



**A29 STEM Outreach –
UAS as a STEM Outreach Learning
Platform for K-12 Students and Educators
(STEM III)
Final Report**

September 30, 2022

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TABLE OF ACRONYMS

ACUASI	Alaska Center for UAS Integration
ASSURE	Alliance for System Safety of UAS through Research Excellence
AUSOME	Alabama Unmanned Systems Operations Mastery for Educators
BVLOS	Beyond Visual Line of Site
CAP	Civil Air Patrol
CITRIS	Center for Information Technology and Research in the Interest in Society
COE	Center of Excellence
DAA	Detect and Avoid
EAOP	Early Academic Opportunity Program
FAA	Federal Aviation Administration
K-8	Kindergarten to 8 th Grade
K-12	Kindergarten to 12 th Grade
LAANC	Low Altitude Authorization and Notification Capability
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NMSU	New Mexico State University
OSU	The Ohio State University
PI	Principle Investigator
PM	Program Manager
POP	Period of Performance
RCEU	Research and Creative Experience for Undergraduates
Sinclair	Sinclair College
STEM	Science, Technology, Engineering, and Math
SOFWOLF	Special Operations Forces, Warrior Outdoor Leadership for the Future
TEK8	Translating Engineering to Kindergarten Through 8th graders
TIM	Technical Interchange Meeting
TRUST	The Recreational UAS Safety Test
UAF	University of Alaska Fairbanks
UAH	University of Alabama in Huntsville
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicle
UCD	University of California Davis
USSRC	U.S. Space and Rocket Center
VTOL	Vertical Takeoff and Landing

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) tasked six universities/schools to expand the number and types of Science, Technology, Engineering, and Math (STEM) Outreach approaches to the FAA that use Unmanned Aircraft Systems (UAS) as the central learning platform. This FAA grant was entitled: *STEM Outreach – UAS as a STEM Outreach Learning Platform for Kindergarten to Twelfth Grade (K-12) Students and Educators (STEM III)* and was issued on September 9, 2019, with a completion date of September 8, 2022, 36 months from date of issue. This effort was an evolution from the previous STEM I and II efforts. Within the framework of the FAA’s UAS Center of Excellence (COE), there is a strong desire to incorporate STEM Outreach to students from groups who are under-represented in STEM fields. Inspiring the next generation toward technical careers, specifically in aviation related fields, is a challenge.

The six universities/schools included University of Alabama in Huntsville (UAH), the University of Alaska Fairbanks (UAF), the University of California Davis (UCD), the Ohio State University (OSU), Sinclair College (Sinclair), and New Mexico State University (NMSU). The thrusts were different for each of the six schools. The completed activities by the team fell into five basic categories: 1) Educator-based STEM outreach program; 2) Rural community education and outreach; 3) UAS centered summer camps; 4) After school programs; and 5) In school immersion programs. All programs leveraged “age appropriate” materials extracted from the Alliance for System Safety of UAS through Research Excellence (ASSURE) COE research results and efforts.

Efforts were offered at six specific diverse geographical locations where the targeted student communities are not similar and face unique educational conditions. The students who the teams interfaced with come from diverse urban areas, Alaskan Native, Native American, tribal communities, rural districts, intercity, farming communities, and more. Many were from under-represented non-traditional STEM backgrounds, including socioeconomically disadvantaged students, women and minority students, and first-generation attending university students. Groups included elementary, middle and high school students as well as educators in STEM programs.

COVID-19 impacted all of the planned activities. Some events were modified, turned from in person to virtual, and others completely readjusted. Locations and number of allowable participants were based on federal, state, and local regulations/guidance at the time. This research team was resilient, adaptable, and creative in getting the good word out about UAS. Table 1 gives a summary of the outreach activities. The diversity of students, communities, and teachers reached was significant. The summary numbers show that almost 12,000 students were reached over the period of this grant. Over 650 teachers/educators were exposed to UAS, with many given the tools to take this back to their communities to expand the impact.

Table 1. Summary of Outreach Activities.

School	Students/Contacts	Teachers
UAH	192	573
UAF	1,542	268
UCD	35	4
OSU	105	22
Sinclair	9,168	30
NMSU	580	0
Total	11,622	897

1. INTRODUCTION AND BACKGROUND

Inspiring the next generation toward technical careers, specifically in aviation related fields is a challenge. Within the framework of the Federal Aviation Administration (FAA) Unmanned Aircraft Systems (UAS) Center of Excellence (COE), there is a strong desire to incorporate Science Technology, Engineering, and Math (STEM) Outreach to students from groups who are under-represented in STEM fields. The FAA made a significant directed focus to include STEM education as part of the ASSURE UAS Center of Excellence in the STEM I effort issued June 6, 2016 for the project titled: *Minority Outreach – UAS as a STEM Minority Outreach*. Additional efforts were funded over the ensuing years which expanded the STEM outreach using drones as the central learning platforms. Short summaries of the outreach numbers for the STEM I and STEM II efforts appear in Appendix A.

There is no one single approach that addresses this for students of different ages, backgrounds, or who have different cultural and regional influences. There are common technical ideas and instructional approaches that can be used as building blocks which can then be tailored to the various under-represented target groups. These building blocks, using the development approaches and support materials, can then be replicated by other ASSURE members or external groups as well. This report details what is commonly referred to as project A29, STEM III. The FAA grant amendment authorizing the project entitled: *STEM Outreach – UAS as a STEM Outreach Learning Platform for K-12 Students and Educators (STEM III)* was issued on September 9, 2019 with a completion date 36 months from date of issue. A completion date of September 8, 2022.

1.1 Purpose

The purpose of this project was to expand the number and types of STEM Outreach approaches to the FAA that use UAS's as the central learning platform. Six different universities/institutions participated in these efforts. Each with a unique approach toward a common focus of providing opportunities and education to underserved groups. The objective of this project was to expand the potential STEM outreach approaches to the FAA and leverage the results of the research conducted to date. With the maturity of the COE and the research efforts completed to date, there is now a broad set of research results that can be used as part of the education materials and lesson plans. For any UAS educational outreach the STEM topics will include fundamental related concepts and will include unique Unmanned Aerial Vehicle (UAV) related content. Some efforts are focused specifically on students and some on "teaching the teachers". These unique approaches by the core schools here provide multiple approaches tailored to their local communities and that can be modified and crafted for STEM education in locations across the country.

A number of various approaches for STEM outreach have been provided and discussed with the FAA. The completed activities that fell into five basic categories;

- 1) Educator-based STEM outreach program;
- 2) Rural community education and outreach;
- 3) UAS centered summer camps;
- 4) After school programs; and

5) In school immersion programs

All of the programs leveraged “age appropriate” materials extracted from the COE research results and from the previous FAA COE STEM efforts.

The key points of contact for each of the six schools were;

Mr. Jerry Hendrix, University of Alabama in Huntsville (UAH)
Dr. Catherine F. Cahill, University of Alaska Fairbanks (UAF)
Dr. Susan L. Ustin, University of California (UCD)
Prof. Kiran D'Souza, Ohio State University (OSU)
Dr. Andrew D. Shepherd, Sinclair College (Sinclair)
Mr. Henry M. Cathey, Jr., New Mexico State University (NMSU) – Team Lead Principle Investigator (PI)

The detailed contact information for each of these individuals is shown in Appendix B.

1.2 Scope

The effort proposed was to develop a number of approaches that can bridge some of these gaps and/or provide opportunities to these under-represented groups. Some of the overarching goals were to develop demonstrations, activities, events, and project-based hands-on learning opportunities for students from under-represented groups using UAS as the central learning platform.

The initial thrusts were different for each of the six schools. The proposed efforts were offered at six specific diverse geographical locations where the targeted student communities are not similar and face unique educational conditions. The students who the teams interfaced with come from diverse urban areas, Alaskan Native, Native American, tribal communities, rural districts, intercity, farming communities, and more. Many were from under-represented non-traditional STEM backgrounds, including socioeconomically disadvantaged students, women and minority students, and first-generation attending university students. Groups included elementary, middle, and high school students, as well as educators in STEM programs.

While their lives and situations may be starkly different, there is a common thirst for knowledge. The incorporation of the UAS COE research results in the activities did provide a common thread of materials and dissemination of the research to date. This was a challenge because the research topics and focus areas by the individual schools were not in many cases age appropriate or too complex to easily disseminate. A goal will be to ignite a desire to study STEM related educational paths.

Details on the specific demographic groups intended to be served by each outreach activity are highlighted below with the descriptions of the programs. The number of potential students impacted and the varied demographics are demonstrations of how these programs met the students where they are and provide paths toward future technical careers.

A key point to highlight with these proposed activities was leveraging previously developed materials. The previous UAS STEM outreach materials generated for the FAA were used as applicable. Existing school specific materials were adapted as appropriate for each region. New materials were developed.

The FAA's technical monitor asked if the materials generated to support the STEM outreach could be provided to the FAA. To support this transfer, the following site was set up by the FAA to deposit files, and the individual school PI's were granted access to the Knowledge Services Network to deposit products. New materials were provided over the course of this effort to the FAA in a common file drop location where schools provided relevant information. The location is as follows:

https://ksn2.faa.gov/nextgen/TechCtr/RD/COE/COE-UAS/STEM/STEM_III/SitePages/Home.aspx

The following sections are divided by school and provide a summary of the work completed and the outreach activities performed as part of this work. For each school, the report details a short summary of the original planned activities, a summary of the activities completed including adaptations required due to COVID-19, and a description of the target groups reached. A short summary of the overall demographics and feedback is also provided for reference. Some lessons learned and conclusions are provided as well.

1.3 COVID-19 Impacts

When the original STEM proposal effort was planned and prepared, there was no way the team could know the overall and far reaching impacts that would result from COVID-19. Just as the planning and initial execution of STEM outreach events started, adjustments had to be made. COVID-19 impacted all of the STEM outreach efforts throughout the entire Period of Performance (POP). The STEM II efforts focused on real world and experiential contact with students to light a fire of aviation curiosity with the hope of filling the UAS skill and job pipeline. Hands-on was central to all of the proposed efforts.

COVID-19 initially cut off the interface lines. Each school had defined sets of programs and outreach activities planned, and for the most part, almost all of them were put on indefinite hold near the start of the program. School systems were closed, access to students for activities was halted, and restrictions were put in place in all locations. Some of the details of the restrictions were different from place to place, but in all cases, the impact was similar to delay or halt all activities.

Throughout the entire effort, each individual school has had to adjust their activities. These changes were noted to the FAA through the monthly Technical Interchange Meetings (TIMs) and submitted quarterly reports. UAF had been coordinating with school districts, schools, and teachers in preparation for school visits in remote Alaskan communities. The focus of their outreach was to fly into some of the remote communities for the STEM efforts. The state shut down all travel to remote communities and limited access via roads as well. Summer camps like those at UCDNMSU were put on hold due to COVID-19.

Sinclair College had a goal of providing UAS STEM outreach presentations and hands-on simulation experiences over many days during the academic year and then the in-school activities were cut off. Sinclair was forced to cancel multiple instructional days that had been scheduled due to COVID-19 related school closures. These are just examples of the impacts across the schools. Outreach plans were initially stopped due to COVID-19. Adjustments were made to make some efforts remote. Adjustments in the delivery and timing were made by all schools. COVID-19 protocols were put in place and evolved and improved. Some locations and deliveries were

proposed to the FAA, adjustments made and new efforts delivered. The numbers of students for events had to be adjusted. Often this followed the Center for Disease Control guidance, state rules, and sometimes both.

The full set of adjustments due to COVID-19 are not detailed here, but this is highlighted because the main focus of this grant was to deliver quality UAS exposure directly to students. In the following sections, you will see threads of how this research team adjusted and adapted to still deliver quality and valuable STEM content to the traditionally underserved communities.

2. PROGRAM OVERVIEW AND EFFORTS

The A29 STEM III effort was implemented by six different schools with six different approaches toward STEM. As noted above, this effort had activities that fell into five basic categories

- 1) Educator-based STEM outreach program
- 2) Rural community education and outreach
- 3) UAS centered summer camps
- 4) After school programs
- 5) In school immersion programs

The program by school were as follows:

- University of Alabama in Huntsville (UAH)
 - Title: Alabama Unmanned Systems Operations Mastery for Educators (AUSOME)
- University of Alaska Fairbanks (UAF)
 - Title: The Alaskan UAS Airshow
- University of California (UCD)
 - Title: STEM Summer Drone Academy
- Ohio State University (OSU)
 - Title: Translating Engineering to Kindergarten Through 8th graders (TEK8) with a Focus on UAS Research
- Sinclair College (Sinclair)
 - Title: Interactive Middle School UAS Introduction and Simulation Experience
- New Mexico State University (NMSU)
 - Title: FAA STEM Program Management and Sinclair Sponsorship

The following sections describe each schools' efforts.

