANTON. Thank you.

We have been hitting this topic I think really beautifully, and I want to focus on a couple of really key parts of what we have tried to do in Psyche, which I think connect so much with everything that we have each said, and that is giving students at all levels the opportunities to work in interdisciplinary teams toward goals.

So Dr. Cassie Bowman is the research faculty at ASU who runs all of the Psyche student collaborations. And one of the innovations that she has made—in fact, we are writing research papers about this—is figuring out how to run capstone teams. But we would really like them not to be capstone teams. We want them to be every semester every year of your education working together where there is an engineer and there is a user experience designer, there is a graphic designer, there is a marketer, there is a student project manager on the team just like it will be when they hit the workforce, trying to solve problems that come from the project. And so our engineers, our people at JPL, our people at Maxar, they share challenges they are facing and give them to these teams.

We had a set of capstones that competed for a flight on a Blue Origin launch, and the team that won was a virtual team. We had someone in the military who was on a ship. We had someone at a university on the east coast, in the south, someone in the north. They literally mailed their hardware back and forth. They did Skype teams. And they won. And so that is the workforce of the future. And that is how we want to engage people. I think we should do as much of this as we can.

Senator SINEMA. Thank you.

Mr. Chairman, I want to just take a moment again to thank all of our witnesses for being here today, and I want to thank you for hosting this Committee hearing. This is something I am very interested in. It is important to my state. I know it is important to our country, not just for the future competitiveness of our country, but for our national security. So thank you for the work that you all do, and thank you in particular for the folks that you are teaching and mentoring across our country to ensure that we remain competitive and safe. I appreciate it.

Senator CRUZ. Well, thank you, Senator Sinema.

And I want to thank each of the witnesses. It is sort of, as Yogi Berra said, "dèjá vu all over again." But thank you for your terrific testimony, for your passion, and for the difference you are making.

The record for this hearing will remain open for the next two weeks. Any Senators are asked during that time to submit questions for the record, and upon receipt, the witnesses are asked to submit your written answers to the Subcommittee as soon as possible.

And with that, this hearing is adjourned.

[Whereupon, at 4:17 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
DR. LINDA T. ELKINS-TANTON

Question. The Cosmosphere, located in Hutchison, Kansas, is a great example of the role informal education centers play in introducing STEM and inspiring students at an early age. Nick Hague, a native Kansan, and astronaut who recently served as Flight Engineer on the International Space Station for Expedition 60 has stated that a junior high trip to the Cosmosphere reinforced his desire to become an astronaut. Additionally, they have hundreds of stories of students who participated in their education or camp programs, ultimately going on to work at NASA, JPL, Space X, Virgin Galactic, the Armed Forces and more. How can we continue to leverage centers like these toward advancing our common goal of furthering STEM education and inspiring future generations?

Answer. I had a similar formative experience as a child while visiting the American Museum of Natural History. The effectiveness of informal education is striking, and it shows the truth of the saying that education is what is done to us, and learning is what we do for ourselves. In museums and libraries and community centers and camps all over the country, people are learning, and that learning feels personal and exciting and important. We need these programs.

The work of the NASA Education group is central to the vibrancy, rigor, and networking of this kind of program. I've followed their work closely and endorse it highly. These programs need a structure and support to grow in synergy and excellence, and not become isolated and possibly outdated. NASA effectively connects the centers with universities and with each other. Further, corporate partnerships with the growing space sector should increasingly help bear the burden and better connect the triangle of private sector—education—government.

Your word, inspiration, is central to all of our efforts. Unless a person is inspired they may wander aimlessly in their education and career; in fact, they may wander off the path. Our world needs all the inspiration we can get and these informal education programs are a key ingredient to societal vigor and progress.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
JEFFREY MANBER

Question. The Cosmosphere, located in Hutchison, Kansas, is a great example of the role informal education centers play in introducing STEM and inspiring students at an early age. Nick Hague, a native Kansan, and astronaut who recently served as Flight Engineer on the International Space Station for Expedition 60 has stated that a junior high trip to the Cosmosphere reinforced his desire to become an astronaut. Additionally, they have hundreds of stories of students who participated in their education or camp programs, ultimately going on to work at NASA, JPL, Space X, Virgin Galactic, the Armed Forces and more. How can we continue to leverage centers like these toward advancing our common goal of furthering STEM education and inspiring future generations?

Answer. Of all the challenges faced by political leaders, convincing students that space exploration is cool is not the biggest hurdle! Kids have a natural feel for learning about space, whether human exploration or scientific missions to other planets. At Nanoracks, we have our educational subsidiary, DreamUp, which has sent hundreds of privately funded student research projects to the International Space Station. The goal is to leverage the communities, the families, the parents and the schools to engage more with local centers and programs. Outreach is the biggest need right now. We have the wonderful partners such as the Cosmosphere. What is needed is more engagement with the communities including outreach and educational programs. It is very important that we ensure the students of today can fill the technical jobs of tomorrow.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
J.R. (JOSH) GLADDEN, PH.D.

