

Iowa Space Grant Consortium

Lead Institution: Iowa State University

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Consortium URL: <http://www.iaspacegrant.org/>

Grant Number: NNX16AL88H

Lines of Business (LOBs): NASA Internships, Fellowships, and Scholarships; STEM Engagement; Institutional Engagement; Educator Professional Development

A. PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Iowa Space Grant Consortium is a Designated Consortium funded at a level of \$760,000 for fiscal year 2017.

B. PROGRAM GOALS

The activities of this program are designed to maximize alignment with NASA's 2014 Strategic Plan, Space Grant goals and objectives, NASA Office of Education's Lines of Business, and the State of Iowa's STEM goals for education and workforce development. The overall program is divided into two elements: primary and secondary. The primary elements focus on higher education in programmatic categories of NASA Internships, Fellowships and Scholarships; Higher Education; and Research Infrastructure. The secondary elements support new STEM participants to enter the higher education pipeline in programmatic categories of Precollege and Informal Education.

PRIMARY ELEMENTS

GOAL 1: Conduct an annual competition to select students for STEM training opportunities, through fellowships and scholarships that align with Higher Education campus base programs, and internships that occur at NASA Centers or industry, to encourage and retain students in STEM fields. (National Center for Education Statistics {NCES} Table 306.6)

Objective 1a. Each year ensure that all awardees are enrolled in a NASA STEM-related research course with an ISGC research mentor, and internship awardees are engaged in NASA-related research.

Objective 1b. Each year ensure that all awardees reflect the diversity of Iowa and meet NASA requirements. For Iowa, the target objective is 40% women and 23.27% underrepresented minority (UM) participants.

Objective 1c. Each year ensure that internship, fellowship and scholarship awardees reflect the diversity of Iowa and meet NASA requirements. For Iowa, the target objective is 40% women and 23.27% UM participants.

GOAL 2: Continue to implement an annual scholarship program for outstanding precollege seniors at the State Science and Technology Fair of Iowa that positively impacts retention of students in STEM-related fields.

Objective 2a. The majority of SSTFI senior entrants are aware of the ISGC awards.

Objective 2b. Ensure that awardee retention in STEM exceeds that of the general STEM student population from a postsecondary institution.

Objective 2c. The majority of awards will go to those who participated previously in SSTFI.

GOAL 3: Continue the development of competitive, self-sustaining base programs that combine active research with student involvement on each core institution campus.

Objective 3a. Each base program will provide research-training instruction for fellowship and scholarship awardees and other student participants.

Objective 3b. Each base program will produce publications and non-ISGC proposals each year.

Objective 3c. Each base program will develop a NASA collaboration that did not exist prior to funding.

Objective 3d. Each base program will generate cash or in-kind match from non-federal funds equal to the NASA funding provided at 125% (1:1.25).

GOAL 4: Support STEM skills development through support of higher education curriculum development and student hands-on projects to align with NASA's education goals.

Objective 4a. Each award will involve curriculum development/enhancement at academic affiliate institutions in areas of importance to the mission of NASA.

Objective 4b. Each award will involve hands-on student projects at academic affiliate institutions in areas of importance to the mission of NASA.

GOAL 5: Continue to develop research infrastructure to build a sustainable capability in the state to support NASA's mission through support of early career faculty and research innovation projects.

Objective 5a. The Early Career Investigator Project will support awards that enable junior faculty to conduct interdisciplinary research, develop a NASA collaboration that did not previously exist, generate nonfederal cash or in-kind match to the NASA funding provided at 125% (1:1.25), and produce evidence of research.

Objective 5b. Research Innovation Awards will fund projects that develop a NASA collaboration that did not previously exist, conduct research important to NASA's mission, and generate nonfederal cash or in-kind match to the federal funding provided at 125% (1:1.25).

SECONDARY ELEMENTS

GOAL 6: Conduct statewide STEM professional development, preservice and in-service training, which serves the NASA mission and showcases NASA content, for formal and non-formal educators working in grades K-12.

Objective 6a. Ensure that STEM professional development workshops engage at least 400 teachers in short-term workshops and 25 to 30 in long-term workshops.