2.1 University of Alabama Huntsville (UAH)

The Alabama Unmanned Systems Operations Mastery for Educators (AUSOME) STEM Outreach had the core concentration of providing teachers with the tools to take UAS education back to their schools and communities.

2.1.1 UAH Planned Approach

The UAH program was focused on “teaching the teachers”. As detailed in the original proposal effort, the research approach was as follows:

- Proposed activities aim to create an educator-based STEM outreach program focusing on UAS for minority and technology centric STEM programs in Alabama.
- The goal is to augment existing STEM programs by developing a component where UAS are used as the central learning platform into the engineering, robotics, environmental science, math, and computer science curricula.
- Teaming with local area schools and STEM education institutes, the program will cater to educators and STEM engagement staff to facilitate addition of UAS topics into programs by co-developing interdisciplinary learning material into their programs and providing training, educational material, and program maintenance support.
- A series of UAS Educator’s Workshops and educational outreach events are planned.
- Research based on on-site demonstrations to educators and modifications to STEM curriculum will be disseminated
- The program is created in collaboration with the Alabama Agricultural and Mechanical University STEM Knowledge Center, the National Aeronautics and Space Administration (NASA) Marshall Space Flight Center Minority University Research and Education Project, and the U.S. Space and Rocket Center Space Camp for Educators program to host at least three UAS Educator’s Workshops per year.

2.1.2 Alabama Unmanned Systems Operations Mastery for Educators (AUSOME) STEM Outreach

The Rotorcraft Systems Engineering and Simulation Center at UAH proposed a unique STEM education project to the third FAA ASSURE STEM Educational Outreach solicitation in 2019. This project, known as the Alabama Unmanned Systems Operations Mastery for Educators (AUSOME), pronounced “awesome”, sought to engage professional development opportunities for teachers across Alabama, especially rural communities with existing or interest in creating STEM programs. Specifically, AUSOME intended to provide educational material and host demonstrations of how UAS could be used as a leading learning platform in a wide range of topics including aviation / airspace education, unmanned systems components, safe operations, regulation knowledge learning and policy development, science and engineering use cases (agriculture, environmental and atmospheric science, natural disaster, transportation, and hands-on participation in flying) including First Person View Operations.

To accomplish this goal, UAH researchers would coordinate with the U.S. Space and Rocket Center (USSRC), home to Space Camp and Aviation Challenge, on their educator professional development workshop series on a UAS-centric workshop which would ultimately evolve into a traveling exhibit for demonstrations in classrooms, as shown in Figure 1 and Figure 2. Unfortunately, not long after the program started, the status quo for education and teacher interaction was shaken to the core by the COVID-19 global pandemic. In addition to an immediate restriction of working at educational institutions, including the university, in late spring 2020 the USSRC came extremely close to permanently closing their doors and ending museum and Space Camp programs.



Figure 1. Casey Calamaio (UAH Research Engineer) demonstrating STEM UAS at the U.S. Space and Rocket Center's International Robotics Day Celebration in February 2020. Two young museum attendees try their hand at flying the Tello EDU quadcopter with appropriate safety gear.



Figure 2. Casey Calamaio (UAH) hosted a UAS-centric Aerospace Education Event with the Alabama Civil Air Patrol (CAP) in the Summer of 2022. Calamaio volunteers as the Director of Operations for UAS in the Alabama CAP program.

Several sources of donations provided the resiliency to hold out until Summer 2021 when the Space Camp for Educators returned with limited capacity and the inaugural AUSOME Demonstration could take place. AUSOME was the first exposure of “drones” not only to the Space Camp for Educators program but also to many of the teachers who went through the summer camp sessions between 2021 and 2022. Smaller scale workshops, guest lectures, and fly-days during the off-season in Fall, Winter, and Spring with the USSRC provided additional opportunities to showcase AUSOME, FAA educational outreach, and the field of UAS research.



Figure 3. The first AUSOME demonstration with Space Camp for Educators tool place in June 2021 with limited capacity due to the COVID-19 global pandemic.

While the scope of AUSOME changed drastically due to the pandemic, a strong mutually beneficial partnership emerged with the USSRC which, in spite of the pandemic, offered a platform to showcase the “awesome” power of drones in the classroom. Beginning in February 2020 with the “National Robotics Day” and ending with the last Space Camp for Educators session in late July 2022, AUSOME demonstrations were performed with 269 students and 515 educators.

Among the educators, as shown in Figure 4, were two groups of the State Teachers of the Year for 2020 and 2021 who are teachers recognized for excellence in their respective states. Additionally, AUSOME was proposed for an undergraduate research opportunity at UAH known as the Research and Creative Experience for Undergraduates (RCEU) program in the Summer of 2022, as shown in Figure 5. One student was down selected for mentorship with the UAH research team to support the last summer sessions with Space Camp for Educators and create a project diving into the Alabama Department of Education “Digital Literacy Requirements” to identify where UAS in the classroom could fill gaps in the standard curriculum.

While the scope of AUSOME changed due to unforeseen events, this program proved resilient in connecting educators with UAS-related training and demonstrations. The greatest result of

AUSOME was the significance placed on the demonstrations with Space Camp for Educators which quickly became a staple of the program and a favorite amongst the attending teachers.



Figure 4. The Alabama Teachers Session in 2021 had 25 educators in two groups from across all of Alabama attend Space Camp for Educators.



Figure 5. The Alabama Teachers Session AUSOME demonstration of 2022 was pleased to see larger groups and demonstrate more capability. Undergraduate Summer RCEU student Matthew See supported Casey Calamaio (UAH Research Engineer) by showcasing how the digital literacy requirements for the State Department of Education could be addressed using UAS in the Classroom.

Elements of other ASSURE research programs were presented during AUSOME demonstrations. Specifically, the research looking into expanded and non-segregated operations of UAS in the

National Airspace System (NAS) conducted under A21 where advanced technologies and capabilities were addressed. One question that always came up at AUSOME demonstrations was where the future of UAS technologies and applications are going. Many of the ASSURE A21 effort, “Integrating Expanded and Non-Segregated UAS Operations into the NAS: Impact on Traffic Trends and Safety” conclusions and the technology surveys were discussed. Another ASSURE tie-in was the work in disaster response and community resilience under A.28. Both with the Space Camp for Educators and with the Civil Air Patrol where emergency services are a core mission. The particular use case of damage assessment and search and rescue was an important note due to the severe weather Alabama experiences on an annual basis.

2.1.3 UAH Summary and Demographics

UAH’s initial focus was “teaching the teachers”. As activities evolved the outreaches included both for students and educators. UAH collected the total numbers of students and teachers reached. Over 18 separate events were staged by the team where 192 student and 573 educators were reached. Like many of the teams, collection of specific demographic information (age, gender, ethnicity, etc.) was not done. UAH has restrictions on both gathering this information and then sharing this information unless it has been through an Institutional Review Board before the activities started. It should also be noted that many of the activities were held at the US Space and Rocket Center and they do not share the demographic data of the campers or teachers. The UAH team collected numbers, but not the specifics of age, gender, or ethnicity.

2.2 University of Alaska Fairbanks (UAF)

UAF proposed aviation-focused STEM efforts (The Alaska UAS Airshow) designed to inspire Alaska Native students living in communities across Alaska that can only be reached by air. The UAF STEM outreach team planned to fly into each selected community with flight simulators, a selection of small drones the students could take apart and put back together again, and presentation materials that included information on drone technology, rules and regulations, careers, and how ASSURE research was being used to improve aviation safety in Alaska. Due to limited flight availability into the communities, the team expected to spend multiple days in each village. The side benefit to this plan was the opportunity to educate the residents of each community about drones, including rules, regulations, uses, and ASSURE safety research, through evening presentations and one-on-one interactions with the villages' public safety officers and other officials.

2.2.1 UAF Planned Approach

The UAF program was focused on reaching rural Native Alaskan communities. As detailed in the original proposal effort, the research approach was as follows:

- Many Alaskan communities can only be reached via air.
- The purpose of this activity is to fly experts from the University of Alaska Fairbanks’s Alaska Center for UAS Integration (ACUASI) to schools across Alaska to teach students about UAS safety, rules, regulations, aerodynamics, and potential careers using UAS.
- The ACUASI team will take flight simulators and small first-person-view UAS for the students to use during the event.

- When ACUASI visits a school for STEM outreach, the personnel also visit with law enforcement, school officials, and the community as a whole.
- These Airshows are a follow-on from the successful roadshows conducted under the previous FAA STEM activities and will use the materials developed, acquired, and used during that effort.
- All materials will be available for and designed to be used by other institutions.

2.2.2 The Alaskan UAS Airshow STEM Outreach

The results of the outreach were exciting. Numerous kids and parents asked the UAF personnel if UAF had courses in drone operations and how they could get involved in UAF's drone research. The educators all wanted the UAF team to return and present to their classes. When the STEM team was able to visit more remote communities, they were able to engage with the residents and talk about the future of drones in Alaska, how drone education could help their kids stay in Alaska and have productive careers, and how UAF research, especially the ASSURE research, is helping ensure aviation safety in Alaska.

The COVID-19 pandemic had a significantly adverse impact on the UAF team's plans and ability to reach underserved populations, specifically the Alaska Native population. The predominantly Alaska Native communities being considered for outreach were closed to outside contact due to the fear of COVID-19 entering a community with extremely limited health care access, so the team could not visit the communities due to a State of Alaska health mandate that banned travel to the remote communities or the communities themselves. Additionally, these communities had limited internet bandwidth for education which made distance delivery impossible or had teachers who were concerned about how much time their students were spending on Zoom and other distance delivery platforms. The kids were, in the teachers' words, "Zoomed out." The UAF team, after having their program shut down for numerous months, was able to pivot to: 1) schools on the road system which opened before those in the remote communities, and 2) participation in programs that brought students from across Alaska into a specific location for camp or educational purposes. One unfortunate aspect of that pivot is that most of the communities on the road system are not predominantly Alaska Native, so fewer Alaska Native students than intended were reached.

During this project's period of performance, UAF conducted the following STEM activities:

September 25, 2019 - UAF hosted 18 members of the Alaska Superintendents Association on Wednesday September 25, 2019 from 2:45-4:30 PM. The Superintendents represented schools across Alaska that were going to be potential schools for the Alaska UAS Airshow.

September 30, 2019 - The UAF team educated UAF Atmospheric Science graduate students about drones and their scientific uses.

October 18, 2019 - The UAF team hosted 26 Nenana High School students for a discussion about careers in the drone field as a part of the Nenana High School Science Day at UAF.

October 24, 2019 - The UAF team hosted the Research Vessel Technical Enhancement Committee about the uses of drones for scientific research and how students could become involved in said research.

December 19, 2019 - The UAF pilots instructed a group of UAF student on how to fly drones and act as Visual Observers.

January 7, 2020 - The UAF team educated a local K-12 teacher and her students on how to teach drone education.

January 30, 2020 - The UAF team participated in STEM Night at Pearl Creek Elementary.

In the second FY quarter of 2020, UAF was coordinating with school districts, schools, and teachers in preparation for school visits in remote Alaskan communities. The team updated the curriculum for the school and associated community visits. Then COVID-19 happened. The team's in-person activities were brought to an abrupt halt. The team could not conduct activities with schools because the schools were closed and all future events were uncertain. Additionally, the team could not fly to rural communities or access communities via the road system per the Alaska Governor's Health Mandate. The team continued to work with schools to prepare for activities when the pandemic receded.

June 30, 2020 - Alaska Gateway School District (on the road system in Eastern Alaska) contacted UAF to say they will be holding in person classes this fall and would like us to visit their schools. The Governor later changed restrictions and put this activity on hold.

During the fall of 2020, the team planned an outreach activity for an in-person visit to the Tok School (~208 miles from UAF) on October 27-28, 2020. This activity was cancelled twice, including the night before the team was scheduled to go to Tok, due to COVID-19 outbreaks in the school.

December 18, 2020 - UAF conducted a live-streamed virtual outreach to a Fairbanks, Alaska, Boy Scout Troop.

During the winter of 2021, the UAF team worked to arrange Tok school visits. The Tok School is on the road system and has internet connectivity, but the students were 'Zoomed out' according to the teachers. Therefore, the UAF team is worked to deliver remote content without using Zoom to the students.