Question. The Cosmosphere, located in Hutchison, Kansas, is a great example of the role informal education centers play in introducing STEM and inspiring students at an early age. Nick Hague, a native Kansan, and astronaut who recently served as Flight Engineer on the International Space Station for Expedition 60 has stated that a junior high trip to the Cosmosphere reinforced his desire to become an astronaut. Additionally, they have hundreds of stories of students who participated in their education or camp programs, ultimately going on to work at NASA, JPL, Space X, Virgin Galactic, the Armed Forces and more. How can we continue to leverage centers like these toward advancing our common goal of furthering STEM education and inspiring future generations?

Answer. I could not agree more that centers such as the Cosmosphere, the Center for Math and Science Education at the University of Mississippi, and many other similar organizations around the country, play a critical role in the sustained interest and passion of young people in the STEM fields. I have a personal story similar to that of Nick Hague referenced in the question. I have no doubt that the visits I made to the Smithsonian Air and Space Museum, as well as other science museums in the southeast U.S. had a profound effect on my interest in the field of physics. These fields take a great deal of education and sustained dedication, so ultimate success in getting into the STEM workforce requires a level of deep interest and passion.

The question is, how can we maximize the exposure of young people to these experiences during their formative years (approximately 6th—12th grade)? I have a few suggestions:

1. Lower the financial bar of entry to these museums and education centers as much as possible. No cost of course would be best, but perhaps free under 18 years old might be more realistic. I understand these facilities are not inexpensive to design, build, and maintain. Perhaps these kinds of endeavors are well suited for public-private partnerships.
2. Increase geographic access as much as possible. While some minimum population center would be needed for sustainability, creative on-line elements such as virtual reality, can help exposure in more rural areas. The University of Mississippi has established a VR Learning Lab to both teach students how to build VR worlds and help public and private sectors understand the training and outreach opportunities.
3. Include elements in these centers that not only talk about the amazing science, engineering and technology; but also what a career in these fields "looks like". These could include regular speakers from professionals in the field, recorded video, and on-line video chats. These should be as interactive as possible so young people can ask questions.
4. Increase awareness as much as possible. This would include outreach to schools, civic groups, local government, social media, religious organizations. Let people know what is available to them in their area and how to access it.
5. Keep the content and programming fresh. Some sections should regularly rotate and capture emerging technologies to provide vision about not only where we have been, but where we are going. This provides some motivation for students to regularly visit and deepen their interest in STEM careers.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JERRY MORAN TO
SHELLA RIVANO CONDINO

Question. The Cosmosphere, located in Hutchison, Kansas, is a great example of the role informal education centers play in introducing STEM and inspiring students at an early age. Nick Hague, a native Kansan, and astronaut who recently served as Flight Engineer on the International Space Station for Expedition 60 has stated that a junior high trip to the Cosmosphere reinforced his desire to become an astronaut. Additionally, they have hundreds of stories of students who participated in their education or camp programs, ultimately going on to work at NASA, JPL, Space X, Virgin Galactic, the Armed Forces and more. How can we continue to leverage centers like these toward advancing our common goal of furthering STEM education and inspiring future generations?

Answer. The influence and impact to students of opportunities like these is prodigious. Many claimed that it truly inspired them to pursue STEM courses and careers. I believe it is best if we continue to provide these kinds of opportunities par-

ticularly internships, not only to undergraduate and post graduate students, but as well as high schools students. An example is how Aurora Flight Sciences, an aerospace company whose headquarters is based on Manassas, VA. Aurora provided internship experiences to 3 of my high school students from Presidio High School during their senior year. Their experiences paved the way for them to pursue mechanical engineering! All three finished with ME degrees, currently 1 is working for Aurora, 1 for Boeing and 1 associate professor of mechanical engineering in a university!

Summer camps and other STEM educational activities can also be a great start to expose young kids however, most of them require extremely expensive fees just to participate. For students coming from rural areas and cannot afford fees, this would limit their chances of participation. There are only a few programs like NASA High School Aerospace Scholars (Texas and Virginia) that provide all expense trip to students who qualified and completed prior work. The NASA Student Launch Initiative for high school and middle school used to provide a small amount of scholarship money to help purchase materials for the rocket at least, but now it is taken away. Therefore, schools who cannot afford the materials, even if they qualify and have students who are skillful cannot participated due to the cost of both rocket and travels. Although my Presidio Rocketry Teams in the past will do anything to make it possible for us to participate, like crazy fundraising (raffling goats, BBQ and donut sales) and driving 24 hrs. on a yellow school bus just to make it to the rocket launch in Huntsville AL, NOT everyone can be willing or has the means to do so.

I believe it is best if we provide more accessible and affordable programs for all. Access to virtual programs can also be an option, specially to those schools in the farthest corners or edges of the country.

As a classroom teacher, I went on my own way to bring STEM to my class. I attended numerous STEM workshops and professional developments on my own dime to ensure I received proper training and enough knowledge to share it to my own schools and students. Again, not all teachers could be willing to use their own money for things like these, but providing teachers training and support may play a big difference. I brought in rocketry, robotics, math and science competitions, STEM business, and so on and so forth so that despite our challenging geographic location, our students can still experience the same opportunities as other kids in the cities. We had virtual career days where students talk to experts and professionals through skype. But these endeavors may be small in scale, but it has a large effect on our little town. Many of the students in the past only wish to graduate from high school to get a job at a grocery store or gas stations, but majority of the students now aspire to go to college and finish college so they can have better lives in the future.