Objective 6b. Ensure at least four communities from tribal and/or other underserved schools will participate in STEM workshops.

Objective 6c. Ensure workshop participation from at least three non-formal organizations such as science museums, clubs, and homeschool groups each year.

Objective 6d. Ensure participants of STEM implementation workshops provide professional development to colleagues and actively engage students within year of workshop participation.

GOAL 7: Continue to promote and provide hands-on opportunities for learners to participate in STEM education engagement activities that serve the NASA mission and showcase NASA content.

Objective 7a. Engage between 550 and 600 precollege students in the SSTFI and at least 100 precollege students in the Iowa Junior Academy of Science in the presentation of research at a professional event.

Objective 7b. The majority of Iowa Junior Academy of Science senior entrants will be aware of ISGC support for the national competition.

Objective 7c. The majority of Iowa Junior Academy of Science winners will matriculate to study in STEM fields.

Objective 7d. The ISGC associate director for education will continue to provide volunteer services to the Governor’s Advisory Council.

Objective 7e. Support programming on Iowa Public Television (IPTV) that will reach at least 20,000 Iowans and is consistent with other ISGC education objectives which uses NASA content and meets the informal education requirements.

GOAL 8: Continue to support STEM informal education programs that enhance public awareness of NASA missions and general scientific literacy for all Iowans through opportunities to engage with NASA unique content.

Objective 8a. Ensure development and delivery of competitively selected informal education projects that meet NASA requirements and engages participants with NASA content from at least 5,000 elementary, middle and high school students and teachers and the Public-At-Large annually.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

- Higher education student hands-on projects: the ISGC two supported teams received three awards at the NASA Student Launch Initiative. Iowa State University’s CySLI team placed 1st in Best-Looking Rocket Award (College Division), presented to the college or university team that is judged by their peers to have had the best-looking rocket. Cedar Falls High School placed 1st in Judges Choice award, presented to the middle or high school team that is selected by a secret panel of judges to have had the most creative payload, best design and workmanship of their rocket and best engagement with the rocket fair crowd. The team also received 1st place in Rocket Fair Display Award (Middle School Division), presented to the middle or high school team that is judged by their peers to have had the best display at the Student Launch Rocket Fair.
- Informal STEM Education, Putnam Museum, Davenport, Iowa: “In all, we are pleased to report that, thanks to ISGC’s support, 1,715 youth and adults participated in Adventures in Space Weekend, nearly three times our original goal of having 600 participants during the weekend. What’s more, activities developed for the weekend were also offered at other

October Putnam education opportunities (e.g., our science club for elementary-aged youth and after-school outreach), extending the benefits of the weekend to an additional 150 students. We are very grateful to ISGC for enabling us to provide informal learning experiences to so many residents of our region and look forward to working together in the future.” - Octavia Houtekier-Boyd, Vice President of Education, Putnam Museum and Science Center

- NIFS: “The funds allocated for lab expense along with the undergraduate scholarship are VERY helpful at least for my projects. Life-science based projects these days require expensive reagents. Most undergrad students have limited training in using these techniques requiring repeated experiments, adding to those reagent costs. These funds that ISGC provides are essential to help those students learn. I would strongly urge that ISGC continue to offer those with the scholarships and increase the amount every 2-3 years to account for the cost of living adjustments.” - Pramod Mahajan, Scholarship Mentor, Drake University

D. PROGRAM ACCOMPLISHMENTS

- **NASA Internships, Fellowships, and Scholarships (NIFS) (Goals 1 and 2):**
 - Interns: In the Spring 2018 semester, four ISU undergrads were placed at NASA Centers, one at ARC; one at JSC and two at MSFC.
 - Fellowships: 16 graduate research students (nine at ISU; eight at UI); 21 undergraduate research students (four at Drake, six at ISU, seven at UI, four at UNI)
 - Scholarships: 15 undergraduate merit awardees which includes one high school senior science fair awardee (matriculated).

In summary, the ISGC awarded 56 students from state-wide competitions in the NIFS category. Longitudinal tracking will be completed in the final report due June 30, 2018.