During the spring/summer of 2021, the State of Alaska and local communities started relaxing COVID-19 travel restrictions, so UAF planned multiple STEM outreach events with various levels of success and delivery mechanisms.

The planned April 28 tour for Delta Junction Junior High School, a school approximately two hours from Fairbanks and on the road system, was postponed due to COVID-19. The students involved in the Delta-Greely RC Flyers Club (official member of the Academy of Model Aeronautics) and aviation classes were the target audience.

May 6, 2021 - The UAF team presented to the Joy Elementary School in Fairbanks. Nick Adkins remotely presented three classes on UAS for Joy's Earth Week.

July 13, 2021 - The UAF team conducted a STEM outreach for Camp Fire Alaska in Cooper Landing, Alaska (2 hours south of Anchorage). Camp Fire Alaska brings kids from across the state to participate in an in-person camp that includes multiple STEM activities. The State of Alaska Department of Transportation and Public Facilities UAS Program Coordinator participated.

August 9-13, 2021 - UAF personnel taught the "Summer Sessions 'Drone Camp'", a week-long, 3 hours per day course on the UAF campus.

September 23-25, 2021 - The team conducted an Airshow at Galena, Alaska. There were approximately 100 kids from many different villages (~60% Alaska Native). Students were talked to about The Recreational UAS Safety Test (TRUST), airspace, ASSURE research on Beyond Visual Line of Site (BVLOS), Detect and Avoid (DAA), operations at airports, remote cargo delivery, challenges like cell phone coverage so poor that getting Low Altitude Authorization and Notification Capability (LAANC) approvals is difficult at best, and other topics of interest to students in a remote community. UAF personnel are going to help the instructor, who is a certified flight instructor, overcome the LAANC problem by helping her get a Dronezone waiver to be able to fly at appropriate places around town.

November 3-4, 2021 - The UAF team conducted an outreach at the Nikiski Middle/High School. There were 3 classes of 15-20 kids each (6-8 grade). The contact has requested UAF work with them to improve their drone programs. UAF has provided parts lists and information on drones they build with our summer camp participants.



Figure 6. Students in Nikiski Middle/High School.

During the November 3-4 trip, the UAF team also conducted an outreach event at the Challenge Learning Center of Alaska for 15 kids (16-18 years old). The Director of Educational Operations requested UAF come back to encourage these kids and future participants to consider careers in drone-related fields. The team provided the parts lists and information on the drones built with UAF summer camp participants.

January 26, 2022 - UAF conducted a STEM outreach to 62 students at Rogers Park Elementary in Anchorage.

January 27, 2022, the UAF team conducted a STEM outreach event for 247 students at Dimond High School in Anchorage.

May 6-8, 2022 - The UAF team and members of the State of Alaska Department of Transportation and Public Facilities conducted an outreach to kids from across Southcentral Alaska during the Great Alaska Aviation Gathering in Palmer.

May 18, 2022 – The UAF team went to Nenana to participate in the Challenger Drone Camp. The team was able to take the students to see operations of one of UAF's large drones, the DRS Sentry (13' wingspan, 280 lbs. dry weight).

June 4, 2022 - The UAF team conducted a drone outreach as a part of the Large Animal Research Station Birthday Bash.

May 19, 2022 - The UAF participated in the Geophysical Institute's Open House with flight simulators, hands-on drones, and one-on-one conversations about UAF's ASSURE research and what it means for aviation in the state.

June 7-9, 14-17, and 20-22, 2022, UAF conducted drone STEM activities during three weeks of Camp Fire Alaska events at different locations on the Kenai Peninsula and in Anchorage. Camp Fire has the advantage of bringing kids from across Alaska together so the team can reach many more kids from remote locations than per our normal outreach event.



Figure 7. Some of the students at Camp Fire Alaska.



Figure 8. Students in the Delta Junction summer camp.

July 12, 2022 - The UAF team provided drone outreach as a part of the Delta Junction Summer School.

July 13, 2022 - The UAF team presented two sessions on drone uses, safety research, and rules and regulations as a part of a UAF law enforcement Summer Crime and Law Camp.

July 13, 2022 - Cathy Cahill, ACUASI Director, presented a Summer Sessions lecture on drones, highlighting UAF's ASSURE research on BVLOS operations, cargo delivery, and operations on and around airports, as a part of the "Explore Alaska."

July 18-20, 2022 - The UAF team conducted a drone summer camp at UAF. The summer camp includes information on drone careers, technology, rules and regulations, safety research, especially ASSURE research on BVLOS, cargo operations, and airport safety. The UAF personnel make the students to take the TRUST exam and mentor them through building a small first-person drone.

July 29, 2022 - The UAF drone team participated in a STEM outreach day at Ben Eielson Junior High School in Salcha.

August 2, 2022 - The UAF team staffed a large booth during UAF Day at the Tanana Valley State Fair in Fairbanks. The flight simulator attracts kids and helps the UAF team sneak in some learning into their fun. The team discusses our ASSURE research efforts with the adults and what the efforts mean to the safe integration of drones into aviation community that is the National Airspace System in Alaska.



Figure 9. Kids using the flight simulator at the Tanana Valley State Fair.

August 28-31, 2022 - UAF personnel conducted STEM outreach in Valdez as a part of a UAF initiative to develop drone curricula for middle-school students.

September 8, 2022 - The UAF drone team hosted 120 students from Pearl Creek Elementary School at their facility on the UAF campus.

In every outreach the UAF team conducted, ASSURE research is highlighted. The amount of detail provided in the interactions depended on the level of the students. With the youngest groups, the team would focus on the fact that ASSURE is studying ways to keep aircraft and drones from hitting each other. At the high school level, the team talked about specific ASSURE projects and how ASSURE is doing some of the testing, such as flying traditional aircraft against different detect and avoid sensors to see what works the best at spotting intruding aircraft.

When the STEM team visited communities and had the opportunity to do presentations on the work the team is doing to facilitate the integration of drones into the National Airspace System, the team included slides on ASSURE and talk about multiple projects and their potential effects on the community. For example, when talking with the folks in Nenana, a community about 60 minutes by road from Fairbanks, the team talked specifically about A18 (DAA), A31 (operations on and around airports), A42 (air cargo), and other ASSURE projects that help safely operate drones out of the Nenana Municipal Airport (non-towered, Class G), deliver cargo to remote communities, and ensure the safety of General Aviation in the area.

There were a number of lessons learned from these outreach activities:

- The aviation focus of Alaskans made it easy to engage the students in a discussion of aviation safety and the results of UAF's ASSURE projects. Most of the students had relatives who were pilots so they quickly grasped the risks of drones flying beyond visual line of sight and the importance of air cargo to their communities, an easy segue to how UAF's ASSURE research in those areas is important to their lives.
- The STEM team should always have an overview of the drone course and degree offerings at their universities with them to hand out to parents and students. The outreach events led to numerous kids, parents, and educators asking how to continue their drone education beyond the outreach event.
- The outreach team needs to be able to pivot the types of outreach they intend to conduct to meet changing conditions. Pivoting from remote communities to communities on the road system allowed the UAF team to continue to conduct drone-based STEM education in the face of closed communities and COVID-19 rescheduling.
- The outreach team should always take multiple flight simulators and a 'petting zoo' of drones the students can handle, especially ones they can take apart and put back together. These hands-on activities really engage students who are too shy to ask questions, but enjoy activities they can do with minimal guidance from strangers.

2.2.3 UAF Summary and Demographics

The UAF STEM team was able to reach 1,542 students and 268 educators during the 29 events conducted as a part of the project. Although the UAF team does not have detailed breakdowns of the demographics. Many of the students they reached in the Anchorage schools which were the most urban of the outreaches the team conducted, were able to provide demographics breakdowns of their student populations that demonstrated a variety of underserved students. The STEM outreach event at Rogers Park Elementary School had the following student demographics breakdown of the 62 students reached:

- 9 - Migrant Ed
- 11 - English Learner
- 8 - Students with Disabilities
- 7 - Title VI, Indian Education
- 2 - Child in Transition or Child Welfare
- 29 - Highly Gifted
- 8 - Gifted

For Dimond High School the student demographics breakdown of the 247 students reached was as follows:

- Male= 152
- Female= 95

- White= 113
- Black = 9
- Hispanic= 20

Asian = 27
American Indian = 4
AK Native= 15
Multi Ethnic= 41
Native Hawaiian/Pacific Islander = 18

2.3 University of California Davis (UCD)

The STEM Summer Drone Academy STEM Outreach by UCD had a goal to reach into underserved communities to provide hands on summer camp experiences with UAS.

2.3.1 UCD Planned Approach

The UCD program was focused on summer camps. As detailed in the original proposal effort, the research approach was as follows:

- Program builds upon the 2018 Summer Drone Academy
- UC Davis enhances its 2019 - 2020 program adding hands-on instruction and activities with Virtual Reality technologies, including real-world applications in Archaeology, Education, Medicine, and other relevant societal applications
- New program includes at least 2 short course events for regional high school students
- Partners with the Center for Information Technology and Research in the Interest in Society (CITRIS) Program. CITRIS supports ongoing research including UAS applications in agriculture, people and robotics, health and women in technology. CITRIS has renewed their support initiative for 2019 programs and beyond, with a pledge to donate and fund new equipment purchases for the Academy use
- Partners with Early Academic Opportunity Program to identify participants in regional schools, both rural and urban
- Program mission includes sharing STEM fields with female and other disadvantaged high school students as a catalyst for them to explore college major and career options they would not otherwise have considered

2.3.2 STEM Summer Drone Academy STEM Outreach

UCD created customized learning STEM Academies using UAS as a learning platform between 2018 and 2022. UCD chose to work with the Early Academic Opportunity Program (EAOP) which was part of identifying students that met STEM requirements for under-represented, non-traditional, socioeconomically disadvantaged, minority, and women students in addition to first-generation attending university students. All of the students meet these criteria. The students were chosen for the activities (unless school was open) from the student participants in the EAOP. The EAOP worked with the UCD campus including 32 high schools and junior highs in the region and having over 3,000 students who currently participate. EAOP primarily serves students who are first generation in their family to attend college or who are considered socioeconomically disadvantaged. Students join in the 7th – 10th grades but the EAOP try to recruit them earlier.

UCD sent applications to their lists of students and accepted them in order of application. Generally, there were more applicants than space but several would drop out right before the classes would start so applicants were slightly under maximum enrollment. UCD aimed for 10-

11th graders. Students from 14 area high schools in under-represented backgrounds with no formal STEM or aviation program applied for the weeklong Academies held during summer and winter breaks at the UC Davis campus. Acceptance was based on student essays and demonstrated interest in UAS or Aerospace careers.

With Nathan Metzler serving as Academy Director and Lead UAS Instructor, UC Davis undergraduate students were trained to serve as co-instructors for the Academy, bringing in their UAS piloting and research experience to share with the students. Students were divided into 4-person teams, named after various NASA missions, and participated in 5-7 rotational sections each day. Sections provided hands-on flight instruction with mini-drones (under 249 grams), FPV Drones, Flight Simulators, Drone building and assembly, and fixed wing model aircraft learning about principals of flight and drone applications in society. Students also participated in team-building events, and industry guest speakers were brought in from NASA, Blue Origin Space Company, the FAA, and UC Davis field research units to discuss career tracks and opportunities in Aerospace and Aviation. A licensed Falconer also presented with live raptor flight demonstrations teaching the students about airfoil and wing aerodynamics used in aircraft and drone designs.

The week concluded with team flight competitions based on real world drone missions, written knowledge tests, and open houses for the families to attend. Several local newspapers had published stories on the Academies, with customized highlight videos shared with the students and high schools afterwards. Students provided feedback forms for each Academy, indicating about a 15% interest rate in Aerospace and Aviation careers at the beginning of the events, to 70% interest by the end of the Academy.

Between March 2020 and June 2021 all in-person events were suspended by the school district. In July 2021, a limited in-person Academy resumed, with three full attendance events held between March and August 2022. Two field visits to area high schools were conducted in March and May, totaling over 280 attending high school students. Images from the different Summer Drone Academies and UCD outreach events are presented below.

There were a number of lessons learned from the UCD STEM outreach activities.

- The interactive, hands-on drone flying activities proved to be a highly effective means for learning and instruction.
- Students consistently reported their teamwork and communication skills had grown throughout the weeklong Academies.
- Show and tell activities with campus research units bringing in their drones and equipment was highly valuable for the students.
- Providing high quality breakfast and lunch was helpful in keeping the student energy levels up throughout the day, and was appreciated by the students coming from low-income families.
- UC Davis is a highly ranked agriculture research university, and utilizing resources on campus like the Bohart Bug Museum and Raptor Center to teach principles of flight was fun, relatable, and educational for the students.

- The student home campuses had little or no aviation career counseling or resources, thus provided links and resources for scholarships and in-state college and training campuses with aviation and STEM/Drone programs.
- Female Academy participants had excellent hand-eye coordination flying the mini-drones without prior experience, often out-scoring their male teammates.
- Students consistently reported that coming into the Academy they had not considered aerospace, aviation or STEM careers as an area of interest. Nearly $\frac{3}{4}$ of the students leaving the Academy reported a newfound interest in such careers or hobbies.
- Students were provided Academy Certificates of Completion to include on college, job and internship applications. Parents appreciated this gesture to motivate them to explore post-secondary school options.
- The parent open house was highly successful. Parents participated in their student events, and commented on how the student would share their activities and accomplishments at home.



Figure 10. UCD April 2021 Preparation for Sumer Drone Academy.



Figure 11. UCD August 9-13, 2021, Drone Academy.



Figure 12. UCD Flight Simulator Training, February 2022.



Figure 13. UCD Florin High School, Sacramento, May 13, 2022.



Figure 14. UCD 5th Summer ASSURE Drone Academy, July 27-30, 2022. Academy Students visit the NASA Gemini Rocket Engine in Davis, CA.



Figure 15. UCD 5th Summer ASSURE Drone Academy, July 27-30, 2022. The FAA Presents on Aerospace Careers to the Academy.



Figure 16. UCD 5th Summer ASSURE Drone Academy activities.



A student looks on through a camera looking at what the drone camera is aiming at. (Carlos Guerrero/Daily Democrat)

Figure 17. UCD Summer Drone Academy in the press.

2.3.3 UCD Summary and Demographics

The majority of students from the schools that participated in EAOP were from minority populations. All students met low income criteria and this was one of the reasons breakfast,

lunches, and snacks were provided. The greater Sacramento region is a melting pot from around the world. Even in "white" Davis the schools say classes normally include multiple languages spoken by up to a third of the students in the classroom. In the valley, the surrounding towns around UCD are predominantly dominated by Hispanics. Latino/a is most common of students but the last summer's drone academy in July 2022 included Latino/a, Chicano, and Hmong., with African American always present in low numbers, and uncommonly Alaskan Inuit.. Caucasians were always the minority in these activities. As an example, one of these students might be is a Russian student as there is a large Russian immigrant population in Sacramento. The valley also has large numbers of Vietnamese and Chinese students.

With under-represented student groups (females and ethnic minorities) making up a very small percentage of the population in traditional aerospace and aviation industries, the UC Davis ASSURE STEM Academies focusing on bringing these topics to the students in a fun, interactive learning environment supported by the ASSURE grant. Students consistently reported apprehension at the beginning of the Academy related to the technical topics and activities, and unfamiliarity with any type of drone or UAS platforms. By the end of the Academies, students reported increased interest in several aerospace career areas, as well as increased confidence and teamwork skills gained from working together.

One thing that was surprising was that female students were either the majority of students in a class (up to 60%) or were participating in near equal in numbers with males. Female students scored as highly as their male counterparts in competitions and were frequently the highest point scorers in drone competitions. EAOP has encouraged their participation and clearly female students responded quickly to applications and were enthusiastic participants.

Florin High School STEM Assembly & Flight Demonstration (215 students), March 2022.

- Asian 43%
- Hispanic 32%
- Black 14%
- White 7%
- Other 4%

Dixon High School STEM Assembly & Team Flight UAS Training (70 students), May 2022.

- Hispanic 56%
- White 31%
- Mixed Race 6%
- Black 3%
- Asian 2%
- Other 2%

UC Davis 2022 ASSURE Academy Demographics, August 2022.

- -60% female, 40% male class ratio
- -Students from 14 Sacramento Area schools up to 70 min-drive away. Grade distribution: 10th graders (50%) , 11th graders (38%), 12th graders (12%)

- -Student ethnicities: Latino/Spanish (29%), African American (4%), Chicano/Mexican American (21%) American/Alaskan Indian (12%), Asian (12%) White/Caucasian (17%), other (5%)

2.4 Ohio State University (OSU)

The Ohio State University’s STEM outreach, “Translating Engineering to Kindergarten Through 8th graders (TEK8) with a Focus on UAS Research” was focused on providing research opportunities for undergraduate students to then reach out to underserved Kindergarten to Eighth Grade (K-8) classrooms.

2.4.1 OSU Planned Approach

The OSU program was focused on providing real world UAS research experiences for students. As detailed in the original proposal effort, the research approach was as follows:

- TEK8 is an existing program at OSU that recruits academically talented undergraduate engineering students to be mentored in the PI’s research labs.
- Students in the PI’s labs will support research focused on UAS development and integration into the airspace.
- Students then take a course in the fall with in-service teachers pursuing graduate coursework
- Undergraduate researchers will team with the teachers to transform their research experience into several engineering design challenges appropriate for grades K-8, and then take the project into underserved K-8 classrooms.
- The goal of this program is to not only encourage undergraduate research and underrepresented minority participation in engineering, but also introduce teachers to project-based learning strategies, and educate them in engineering practice and the design process.
- The engineering design challenges are also refined and documented in a web-hosted university extension to be used in informal education settings.

2.4.2 Translating Engineering to Kindergarten Through 8th graders (TEK8) with a Focus on UAS Research STEM Outreach

In the spring of 2020, two undergraduate students were recruited to conduct summer research in the lab as a part of the TEK8 program. Freeman Gao was recruited by Professor Kiran D’Souza to support the ASSURE UAS Engine Ingestion research project, and Yuto Nakahata was recruited by Dr. Matt McCrink to support the design and flight-testing of a weather monitoring drone. Due to the COVID-19 pandemic both students conducted their research with their respective mentors virtually in the summer of 2020. They then translated their research experience into a design challenge for STEM outreach in the Fall of 2020 in the TEK8 course.

Freeman Gao delivered his design challenge with his outreach team to a group of 15 students from Metro Middle School who participated in an after-school engineering club on October 6, 2020. The student handout for this design challenge is shown in Figure 18.

The student handout, facilitator guide, introductory video, and design challenge video are hosted on the TEK8 site: <https://u.osu.edu/tek8/2020-design-challenges/airborne-collision-repair/>. The introductory and design challenge videos provide an overview and motivation for the design

Airborne Collision Repair

ENGINEERING DESIGN CHALLENGE



The Story

Airplanes have dominated the skies for the past few decades, with all hazards such as hail and birds studied extensively to ensure that airplanes can safely fly. However, in the last 5 years, a new hazard has entered the sky: the UAV (Unmanned Aerial Vehicle), or as you might know it, the drone. With UAV's being a possible threat to planes, many researchers are studying how the damage affects planes when the most vulnerable part of the plane, the turbine, is hit by one.

Identify

Problem

- In this challenge, your job is to design a new way to repair planes you made out of paper that have lost one of their wings. You can use popsicle sticks, tape, pipe cleaners, tape, and other everyday materials.

Design Challenge Testing

- Test out a functioning airplane by throwing it three times and placing a marker in the middle of where it lands. After designing and building your repair, test it again by throwing it three times and placing a marker in the middle of where it lands
- Your design is successful if it:
 - Can make it as far as the original plane

Primary Goal

- Design and create a repair for an airplane that can go as far as the original undamaged airplane

Secondary Goals

- Try it again without one of the materials you used the most of
 - Example: If you used a lot of aluminum foil, try making a design without that
- Try to make it go farther than the original airplane

Design, Build and Test

Now it's your turn to be the engineer. So far, we have **IDENTIFIED** the problem. Brainstorm ideas that you think will solve the problem and draw the best **DESIGN** on a piece of paper. Then, pick out your materials and **BUILD** your design. **TEST** your design. What worked well? What could have worked better? When you **IDENTIFY** an improvement, re-**DESIGN**, re-**BUILD**, and re-**TEST** until you have the best design possible!



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TEK8
Translating Engineering
Research to K-8

Figure 18. Student handout for airborne collision repair design challenge.

challenge. In combination with the student handout and facilitator guide, these design challenges can continue to be used in informal STEM settings. Yuto Nakahata virtually delivered his design

challenge with his outreach team on October 12th to 30 students in a Metro Middle School class. A facilitator guide for this handout is shown in Figure 19. The student handout, facilitator guide,

Drone Building

ENGINEERING DESIGN CHALLENGE

Facilitator Guide

The Story

- One of the most important job of the drone is that the drone needs to fly straight up. To do this the easiest way is to run each motor at the same power. But there is one problem with running the motor at the same power to fly straight up. If one side is heavier one side than the other, the heavier side has to work harder to fly straight up. One solution is to make both sides heavy. This would make both motor having to work hard to keep the drone straight.

Identify the Problem

- The drone is currently unbalanced and weak to wind.
- Use coins and tapes to make them balance and strong to wind.
- You need to make sure that you have 2 coins for each propeller and 4 coins for battery.

Design Challenge Testing

- Pencils – drones
- Coins – weight/motor/battery

Primary Goal(s)

- Build a structure that holds the battery, motor, and propeller
- The whole drone must stay horizontal when we lift it at the center.
- Try shaking the drone and nothing should fall off the drone

Secondary Goal(s)

- Add some weight to the drone. This can be done using more coins or anything you can find in your room. Now try balancing the drone and prevent anything from falling off.
- Try making an X shape with two pens making a 4 rotor drone and see if the drone can carry the package while being balances and resistant.






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A collaboration of the Colleges of Engineering and Education and Human Ecology.

TEK8
Translating Engineering
Research to K-8

What will you engineer?

Figure 19. Facilitator guide for drone building design challenge.

introductory video, and design challenge video are hosted on the TEK8 site: <https://u.osu.edu/tek8/2020-design-challenges/drone-building/>

In the spring of 2021, Mitchell Wong was recruited by Professor Kiran D’Souza to support the ASSURE UAS Engine Ingestion research projects, and Lexi Moore was recruited by Dr. Matt McCrink to support the development of a test stand for a next generation Mars flight vehicle. Due to the ongoing COVID-19 pandemic, Mitchell Wong conducted his research virtually, while Lexi Moore did her research in-person at the Aerospace Research Center at OSU. They then both

translated their research experience into a design challenge for STEM outreach in the Fall of 2021 in the TEK8 course.

Mitchell Wong delivered his design challenge with his outreach team in person to approximately 30 students in a Metro Middle School class on November 16, 2021. Some pictures from Mitchell and his team delivering this design challenge are shown in Figure 20. The student handout, facilitator guide, introductory video, and design challenge video are hosted on the TEK8 site: <https://u.osu.edu/tek8/2021-design-challenges/airfoil-analysis/>

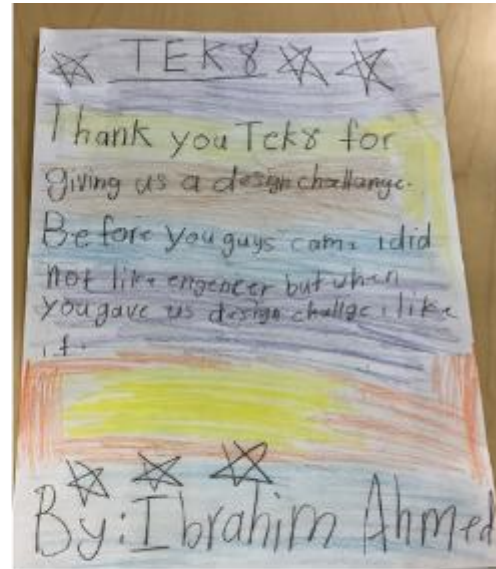


Figure 20. Pictures from outreach event where Mitchell Wong delivers airfoil analysis design challenge to middle schoolers.

Lexi Moore delivered her design challenge with her outreach team on November 30th to approximately 30 students in a Metro Middle School class. Pictures of a student design and a thank you note from one of the participants are shown in Figure 21. The student handout, facilitator guide, introductory video, and design challenge video are hosted on the TEK8 site: <https://u.osu.edu/tek8/2021-design-challenges/abcs-of-airplanes/>



Student design



Thank you note from middle school student

Figure 21. Images of student design and thank you note from student participating in ABCs of airplane design challenge.