- **Higher Education projects (Goal 3):**
 - Two research base programs funded at academic affiliates:
 - Countermeasures to Regain Gravity Sensing after Ear Manipulations, University of Iowa
 - Biogeochemical Evolution of The Atmosphere: The BETA project, University of Northern Iowa

In summary, two research base programs were funded, at two of our core academic affiliates. These projects provide support for NASA-related research and have produced 15 peer reviewed publications, two refereed conference presentations, and four invited talks. There is one patent pending. The base support has led to an additional \$275,000 in non-ISGC grants. These projects involve ten PI's, Co-PI's, and collaborators from Goddard Space Flight Center, NASA Glenn Research Center and NASA Ames Research Center. Collaborators from NIH, Iowa Department of Aging, and other universities worked on the projects.

The base programs involved many student participants in this active research. An undergraduate student commented, “I never thought that I would be helping in research with NASA and get to attend conferences to present our research.” Progress has been shown in a variety of areas, including advancements in understanding the

earth's atmosphere, ancient, Devonian, and present; and research to better characterize gravity sensing in manipulated ear systems by advancing to ear transplants in chickens, further characterizing movements in frogs. The range of research topics stretches across the NASA Mission Directorates and provides Iowa with sound research and opportunities to actively engage students.

An additional higher education project was funded at Iowa State University: Ischemic Preconditioning –a Countermeasure to improve Cardiovascular Health in Astronauts. The project involved one PI and seven students. The project has completed all compliance components for performing data collection in humans which includes both institutional review board approval at ISU (17-608-00) and an FDA IND# for drug administration (#138343). Moreover, they have trained graduate and undergraduate students on all techniques and protocols.

- Iowa-Wide Space Flight Operations Workshop at Iowa State University:
The fourth annual Spaceflight Operations Workshop expanded reach by adding faculty from the University of Iowa previously funded by ISGC; NASA's Dr. J. D. Polk, D.O.; Tomas Gonzalez-Torres, retired NASA Flight Director, and additional instructors from Higher Ed and Industry. The workshop included classroom training and field exercises to introduce 12 students to the logic and nuances of operational thinking. Participants were selected from nearly 60 applicants including engineering and preservice education students from two ISGC affiliates and Tuskegee University. All students in the workshop exhibited growth in their ability to think in a more operational manner. The unique partnering of engineering and preservice education students had a positive impact on both groups because of the interactions that were based in different frames of reference. This workshop is led by Clayton C. Anderson, U.S. Astronaut, Retired.
- Three curriculum development grants awarded (Goal 4):
 - Introduction to Precision Medicine: An Experiential Course for Iowa's STEM Teachers at Drake University
 - Course revisions and workstation development for IE 222 (Design & Analysis Methods for System Improvements) and IE 432 (Industrial Automation) at Iowa State University
 - Instrumental characterization of post-consumer recycled space grade polymers, as the educational model of meeting NASA weight-specific mission objectives at Iowa State University

These projects are in two distinct categories: courses for students pursuing STEM degrees, and courses for STEM education improvement. These projects provided students and in-service teachers at two core academic affiliates novel and improved courses based on the ISGC-funded curriculum development and course revisions program. The curriculum included traditional STEM courses that focused on recycling polymers during long-duration space missions, improved engineering workstations to improve student learning opportunities, and STEM teaching and learning. One project helped provide a foundation for working with science teachers to introduce lower cost medical testing into STEM learning and improve their understanding of effective teaching and curriculum using modern techniques. The other project's efforts were to construct workstations for students to use in multiple

classes. When completed, goals of enhancing student learning opportunities and better preparing our students will be realized. The goal of providing young women outstanding leadership opportunities is being met, and student inputs/perspectives will be better understood with the completion of a final survey at the end of the project. The third project is in phase II, to investigate the response of the students to the curriculum as written, in phase I. Input from the investigating student has been used to adapt the curriculum so that it is easier to comprehend and deliver better understanding of the chemical, physical, and engineering principles of the curriculum. One key response is, that recordings of the experimental procedures be included as part of the pre-lab experience, so that students can see with their eyes how the procedure is carried out, leaving no room for misinterpretation.