In the spring of 2022, Keaton Nichols was recruited by Professor Kiran D'Souza to support the ASSURE UAS Engine Ingestion research projects, and Evan Kaullen was recruited by Dr. Matt McCrink to research a rotor thrust measurement system for a flight vehicle for Mars. Both Keaton and Evan conducted their research in-person at the Aerospace Research Center at OSU.

Then both began the TEK8 course in the Fall of 2022, where they're currently translating their research experience into design challenges for STEM outreach later in the Fall of 2022. They'll each be delivering their design challenge to approximately 30 students in a Metro Middle School class, and their design challenges will be hosted on the TEK8 website.

2.4.3 OSU Summary and Demographics

The OSU team mentored 6 undergraduates in summer research programs related to UAS design and integration into the airspace. Three of the research projects were related to UAS design and optimization and three were focused on safety concerns related to UAS ingestion into engines. All these students have or are currently participating in the Translating Engineering to K-8 course. Four of the students have completed the course and conducted outreach activities to Metro Middle School students, and two will complete their outreach activity in Fall 2022. A summary of the outreach activities is given in Table 2.

Table 2: Summary of OSU Outreach Activities.

OSU Student	Date	Delivery Mode	# of Middle School Students	Topic
Freeman Gao	10/6/20	Virtual	~15	Airborne Collision Repair
Yuto Nakahata	10/12/20	Virtual	~30	Drone Building
Mitchell Wong	11/16/21	In person	~30	Airfoil Analysis
Lexi Moore	11/30/21	In person	~30	ABCs of Airplanes
Keaton Nichols	Fall 2022	In person	Date TBD	UAS ingestion
Evan Kaullen	Fall 2022	In person	Date TBD	UAS design

The design challenges that have been completed, have been shared with the FAA and are being hosted online at the OSU sites: <https://u.osu.edu/tek8/2020-design-challenges/> and <https://u.osu.edu/tek8/2021-design-challenges/>. Finally, an additional 2 design challenges will be made available and posted to the OSU TEK8 site in early 2023.

2.5 Sinclair

Sinclair’s “Interactive Middle School UAS Introduction and Simulation Experience” had the focus of STEM outreach to large number of students through immersive experiences. The original purpose of the A29 effort as it related to Sinclair was to provide presentations highlighting UAS applications, careers, and technologies, as well as selected ASSURE projects, coupled with interactive hands-on simulation leveraging RealFlight simulators operated in the Sinclair Tactical Ground Control Station or Mobile Ground Control Station deployed to sixth grade classes around the State of Ohio. Early success was achieved from January through early March 2020 with 19 outreach days at 18 schools reaching 2,508 students in sixth grade classes in the greater Dayton, Cincinnati, Columbus, and Cleveland regions. The project was on track to reach the goal of 40 outreach days in the first grant year and the overall goal of 120 outreach days over the grant period of performance. However, with the school closures due to the COVID-19 pandemic experienced beginning in March 2020 and continuing through the end of the 2019-2020 academic year, the first year of the project remained a challenge and required alterations to the outreach plan, which were proposed and accepted by the FAA in July 2020.

Sinclair’s staff explored and secured alternative engagement opportunities to continue to advance the outreach goals of the project during those challenging circumstances, while following best practices for social distancing, wearing masks, cleaning equipment, and other mitigations. These included coordinating participation in events at public museums including the WACO Aviation Learning Center, National Museum of the United States Air Force, Carillon Historical Park, National Park Service Dayton Aviation Heritage Area, and Mound Cold War Discovery Center. Additionally, Sinclair participated in or hosted camps in collaboration with Air Camp, the WACO Aviation Learning Center, the Wright Brothers Institute, the Dayton Early College Academy, and Special Operations Forces, Warrior Outdoor Leadership for the Future (SOFWOLF). By necessity, those reached through these engagements expanded from solely sixth grade students and teachers to include elementary and high school students, K-12 teachers, and the general public. As the worst conditions of the pandemic waned, Sinclair was permitted to reenter sixth grade classrooms to continue with the original vision of the project.

In all cases, participants were introduced to UAS applications, careers, and technologies. These presentations also highlighted ASSURE research including UAS noise measurement and certification, UAS airborne collision severity evaluations, and UAS detect and avoid requirements necessary for limited BVLOS operations. Additionally, all recorded participants had an opportunity to operate Sinclair's RealFlight simulators flying various fixed-wing and Vertical Takeoff and Landing (VTOL) aircraft, either in a free flight mode or through various challenges depending on the time available and age of the participants.

2.5.1 Sinclair Planned Approach

The Sinclair program was focused on reaching thousands of students with hands on UAS experiences. As detailed in the original proposal effort, the research approach was as follows:

- The Sinclair National UAS Training and Certification Center will extend a successful UAS STEM outreach model deployed initially in the 2017- 2018 school year in Greene County, Ohio, which currently reaches every 6th grade class in Greene County, Ohio, or approximately 1,800 students per year.
- Under that program, Sinclair provides an introductory briefing on UAS technologies, applications and careers, plus an initial UAS simulation session leveraging RealFlight and Simlat software in either the Sinclair Mobile-Ground Control Station or Tactical - Ground Control Station.
- Effort will expand the program statewide, with an initial scope of an additional eight weeklong deployments (40 days) to the Toledo, Cincinnati, Columbus, Cleveland, and Athens regions each academic year from 2019 - 2021 reaching approximately an additional 7,200 students per year (21,600 over three years).

The original vision for the project required some modification to meet the realities of the pandemic, particularly in 2020 and 2021. This was recorded in a written change request, which was approved by the FAA in July 2020, and included a transition from only sixth grade class outreach to incorporate public venues such as museums, libraries, and other sites, plus project activities in many aviation and UAS themed camps hosted by or at Sinclair or partner locations. This allowed progress to continue during challenging circumstances, but did not result in the originally envisioned total number of individuals served. However, given the situation, the results were very positive and enabled broad public awareness of UAS careers, applications, technologies, and ASSURE research, as well as opportunities to participate in RealFlight simulation experiences that would otherwise not have been available.

2.5.2 Interactive Middle School UAS Introduction and Simulation Experience STEM Outreach

As noted, the original vision of the project was to visit sixth grade classes throughout the state of Ohio, providing a presentation on UAS careers, applications, technologies, and selected ASSURE research, along with UAS simulation experiences leveraging RealFlight run on Sinclair laptops and in the Mobile and Tactical Ground Control Stations. This approach was successfully implemented beginning in January 2020 and continued through early March 2020 in the Dayton, Columbus, Cincinnati, and Cleveland, Ohio regions. However, activities were paused in mid-March 2020 as schools were forced to close due the pandemic. Modified outreach resumed in July 2020 at

museums, libraries, and other public venues, with camps added in starting in August 2020 and school visits resuming beginning in May 2021.

Generally, outreach efforts were centered on the Dayton, Ohio region, but also included the Cincinnati, Columbus, and Cleveland, Ohio regions, as well as the SOFWOLF DRONE WOLF UAS camp in Provo, Utah. All events included the project presentation and hands-on RealFlight simulation experience. However, camps also included expanded experiences based on the facilities and equipment available for the site that included UAS demonstration and hands-on UAS indoor and outdoor flights, UAS maintenance, traditional aircraft simulation, wind tunnel demonstrations, computer aided design, CNC machining, 3D printing, data analytics, remote pilot ground school, first responder application exercises, UAS focused business plan development and concept elevator pitches, and other activities as appropriate to participant ages and resources.

General outlines of the air camp sessions are shown below. It should be noted that the camp sessions incorporate the ASSURE STEM research slides into the air camp and other events.

Elementary school camp (grades 4-6)

- Exploring the fundamentals of the Physics of Flight and Applications in Aeronautical Engineering
- Engaging in the science, technology, engineering, and math of aviation and aeronautics
- Developing leadership skills by working with others to share ideas and solve problems
- Discovering solutions to challenges that affect individuals, communities, and the world
- Fostering curiosity and a commitment to scholarship through hands-on experiences
- Collaborating to explore and initiate acts of citizenship and learning why it is important to help others
- Experiencing Flight Using state of the art table-top Aircraft Simulators
- Unmanned Aerial Systems Coding and Flying Missions
- Introduction to UAS Manufacturing Processes and Applications.
- UAV Cargo Drop

Middle school camp (grades 7-9)

- Exploring the fundamentals of the Physics of Flight and Applications in Aeronautical Engineering (With an Emphasis on Actual Aircraft Use and Development)
- Taking the Controls from the Pilot's Seat During an Actual Flight in a Single-Engine Aircraft Under the Direction of a Certified FAA Flight Instructor
- Demonstrating an understanding of the science, technology, engineering, and math of aviation and aeronautics while discovering general logistics and operations
- Taking flight ground school and piloting a plane at a local airport
- Engaging in Fire and Rescue Learning Modules
- Demonstrating a curiosity about and a commitment to scholarship under the direction of aviation engineers, pilots, mechanics, UAS manufacturers, and many others
- Executing leadership skills through team engineering design challenges
- Integrating citizenship skills by designing and participating in a service initiative
- Mission Planning and Solution-Based Challenge / Competition
- Virtual Reality and Augmented Reality Experiences in Preparation of and Operations During the Flight of Unmanned Aerial Systems
- Analyzing Flight Charts and Key Symbols for Navigation

High school camp (grades 10-12)

- Explore the fundamentals of the Physics of Flight and Applications in Aeronautical Engineering (With an Emphasis on Actual Aircraft Use and Development)
- Taking the Controls from the Pilot’s Seat During an Actual Flight in a Single-Engine Aircraft Under the Direction of a Certified FAA Flight Instructor
- Cyber Security (Hardware and Software Applications)
- UAS Materials Testing
- Digital Thread Engineering
- CAD System Utilization
- UAS Manufacturing (additive and subtractive)
- Aeronautical Chart Interpretation
- Technical Operations at Airports
- Aeronautical Navigation
- Aeronautical Engineering
- Investigate Connections Between Aviation and Aeronautics with Key Engineering Fields like Chemical, Civil, Biological, etc.
- Explore the Engineering Design of Airports
- Analyze Flight Charts and Key Symbols for Navigation
- Manipulate Closed Circuit and Electrical Systems
- Apply Key Concepts of Combustion to Airplane Mechanical Systems
- Strategic Mission Planning
- Practice Flight Using Flight Simulators Used by Professionals in the Field

Teacher camp:

- Ground School
- FAA Briefing
- 6 Pack Educational Materials

Table 3 records activity dates, locations, the number of individuals engaged, and the number of days by event.

Table 3: Sinclair UAS Activities by Region.

Dayton, Ohio Region			
Date(s)	Location	# of Individuals	# of Days
6-7 Jan 20	Baker Middle School	268	2
8-9 Jan 20	Warner Middle School	287	2
10 Jan 20	Greenview Middle School	103	1
13-14 Jan 20	Bellbrook Middle School	191	2
16 Jan 20	Greene Educational Service Center	10	1
17 Jan 20	Mills Lawn Middle School	42	1
22 Jan 20	Greene County Educational Service Center	12	1
12 Jul 20	WACO Aviation Learning Center	20	1
8-9 Aug 20	WACO Aviation Learning Center	108	2
11-14 Aug 20	WACO Aviation Learning Center	15	3
15 Sep 20	Carillon Historical Park	65	1
19-20 Sep 20	WACO Aviation Learning Center	132	2

22 Sep 20	Carillon Historical Park	60	1
26 Sep 20	WACO Aviation Learning Center	35	1
29 Sep 20	Carillon Historical Park	115	1
7 Oct 20	Carillon Historical Park	30	1
10-11 Oct 20	WACO Aviation Learning Center	49	2
16 Oct 20	National Park Service Dayton Aviation Heritage Area	25	1
17 Oct 20	National Park Service Dayton Aviation Heritage Area	9	1
23 Oct 20	Carillon Historical Park	52	1
12 Nov 20	Carillon Historical Park	4	1
13 Nov 20	Mound Cold War Discovery Center	0	1
20 Nov 20	National Park Service Dayton Aviation Heritage Area	3	1
21 Nov 20	National Park Service Dayton Aviation Heritage Area	9	1
10-12 Dec 20	Carillon Historical Park	162	3
17-19 Dec 20	Carillon Historical Park	102	3
7 Jan 21	Carillon Historical Park	3	1
8 Jan 21	Mound Cold War Discovery Center	3	1
17 Jan 21	Carillon Historical Park	20	1
11-13 Feb 21	Carillon Historical Park	20	3
20 Feb 21	National Museum of the USAF	591	1
1 Mar 21	Carillon Historical Park	9	1
11-12 Mar 21	Carillon Historical Park	18	2
8-9 Apr 21	Carillon Historical Park	60	2
15 Apr 21	Carillon Historical Park	25	1
21 Apr 21	Carillon Historical Park	62	1
23 Apr 21	National Park Service Dayton Aviation Heritage Area	27	1
29 Apr 21	Carillon Historical Park	57	1
13-14 May 21	Carillon Historical Park	106	2
17-19 May 21	Troy Middle School	258	2
20-21 May 21	Van Cleve Middle School	277	2
22-23 May 21	WACO Aviation Learning Center	18	2
10-11 Jun 21	Carillon Historical Park	45	2
14-15 Jun 21	Air Camp (Sinclair)	36	2
17 Jun 21	Air Camp (Sinclair)	36	1
19-20 Jun 21	WACO Aviation Learning Center	3	2
21-22 Jun 21	Air Camp (Sinclair)	32	2
23 Jun 21	Teacher Air Camp (Sinclair)	35	1
1 Jul 21	Air Camp (Sinclair)	36	1
9 Jul 21	WACO Aviation Learning Center	17	1
12 Jul 21	Air Camp (Sinclair)	36	1
14 Jul 21	Air Camp (Sinclair)	35	1

20-22 July 21	Dayton Early College Academy (Sinclair)	12	3
3-5 Aug 21	WACO Aviation Learning Center	15	3
9-10 Sep 21	Ankeney Middle School	224	2
18-19 Sep 21	WACO Aviation Learning Center	75	2
20-21 Sep 21	Kettering Middle School	286	2
24 Sep 21	Dayton Arcade Ohio Tech Day	47	1
25 Sep 21	Wright State University Festival of Flight	56	1
27-28 Sep 21	Coy Middle School	343	2
16-17 Oct 21	WACO Aviation Learning Center	3	2
26 Oct 21	Greene County Educational Service Center	6	1
28 Oct 21	Greene County Educational Service Center	19	1
4-5 Nov 21	Dayton Metro Library	950	2
2 Dec 21	Trotwood Middle School	300	1
10 Dec 21	Yellow Springs Middle School	44	1
28 Jan 22	Cedar Cliff Middle School	66	1
25-27 Feb 22	National Museum of the USAF	206	3
19 Apr 22	Greenview Middle School	97	1
27-29 Apr 22	Warner Middle School	242	3
4 May 22	Dayton Metro Library	53	1
23-24 May 22	Van Cleve Middle School	316	2
13-14 June 22	Air Camp (Sinclair)	37	2
29 Jun 22	Air Camp (Sinclair)	50	1
11-12 July 22	Air Camp (Sinclair)	33	2
13 Jul 22	Air Camp (Sinclair)	48	1
19 Jul 22	Air Camp (Sinclair)	40	1
19-21 July 22	Wright Brothers Institute	8	3
20 Jul 22	Air Camp (Sinclair)	49	1
26-28 July 22	Dayton Early College Academy (Sinclair)	14	3
2-4 August 22	WACO Aviation Learning Center	16	3
Columbia, Ohio Region			
Date(s)	Location	# of Individuals	# of Days
28 Feb 20	Metro Early College Middle School	100	1
24 Feb 20	Emmanuel Christian Middle School	38	1
25 Feb 20	Reid Elementary Middle School	70	1
26 Feb 20	Possum School Middle School	76	1
3 Mar 20	Rockway School Middle School	24	1
Cleveland, Ohio Region			
Date(s)	Location	# of Individuals	# of Days
9 Mar 20	Grand Valley Middle School	71	1
10 Mar 20	Cardinal Middle School	62	1
11 Mar 20	Durling Middle School	117	1
Cincinnati, Ohio Region			
Date(s)	Location	# of Individuals	# of Days
27-28 Jan 20	Goshen MS	211	2
29-30 Jan 20	West Clermont MS	704	2

31 Jan 20	Bethel Tate MS	123	1
22 Sep 20	St. Francis Desales Middle School	47	1
2 Sep 21	Talawanda Middle School	82	1
Provo, Utah Region			
Date(s)	Location	# of Individuals	# of Days
9-13 July 21	SOFWOLF	15	5

2.5.3 Sinclair Summary and Demographics

At the conclusion of the effort, Sinclair had completed 148 outreach days, reaching 9,168 total participants who were provided with the project presentation and RealFlight simulation experience. Efforts were made to reach schools across a range of locations and economic demographic conditions, as well as to participate in public access events in underserved areas including west Dayton. Demographics were difficult to record in all cases because of the transition to include open public events, and restrictions from schools related to sharing these data for minors, etc. However, several highlights based on observation or data provided by partners follows:

Dayton Early College Academy UAS Camps:

The Dayton Early College Academy primarily serves minority populations in Dayton, Ohio. The three-day UAS camp organized and hosted by Sinclair in 2021 included 12 disadvantaged and minority middle and high school students, while 14 included in the three-day camp hosted in 2022.

Air Camp

Air Camp provided a demographic report for the participants in events at Sinclair in 2021, which noted 24 of 118 elementary students, 31 of 69 middle school students, 19 of 67 high school students, and 13 of 70 teachers were drawn from minority ethnic populations. A report from Air Camp was not provided for 2022 at the time of this report. However, the proportions were similar.

SOFWOLF

The participants in the SOFWOLF DRONE WOLF UAS camp were all Gold Star children, who are the children or step-children of fallen soldiers or first responders. Sinclair’s team traveled to the Provo, Utah region to support the camp, which included provision of a remote pilot ground school, UAS flight operations and demonstrations, and other hands-on activities in addition to the standard project presentation and UAS simulation experience.

Summary

Although there were challenges related to the pandemic, school policies, and development of effective alternative activities and venues, the project was very successful, reaching thousands, many of whom were drawn from minority or disadvantaged groups.



Figure 22. Project Presentation and RealFlight Simulation Stations at the National Museum of the United States Air Force.



Figure 23. Air Camp High School Student Installing a Sensor Mount on a SelectTech EH-8 UAS.



Figure 24. Air Camp High School Students Designing a UAS Sensor Mount for CNC and Additive Manufacturing.



Figure 25. Middle School Students Listening to the Project UAS Careers, Applications, Technologies, and Research Presentation.



Figure 26. Middle School Students Learning About VTOL and Fixed-Wing UAS Designs and Applications.



Figure 27. The Project Presentation and UAS Simulation Experience Setup at Carillon Historical Park.



Figure 28. Project Presentation and UAS Simulation Experience Setup at Carillon Historical Park.



Figure 29. Sinclair Mobile Ground Control Station at Carillon Historical Park.



Figure 30. Sinclair Tactical Ground Control Station at Carillon Historical Park.



Figure 31. Middle School Students Flying UAS Simulators in the Sinclair Tactical Ground Control Station.



Figure 32. Middle School Students Listening to the Project Presentation.



Figure 33. Dayton Early College Academy Students Receiving UAS Design Briefing.



Figure 34. Middle School Students Flying UAS Simulators in the Sinclair Mobile Ground Control Station.

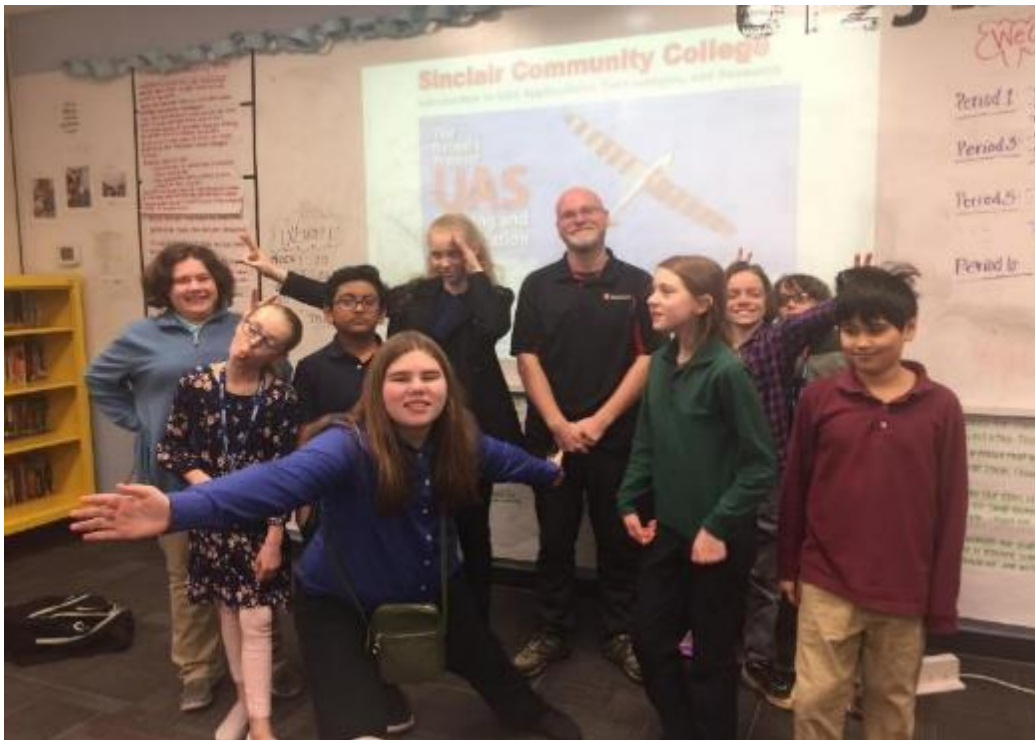


Figure 35. Middle School Students Following Outreach Event.



Figure 36. KSL Channel 5 SOFWOLF DRONE WOLF UAS Camp Story in Provo, Utah.

2.6 New Mexico State University (NMSU)

New Mexico State University's original focus with this STEM effort was limited to the STEM program management role and managing/sponsorship of a subcontract for the Sinclair STEM outreach efforts. As expiring funds were transferred over from another effort, NMSU was able to add in UAS summer camps.

2.6.1 NMSU Planned Approach

The NMSU program was originally focused only on Program Management of this effort and support the subcontract with Sinclair. As detailed in the original proposal effort, the research approach was as follows:

- NMSU PSL to continue in its role as the ASSURE PI/coordinator for the funded STEM activities.
- Point person for the FAA contacts, coordinating/preparing the monthly reporting, quarterly reporting, presentation preparation and presenting at the semi-annual FAA/ASSURE meetings, TIM briefings, deliverables, coordinating annual report inputs, team coordination, information dissemination, handling external requests for information, presenting information to a broader audience at FAA direction, etc.
- Sinclair College activities will be coordinated through a subcontract with NMSU.
- Minimal additional STEM funds will be used for a number of proven existing outreach activities like UAS Roadshows and UAS summer camps.

As the effort proceeded, funds were reallocated to this effort and they were focused on providing a few additional activities and to fulfill the last bullet noted above for summer camps.

2.6.2 FAA STEM Program Management, Summer Camps, and Sinclair Sponsorship STEM Outreach

The initial role of NMSU in this effort was focused on management and coordination of the overall effort. This has included ensuring the TIM materials were prepared and submitted, leading, and documenting the team presentations monthly. Meeting notes were distributed to a wide audience after each meeting. Sinclair's support was subcontracted under NMSU and their effort was managed. The very limited initial funding to NMSU had no specific STEM outreach events. As the support evolved, additional funding was added to this effort so that STEM outreach could be performed.

The first TIM and kickoff meeting was on October 22, 2019. At the beginning there were a few additional requests from the FAA PM for additional reporting on the STEM efforts and NMSU coordinated these responses. Before funding beyond management level support was provided, the NMSU team took advantage of some ongoing STEM activities as match events. The New Mexico State University supported the El Paso Space Festival in early October 2019 as shown in Figure 37.



Figure 37. The El Paso Space Festival provided hands on flight simulator time for students and families.



Figure 38. The Las Cruces “Fly In” at the Las Cruces International Airport was a hands-on demonstration of UAS, flight simulator fun, and discussions about the ASSURE COE UAS research.

As illustrated in Figure 38, the team also supported the October 19, 2019 “Fly In” at Las Cruces International Airport. During the April 2020 time frame, many of the outreach plans were stopped due to COVID-19. This is covered in another section of this report. During this time frame, a request from ASSURE was received to support a STEM Outreach Presentation. NMSU personnel filled in on a panel for the online “Drone Workforce Conference” on Wednesday morning June 10, 2020. Copies of the request and presentation materials were provided to the FAA. The presentation via Zoom highlighted at a top level the various approaches used for STEM under this grant.