- Eleven teams funded under student hands-on competitions (Goal 4b); one at Drake University, six at Iowa State University (ISU) three at University of Iowa (UI) and one at the University of Northern Iowa (UNI):
 - Computer Vision & Robotics: Design, Construction, and Implementation Drake
 - Aerospace Engineering 461/462 Capstone/Senior Design Project – ISU
 - Space Flight Operations Workshop – ISU
 - NASA Robotic Mining Competition – ISU Cyclone Space Mining team
 - “Make to Innovate” (M:2:I) lab support for three projects at ISU:
 - NASA CubeSat Launch Initiative (CSLI) – ISU CySat (Cyclone cubeSat)
 - 2018 University Rover Challenge MAVRIC (Mars Analog Vehicle for Robotic Inspection and Construction) – ISU
 - NASA University Student Launch Initiative – ISU CySLI team
 - Student Participation on HaloSat – UI
 - 2018 University Rover Challenge – UI Robotics Club
 - Space Grant Midwest High-Power Rocket Competition – 2017-2018: UI AIAA
 - UNI & Cedar Falls High School Rocket Club Collaboration – UNI

In summary, these hands-on student projects are creating opportunities for a wide range of students across different colleges and majors to engage with NASA-related STEM activities and competitions. The teams’ reports indicate the members learned critical lessons related to the engineering process, as well as team communication and the complexity of systems integration for a final product. The teams are active in outreach events, including efforts that also support ISGC goals for precollege and informal education. Numbers of direct and indirect participants from these events will be included in the final report for FY2017.

- **Research Infrastructure projects (Goal 5):**

In summary, the ISGC funded three projects: one for an early career faculty member from Drake University, and two professors from ISU for travel to NASA Centers (Langley, JPL).

- a. Shankar Munusamy, Drake Associate Professor of Pharmacology, Pharmaceutical and Administrative Sciences “Investigating the Anti-Cancer Potential of Metformin in Renal Cell Carcinoma.” Occupational exposure to TCE (once used as a degreaser at aerospace stations by NASA) is one of the major risk factors for RCC, and minimizing such exposure is considered a priority by NASA.
- b. Ashraf Bastawros, ISU Professor of Aerospace Engineering “Characterization of Surface Adhesions for Various Space Applications: Establishing Collaboration

with NASA Langley” This project’s purpose: “Perform preliminary study to show the feasibility of nano-indentation to measure and characterize the adhesion forces at the microstructural length scale of these coating systems, and provide a framework to rationalize the relationship between the different additives/controlling parameters and resulting interfacial adhesion forces.

- c. Ganesh Rajagopalan, ISU Professor of Aerospace Engineering “A Computational Model for V/STOL Aircrafts in Non-Terrestrial Applications” This project’s purpose is to further this research by traveling to NASA and JPL to collaborate simulation efforts and enhance the potential for larger grants. The focus of this effort is to work with NASA and JPL to develop a test apparatus to successfully artificially generate winds for the testing of the Mars Helicopter.
- **Precollege projects (Goals 6-7):**
 - a. This year, the ISGC provided NASA professional development trip for 18 ISGC Partner School Program educators with travel and lodging to Marshall Space Flight Center (MSFC) and United States Space and Rocket Center (USSRC) in Huntsville, Alabama. The workshops were conducted on February 7-10, 2018. The cohort of educators included K-4, 5-8, and 9-12 educators, an ISU Extension and Outreach 4-H Youth educator, five preservice educators from higher education affiliates ISU, UNI, and U of I. In addition the partners included four faculty and staff from higher education affiliates, UNI and U of I. Day one of the event had ISGC partners meeting with MSFC historian, archivist, and educator to discuss a unique ISGC sponsored program. This program is developing an interactive theater piece that engages autistic youth in STEM on stage working with the acting troupe. The STEM focus is the Moon landing, in honor of the 50th anniversary for the debut of the play. The play will include three parts that focus on ancient moon mythology, STEM issues for traveling to the moon, and being on the moon’s surface. After completion of the play development materials will be shared with ISGC. The MSFC team helped the ISGC partners think through the historic event and how that can be parsed into interactive activities that can be done safely on stage. On day two, MSFC hosts worked with the educators to experience NASA STEM educational products and discuss implementation and strategies to engage students with NASA STEM. Day three was spent at MSFC visiting labs and talking with NASA scientists, engineers, and interns. The day was completed with a tour at USSRC with retired astronaut and Brigadier General Robert Steward and John Weis. The educators will use what they learned and NASA educational products to conduct professional development for other Iowa colleagues and provide learning opportunities for Iowa youth based on this NASA PD. The 4-H educator partnered with schools to provide outreach in form of day camps and after school programming.
 - b. ISGC associate director partnered with Iowa State University School of Education to teach a masters class for preservice science educators focusing on improving teacher skills for STEM education and supportive NASA curriculum. The program included STEM. The course includes six class room sessions, three hours each and classroom observation visits during May 2018. The class will focus on STEM content, pedagogy, and implementation planning.