In the late summer of 2020, the FAA transferred funding (\$29,316.25) from other completed ASSURE effort to support STEM outreach efforts under this task. This funding ended up being used to support summer camp for two summers. The ongoing conversation with the NMSU STEM Outreach Center resulting in curricula development and summer camps for the summer of 2021.

In early 2021, NMSU coordinated two requests from the FAA for STEM speakers at the upcoming FAA UAS Symposium to be held in early June. The STEM team participated in two different sessions in the June meeting. Cathy Cahill (UAF) and Jerry Hendrix (UAH) participated in the FAA Symposium panel, “STEM: Helping Aviation Skills Take Root” which was moderated by the FAA’s STEM III Program Manager, Richard Lin. Henry Cathey (NMSU) participated in the FAA Symposium panel, “STEM + UAS: Your Next COO Could Still Be in High School,” which was moderated by the FAA’s Sabrina Saunders-Hodge.

In the summer of 2021, a request was received from Sarah Nicole Ruffin at the FAA, Aerospace Human Factors Research Division, located in the Civil Aerospace Medical Institute at the Mike Monroney Aeronautical Center. She extended an invitation to ASSURE STEM researchers to present research on “UAS as a STEM Outreach Learning Platform for K-12 students and educators (STEM III)”. A presentation was made on July 29, 2021 via Zoom by Henry Cathey (NMSU) with FAA management and researchers from the other schools online for the meeting.

NMSU UAS STEM Summer camps were offered in July of 2021 as shown in Figure 39 and Figure 40. NMSU STEM Outreach Center offered “Drone Camps” with a limit of 10 students per session (with COVID-19 protocols in place including masks). July 12-16, 2021 was “Drones 1 – Drones for Beginners (AM and PM sessions)”; and July 19-23, 2021 had “Drones 1 – Drones for Beginners (AM session)”, and “Drones 2 – Drones for Advanced Flyers (PM session)”. In total, 30 middle school grade students attended the camps. Campers explored the basics of flight. With this foundational knowledge, they explored piloting through the flight simulators. Finally, campers tested out their skills with driving drones through obstacle courses.

NMSU's FAA UAS Summer Camp (on one slide)

1. Aviation Education and Flight Safety



2. Flight Simulator Time



6. Flying, 7. Programming, and 8. Payload Challenge with Mini Drones



3. Driving, 4. Programming, and 5. Payload Challenge with Ground Bots

9. UAS Flight Test Site Visit

10. Combined Challenge with Ground and Flight Vehicles

Figure 39. The NMSU 2021 Drone Summer Camps used the previously developed and successful educational program format.



Figure 40. NMSU 2021 Drone Summer Camp activities.

The NM Flight Test Site STEM team supported the “Wings ‘n Wheels Fest ‘21” seen in Figure 41 at the Las Cruces International Airport on September 25, 2021 (8 AM to 4 PM), with display and hands on activities. The NMSU team had an Aerostar and helicopter on display along with flight simulators and ground bots for hands on activities. Approximately 2,900 people attended the event (where many children come by to “play” and “fly”). There was a B-25 on display and giving flights, 34 airplanes on display at the show, 59 show cars, 4 motorcycles, 6 big trucks, and one jet boat too!



Figure 41. Wings ‘n Wheels Fest ’21 reached many students in the local Las Cruces area.

Near the end of 2021, a number of members of the STEM III team supported and worked with the FAA Communications Office’s Jim Tice as he prepared the STEM article for the FAA.

With the limited funding, NMSU was able to stretch them to offer UAS summer camps in June of 2022 as seen in Figure 42. The planning for summer 2022 UAS camps was coordinated through the NMSU STEM Outreach Center in the spring of 2022. Updates to curricula were ongoing. The class size was still limited from COVID-19 restrictions to 15 students per session, with a target of 60 students total. Successful summer 2022 UAS camps were completed with coordination through the NMSU STEM Outreach Center. Updates to curricula were integrated this year. Four sessions were completed; June 6 to 10 (Drone for Beginners – both AM and PM sessions); and June 20 to 24 (Drone for Beginners – AM only and Drones for Advanced Flyers – PM only). The June 6 to 10 camps were focused on students from the Gadsden Independent School District which has 97% minority enrollment. The team used indoor space in Renfro Hall to host the camps so that all flying camp was conducted safely indoors (and away from the heat!).

To support these camps, the NMSU STEM Outreach Center procured new drones, iPads, and modified curricula. Costs for these were not under this grant (this was not funded by the FAA), and came out of state funds. FAA funding paid for instructor time only. Like previous offerings, these camps were focused on establishing basic drone pilot and safety skills. Campers used plastic bricks to construct landing pads and racing gates for their drones. One of the PSL UAS Safety Analyst and drone pilot provided support. He talked to the students about being a professional in this field, his experiences, and about the FAA ASSURE UAS research being done by NMSU. The desire is to set up for longer term post FAA support.



Figure 42. NMSU 2022 STEM Summer Camps.

2.6.3 NMSU Summary and Demographics

NMSU summer camps, even with COVID-19 restrictions, reached 80 students over two summers. While specific demographic information is unable to be published due to university and federal restrictions, the predominant number of students (over 90%, primarily Hispanic) were from underrepresented groups. As noted previously, June 6 - 10, 2022 camps were focused on students from the Gadsden Independent School District which has 97% minority enrollment. The total outreach “touchpoints” was almost 600 connections.

3. ASSURE RESEARCH TIE-INS

All of the six STEM teams incorporated ASSURE research tie-ins as part of the STEM outreach activities and events. These are noted in detail previously in the text sections for each school. It is worth reiterating a few specific items. For all schools with active ASSURE reach efforts, these efforts were part of the discussions with both students and teachers.

UAH presented research looking into expanded and non-segregated operations of UAS in the NAS conducted under A21 where advanced technologies and capabilities were addressed. Multiple schools highlighted the ASSURE research tie-ins to the A28 (and follow on efforts) related to disaster preparedness and response. Community resiliency was discussed as part of this. UAH included this with both the Space Camp for Educators and with the Civil Air Patrol where emergency services are a core mission. The particular use case of damage assessment and search and rescue was an important note due to the severe weather Alabama experiences on an annual basis.

In all of the ASSURE research tie-ins, the amount of detail provided in the interactions depended on the level of the students. With the youngest groups, the focus was on the fact that the teams are studying ways to keep aircraft and drones from hitting each other. At the high school level, talks focused on specific ASSURE projects and how teams are doing some of the testing, such as flying traditional aircraft against different detect and avoid sensors to see what works the best at spotting intruding aircraft. Other research areas noted included UAS noise measurement and certification, UAS airborne collision severity evaluations, and UAS detect and avoid requirements necessary for limited BVLOS operations.

UAF has noted that when the STEM team visited communities and had the opportunity to do presentations on the work their team is doing to facilitate the integration of drones into the National Airspace System, they include slides on ASSURE and talked about multiple projects and their potential effects on the community. For example, when talking with the folks in Nenana, a community about 60 minutes by road from Fairbanks, they talked specifically about A18 (DAA), A31 (operations on and around airports), A42 (air cargo), and other ASSURE projects that help us safely operate drones out of the Nenana Municipal Airport (non-towered, Class G), deliver cargo to remote communities, and ensure the safety of General Aviation in the area.

With various outreach efforts, and again depending on the audience, students were talked to about TRUST, airspace, ASSURE research on BVLOS (including) DAA, operations at airports, and remote cargo delivery, challenges like cell phone coverage so poor that getting LAANC approvals is difficult at best, and other topics of interest to students their geographic locations such as in a remote community.

The OSU STEM activities integrated the students directly into the ASSURE research efforts. This has included supporting the engine ingestion program (supporting A17 and A43), the A35 Wake and Flutter encounter program, and a few other ASSURE efforts.

Also tied in to the specific ASSURE research efforts, participants were introduced to UAS applications, careers, and technologies. These presentations also highlighted specific ASSURE research but were focused on providing the bigger picture to the teachers and students. The following figures are representative examples of what these materials looked like.



Figure 43. NMSU STEM activities provide a broad vision of UAS operations and the impact to society.

- Flight safety, how FAA interfaces with UAS, and technical careers in related fields



Figure 44. NMSU STEM activities highlight FAA COE research a future opportunity with the FAA and in aviation.

4. SUMMARY AND DEMOGRAPHICS

The STEM III team maintained a “Contact Tacking” spreadsheet throughout the effort. This was provided periodically to the FAA Program Management over the duration of the STEM III effort with updates on what activities/events had been completed as well as projections of events in the future. The activities/events were listed by school, date completed, location, number of students reached, and number of educators reached. A full copy of this final Tracking sheet is included in Appendix C, as well as a separate attachment. The event list has 188 separate distinct line items for the activities/events held. Summary totals by school were as follows:

Table 4. STEM III Summary Outreach Numbers.

School	Students/Contacts	Teachers
UAH	192	573
UAF	1,542	268
UCD	35	4
OSU	105	22
Sinclair	9,168	30
NMSU	580	0
Total	11,622	897

As noted above, the team collected information on the number of students reached. Collection of specific demographic information (age, gender, ethnicity, etc.) was not generally done. In many cases, the Universities have restrictions on both gathering this information and then sharing this information, if this information was even gathered. Again, the teams collected numbers, but in many cases not the specifics of age, gender, ethnicity. Some of these specifics are noted in previous sections by school.

5. CONCLUSIONS

Using UAS as the central learning platform was very successful for the ASSURE Center of Excellence A29 STEM III team. The six universities and team members included;

- University of Alabama in Huntsville
- University of Alaska Fairbanks
- University of California Davis
- Ohio State University
- Sinclair College
- New Mexico State University

There is no one single approach that addresses this for students of different ages, backgrounds, or who have different cultural and regional influences. All of the programs leveraged “age appropriate” materials extracted from the COE research results and from the previous FAA COE STEM efforts. Each school develop and provides separate approaches that focused on activities that fell into five basic categories;

- 1) Educator-based STEM outreach program;
- 2) Rural community education and outreach;

- 3) UAS centered summer camps;
- 4) After school programs; and
- 5) In school immersion programs

COVID-19 impacted all of the different planned activities. Some events were turned from in person to virtual. Some events were modified. Some of the programs had to be completely readjusted. Locations and the number of allowable participants were based on federal, state, and local regulations/guidance at the time. This research team was resilient, adaptable, and creative in getting the good word out about UAS.

There is no easy way to succinctly capture all of the great work completed by the team, but the bullets below provide a few key highlights from each school.

- University of Alabama in Huntsville
 - Teaming with Space Camp for Educators, hundreds for teachers in Alabama were educated about drone and how these tools can be used in the classroom
 - Working with the Civil Air Patrol Alabama Wing Summer Encampment, the UAS Aerospace Education Activity included an "sUAS Solo Achievement"
- University of Alaska Fairbanks
 - COVID-19 impacts, and the inability to go into the remote communities made UAF adjust programs to still deliver high value content through camps, other school visits, and Campfire Alaska
 - Flight simulators and the UAS "petting zoo" were central to these outreach activities
- University of California Davis
 - UCD conducted multiple Summer Drone Academies that targeted low income and underserved groups
 - UCD brought in guest speakers from the FAA and others as well as used biology inspired aviation (insects and birds) to teach flight principals
- The Ohio State University
 - Six OSU students supported real world research projects that were part of OSU's ASSURE research work including Airborne Collision Repair, Drone Building, Airfoil Analysis, ABCs of Airplanes, UAS ingestion, and UAS design
 - The six students developed design challenges for middle school students
- Sinclair College
 - Sinclair's Interactive Middle School UAS Introduction and Simulation Experience completed 148 outreach days, reaching 9,168 total participants
 - Additional activities included the Dayton Early College Academy UAS Camps, Air Camp, and SOFWOLF
- New Mexico State University
 - NMSU summer camps reached 80 students from underrepresented groups over two summers
 - Multiple other outreaches and hands on events made almost "touchpoint" connections

The diversity of students, communities, and teachers reached was significant. The summary numbers show that almost 12,000 students were reached over the period of this grant. Over 650 teachers/educators were exposed to UAS, with many given the tools the take this back to their communities to expand the impact.