- c. Ongoing leadership and support for the State Science and Technology Fair of Iowa (SSTFI) continues to support ISGC precollege efforts. The ISGC Associate Director managed the fair for FY2018 at Iowa State University on March 22-23, 2018 with approximately 800 students. The Fair had 43 seniors, the highest number since ISGC started supporting the fair and targeted retention.
 - d. The Iowa Junior Academy of Science (IJAS) promotes and supports precollege student research with process, funding, and conference attendance opportunities. Forty proposals were submitted for review and funding. Projects will be presented at the Iowa Academy of Science Junior Academy poster session and two will advance to the American Junior Academy of Science annual meeting. The IJAS project continues to support student engagement in STEM through support of their work from proposal through poster presentation.
 - e. Continued support for the Iowa Governor's STEM Advisory Council's efforts. ISGC Associate Director served on a search committee to hire a STEM Hub Manager and has met with the executive team to collaborate with the group to improve STEM learning in Iowa.
- **Informal Education projects (Goal 8):**
 - a. The ISGC is sponsoring four projects with three informal education affiliates: National Mississippi River Museum and Aquarium, Putnam Museum, and the Science Center of Iowa. Attendees will learn about NASA-related STEM through the projects.
 - b. The Science Center of Iowa worked with the University of Iowa to develop an addition to their "Why the Sky," Launching Iowan's Space Exploration. UI is a higher education affiliate and has extensive space exploration history. The exhibit features UI Space artifacts and developed educational materials that highlight the STEM concepts related to the historic artifacts.
 - c. The Putnam Museum with ISGC support conducted the Space Adventures Weekend that included free admission to all school groups attending on Friday, October 20, 2017. The NASA Glenn traveling exhibit, "Journey to Tomorrow", was the centerpiece and attracted 1,600 guests in the three days of the event. Students (400) and accompanying adults from seven local elementary schools took part in the event on the opening Friday. Hands-on space activities were also featured for the participants. The proposal for the event targeted 600 attendees. The event reached 1,715 non-duplicated individuals. ISGC Associate Director attended the Friday opening and greeted visitors and volunteers working on this project.
 - d. ISGC sponsored an informal outreach program by partnering with the Ames Historical Society and *The Greatest Story Never Told* non-profit organization to host an exhibit showcasing the life of James H. Banning, the first African-American to obtain a commercial pilot's license and first to complete a transcontinental flight by an African-American accompanied by mechanic Thomas Cox Allen, also an African-American. The project featured a static display at the Ames Public Library and an accompanying play that features actors that portray the Banning and Allen story. The play was also performed at Iowa State University's Aerospace Engineering Department. Banning was an ISU student nearly 100 years ago.
 - e. National Mississippi River Museum and Aquarium developed a conservation education outreach program, "Waterways of the World." The project used satellite

imagery to compare local waterways to others around the world. The project features NASA technology and inserts this technology into STEM lessons that increase understanding of Earth's ecosystems. 13 outreach sessions were conducted.

E. PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS

- **Diversity:**

Eight of 12 executive committee and management team members from our core academic affiliates are women. Two of our team members are URM. Internships, Fellowship and Scholarship activities supported 56 students. Females total 27 (48.2%), with 13 from URM populations (23.2%). Our goals are 40% women and 23.27% URM students, per the National Center for Education Statistics (NCES) 2013 data table 306.6.

- **Minority Serving Institution Collaborations:**

Iowa has no minority serving institutions.

- **Office of Education Annual Performance Indicators:**

- API 2.4.1: ED-17-1 40 (Number of NIFS to racially or ethnically underrepresented students, women, persons with disabilities, and U.S. veterans)
- API 2.4.2: ED-17-2 53 (Number of educators)
- API 2.4.4: ED-17-4 18 (Number of informal education events.) Events are scheduled between this writing and June 21, 2018.
- API 2.4.5: ED-17-5 617 (Number of K-12 students)

F. IMPROVEMENTS MADE IN THE PAST YEAR

- Added Assistant Director, Tomas Gonzalez-Torres (former NASA flight director).
- Successful internship placements through improved process with NASA Centers.
- Better engagement through outreach programs and campus tours by assistant director, and improved social media presence.
- Awarded two faculty members for travel to NASA Centers for research collaborations
- Two interns selected for NASA's Pathways program for placement in FY2018.

G. CURRENT AND PROJECTED CHALLENGES

- Change of directors - two in this reporting period – initiating new personnel to NASA HQ, National Space Grant Program and Lead Institution policies and procedures.
- Orient two new executive committee members at two of our four core institutions (academic affiliates)
- Working with faculty to improve application processes and support mechanisms for scholarships and fellowships.
- Continue efforts to increase faculty proposals for research collaborations

H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

The participation of partners varies as research topics and themes vary from year-to-year. Specific involvement in the current program year is listed in italics below.

1. Aerodyne Laboratories (industry) *support through annual membership fee to the ISGC*
2. Ames Laboratory of the U.S. Department of Energy (federal lab) *advisor for DOE alignment*
3. Drake University (private four-year university) - *Executive Committee member, curriculum development, scholarships, scholarship mentor program student hands-on projects, early career investigator research program, precollege program*
4. Grout Museum District (science museum) - *Informal education competition participant*
5. Iowa Academy of Science (nonprofit organization) - *IJAS poster competition*
6. Iowa Aviation Promotion Group (nonprofit organization) - *Informal education competition participant*
7. Iowa Department of Education (state government) - *Partner Schools program, State Science and Technology Fair of Iowa*
8. Iowa Department of Natural Resources - Iowa Geological & Water Survey (state government) *advisor for alignment to jurisdiction*
9. Iowa Department of Transportation, Office of Aviation (state government) *advisor for alignment to jurisdiction*
10. Iowa State University (public Ph.D.-granting university) - *Lead institution, Executive Committee member, curriculum development, collaboration program, internships, scholarships and fellowships, scholarship mentor program, student hands-on projects, research innovation, State Science and Technology Fair of Iowa, precollege program*
11. United States Department of Agriculture (USDA) National Lab for Agriculture & the Environment (federal lab) *advisor for USDA alignment*
12. National Mississippi River Museum & Aquarium (science museum) - *Informal education competition winner*
13. Putnam Museum (science museum) - *Informal education competition winner*
14. Rockwell Collins (industry) *support through annual membership fee to the ISGC, aerospace industry advisor*
15. Science Center of Iowa (science museum) - *Informal education competition winner*
16. Softronics Limited (industry) *annual membership fee to the ISGC, aerospace industry advisor*
17. University of Iowa (public Ph.D.-granting university) - *Executive Committee member, base program, scholarships and fellowships, scholarship mentor program, student hands-on projects*
18. University of Northern Iowa (public comprehensive university) - *Executive Committee member, base program, scholarships, scholarship mentor program, student hands-on projects, precollege program*
19. Loras College (private college) - *scholarships, collaboration program*
20. Des Moines Area Community College (public community college) – *Collaboration program, precollege program*
21. Iowa State University Extension and Outreach 4-H Youth program – *Dual appointment of Associate Director, precollege outreach programming, ISGC Partner Schools*