APPENDIX A

STEM I and STEM II Reference Information

STEM I

Tuskegee

- UAS Roadshows
 - Promised 2 roadshows (target 120 students)
 - Completed 4
- Summer Camp – Promised 1 summer camp (target 25 students)
 - Completed 1

NMSU

- UAS Roadshows – Promised 2 roadshows (target 250 students)
 - Completed 3
- Summer Camp – Promised 1 summer camp (target 25 students)
 - First Summer Completed 4 (two AM and two PM sessions)
 - Additional summer camps held in the following 2 years

School	Date	Description	Location	Number of Students
Tuskegee	9/22/2016	UAS Roadshow	Tuskegee Institute Middle School	65
NMSU	9/26/2016	UAS Roadshow	NMSU Basketball Arena, 8 th grade Middle school students from Las Cruces, NM	500
Tuskegee	10/18/2016	UAS Roadshow	St. Joseph School, Tuskegee (abbreviated event)	15
NMSU	10/27/2016	UAS Roadshow	Laguna Elementary School, Laguna Pueblo, NM – 3 rd , 4 th , 5 th , and 6 th grade students	94
Tuskegee	11/3/2016	UAS Roadshow	Notasulga School	60
NMSU	3/3/2017	UAS Roadshow	“The 2017 STEM Discovery Showcase” at the Dōna Ana Community College – The day was focused on STEM outreach to local high school students (there were 7 or more of the local schools in attendance) and to some of the Community College students	300
Tuskegee	June 19 to 23, 2017	Summer Camp	Tuskegee University	20
NMSU	June 19 to 30, 2017	Summer Camp	New Mexico State University	57
NMSU	July 10 to 21, 2017	Summer Camp	New Mexico State University	59
Tuskegee	10/5/2017	UAS Roadshow	Tuskegee Middle School	65

Total 1235

STEM II

University of Alaska Fairbanks

- At least two remote UAS Roadshows – target ~100 students
 - Three or more held – reached ~300+ students and community members
- Additional STEM Outreach activities – target 2 events
 - 4 events held – ~400+ people
- Summer camp – target 1 camp
 - One camp, all day for 1 week, with 21 students

University of California

- STEM Outreach activities – target 3 events – UCD Picnic Day, High School Open houses, and Yolo county Fair
 - 3 events held with several thousand visitors attending events
- Summer Camp – target 1 camp, all day for 1 week with 25 students
 - 15 students attended

Montana State University

- STEM Outreach activities – target 2 different events
 - Two events held – 100+ contacts
- Montana Apprentice Program – target support for 2 students
 - Successful summer program with 2 Native American students

New Mexico State University

- Project Management – no specific outreach, just management
- Target One UAS Roadshow
 - One activity supported – ~50 students
- Additional STEM Outreach activities – target 2
 - Five different speaking and hands on activities - ~350 students contacted
- Summer camp – target 2 camps, 60 students
 - 4 camps completed with 120 students

Other

- Cloned NMSU summer camp in El Paso. They used our materials and instructor. 25 students
- Completed a third set of summer camps in NM
 - 4 camps (Beginners 45, Advanced 18, and Drone Engineering 19) total of 82 students

APPENDIX B

- **University of Alabama in Huntsville (UAH)**
 ➤ Mr. Jerry Hendrix, Rotorcraft Systems Engineering and Simulation Center (RSESC), University of Alabama in Huntsville, jerry.hendrix@uah.edu, (256) 679-5608
- **University of Alaska Fairbanks (UAF)**
 ➤ Dr. Catherine F. Cahill, Director, Alaska Center for Unmanned Aircraft Systems Integration, University of Alaska Fairbanks, cfcahill@alaska.edu, (907) 474-6905
- **University of California (UCD)**
 ➤ Dr. Susan L. Ustin, Professor of Environmental and Resource Sciences, University of California, Davis, slustin@ucdavis.edu, (530) 752-0621
- **Ohio State University (OSU)**
 ➤ Prof. Kiran D'Souza, Gas Turbine Laboratory, The Ohio State University, dsouza.60@osu.edu, (614) 292-5926
- **Sinclair College (Sinclair)**
 ➤ Dr. . Andrew D. Shepherd, Executive Director and Chief Scientist, Sinclair National UAS Training and Certification Center. Andrew.Shepherd@sinclair.edu, (937) 512-4848
- **New Mexico State University (NMSU) – Team Lead PI**
 ➤ Mr. Henry M. Cathey, Jr., Physical Science Laboratory, New Mexico State University, HCathey@psl.nmsu.edu, (575) 646-9474

Figure 45. STEM III ASSURE COE Schools, PI's, and Contact Information.

APPENDIX C

Table 5. FAA UAS STEM III Outreach Activities.

FAA UAS STEM III					Sept. 2022
Completed					
School	Accomplishment	Date Completed	Location	Number of Students	Number of Educators
All Schools	initial coordination activities and outreach activities	N/A	N/A	N/A	N/A
UAF	Hosted 18 members of the Alaska Superintendents Association (ASA)	9/25/2019	Fairbanks, AK	N/A	18
UAF	Hosted current UAF freshmen in Atmos Science degree program	9/30/2019	Fairbanks, AK	5	N/A
NMSU	El Paso Space Festival Support	10/5/2019	El Paso, TX	250	N/A
UAF	Hosted 26 Nenana High School students for UAS careers, Nenana HS Science Day at UAF	10/18/2019	Nenana, AK	26	N/A
NMSU	"Fly In" at the Las Cruces International Airport	10/19/2019	Las Cruces, NM	60	N/A
UAF	Hosted the Research Vessel Technical Enhancement Committee (RVTEC)	10/24/2019	Fairbanks, AK	N/A	42
UCD	Met with Davis Woodland Aeromodelers Club to extend 2020 Flying agreement	Oct-19	Davis, CA	7	1
UAH	Space Camp Educators PD Workshop and MOU Signed	Oct-19	Huntsville, AL	N/A	30
OSU	Undergraduate student Freeman Gao, supervised by Prof. Kiran D'Souza, led a design challenge with Metro middle school students participating in after school engineering club. Challenge was related to UAS engine ingestion research.	10/16/2020	Columbus, Ohio (Virtual)	15	6
OSU	Undergraduate student Yuto Nakahata, supervised by Dr. Matt McCrink, led a design challenge with a Metro middle school class. Challenge was related to design and flight-testing of a weather monitoring drone.	10/12/2020	Columbus, Ohio (Virtual)	30	6
Sinclair	POC's provided by Dayton Regional STEM Center and Montgomery County Educational Service Center	Oct-19	Dayton, OH	N/A	N/A
UAH	Alabama Math, Science, and Technology Initiative Follow-Up Meeting	Nov-19	Huntsville, AL	N/A	2
UAH	Multiple meetings, MOU, and planning activities	Dec-19	U.S. Space and Rocket Center (USSRC) in Huntsville, AL	N/A	4

UAF	Instructed UAF students on flying UAS and acting as VO's	Dec-19	Fairbanks, AK	6	2
Sinclair	Middle school outreach event (all match)	6-Jan-20	Baker MS (Greene County)	134	N/A
Sinclair	Middle school outreach event (all match)	7-Jan-20	Baker MS (Greene County)	134	N/A
UAF	Educated local K-12 teacher and her students on how to teach UAS education	7-Jan-20	Fairbanks, AK	4	1
Sinclair	Middle school outreach event (all match)	8-Jan-20	Warner MS (Greene County)	145	N/A
Sinclair	Middle school outreach event (all match)	9-Jan-20	Warren MS (Greene County)	142	N/A
Sinclair	Middle school outreach event (all match)	10-Jan-20	Greenview MS (Greene County)	103	N/A
Sinclair	Middle school outreach event (all match)	13-Jan-20	Bellbrook MS (Greene County)	105	N/A
Sinclair	Middle school outreach event (all match)	14-Jan-20	Bellbrook MS (Greene County)	86	N/A
Sinclair	Middle school outreach event (all match)	16-Jan-20	Greene ESC (Greene County)	10	N/A
Sinclair	Middle school outreach event (all match)	17-Jan-20	Mills Lawn (Greene County)	42	N/A
Sinclair	Middle school outreach event (all match)	23-Jan-20	Greene County ESC (Bellbrook)	12	N/A
Sinclair	Middle school outreach event	27-Jan-20	Goshen MS (Cincinnati Region)	109	N/A
Sinclair	Middle school outreach event	28-Jan-20	Goshen MS (Cincinnati Region)	102	N/A
Sinclair	Middle school outreach event	29-Jan-20	West Clermont MS (Cincinnati Region)	350	N/A
Sinclair	Middle school outreach event	30-Jan-20	West Clermont MS (Cincinnati Region)	354	N/A
UAF	Participated in STEM Night at Pearl Creek Elementary	30-Jan-20	Fairbanks, AK	300	30
Sinclair	Middle school outreach event	31-Jan-20	Bethel Tate MS (Cincinnati Region)	123	N/A
UAF	Talk with homeschoolers	3-Feb-20	Fairbanks, AK	7	N/A
UCD	High School Drone Build Camp	9-Feb-20	UC Davis campus	12	3
Sinclair	School outreach event	24-Feb-20	Emmanuel Christian (Springfield)	38	N/A
Sinclair	School outreach event	25-Feb-20	Reid Elementary (Springfield)	70	N/A
Sinclair	School outreach event	26-Feb-20	Possum School (Springfield)	76	N/A
Sinclair	School outreach event	28-Feb-20	Metro Early College MS (Columbus)	100	N/A
UAH	USSRC Robotics Day	29-Feb-20	Huntsville, AL	120	30
Sinclair	School outreach event	3-Mar-20	Rockway School (Springfield)	24	N/A
UAF	Educating teachers from the Alaska Gateway School District involved in the RAVE (Rural Alaskan Village Entrepreneurs)	7-Mar-20	Fairbanks, AK	0	10
Sinclair	School outreach event	9-Mar-20	Grand Valley MS (Cleveland)	71	N/A
Sinclair	School outreach event	10-Mar-20	Cardinal MS (Cleveland)	62	N/A
Sinclair	School outreach event	11-Mar-20	Durling MS (Cleveland)	117	N/A

UAH	Space Camp for Educators (Alabama Teachers)	22-Jun-20	Huntsville, AL		45
Sinclair	Aviation Day	12-Jul-20	WACO (Troy, OH)	20	N/A
UAH	Elite Space Academy AUSOME Demos	27-Jul-20	Huntsville, AL	72	
Sinclair	STEM weekend	8-Aug-20	WACO (Troy, OH)	54	N/A
Sinclair	STEM weekend	9-Aug-20	WACO (Troy, OH)	54	N/A
Sinclair	UAS Camp	11-Aug-20	WACO (Troy, OH)	15	N/A
Sinclair	UAS Camp	12-Aug-20	WACO (Troy, OH)	0	N/A
Sinclair	UAS Camp	13-Aug-20	WACO (Troy, OH)	0	N/A
Sinclair	UAS Camp	14-Aug-20	WACO (Troy, OH)	0	N/A
Sinclair	Home School days	15-Sep-20	Carillon Park (Dayton, OH)	65	N/A
Sinclair	Bi Planes ride event	19-Sep-20	WACO (Troy, OH)	66	N/A
Sinclair	Bi Planes ride event	20-Sep-20	WACO (Troy, OH)	66	N/A
Sinclair	School outreach event	22-Sep-20	St. Francis Desales (Lebanon, OH)	47	N/A
Sinclair	Home School days	22-Sep-20	Carillon Park (Dayton, OH)	60	N/A
Sinclair	RC Demo	26-Sep-20	WACO (Troy, OH)	35	N/A
Sinclair	Home School days	29-Sep-20	Carillon Park (Dayton, OH)	115	N/A
Sinclair	Home School days	7-Oct-20	Carillon Park (Dayton, OH)	30	N/A
Sinclair	STEM outreach	10-Oct-20	WACO (Troy, OH)	49	N/A
Sinclair	Community Outreach	10-Oct-20	DH National Park (Dayton, OH)	25	N/A
Sinclair	Community Outreach	11-Oct-20	DH National Park (Dayton, OH)	9	N/A
Sinclair	Home School days	23-Oct-20	Carillon Park (Dayton, OH)	52	N/A
Sinclair	Community Outreach	13-Nov-20	Discovery Center (Dayton, OH)	4	N/A
Sinclair	Community Outreach	14-Nov-20	DH National Park (Dayton, OH)	0	N/A
Sinclair	Community Outreach	20-Nov-20	DH National Park (Dayton, OH)	3	N/A
Sinclair	Community Outreach	21-Nov-20	DH National Park (Dayton, OH)	9	N/A
Sinclair	Home School days	10-Dec-20	Carillon Park (Dayton, OH)	46	N/A
Sinclair	Home School days	11-Dec-20	Carillon Park (Dayton, OH)	58	N/A
Sinclair	Home School days	12-Dec-20	Carillon Park (Dayton, OH)	58	N/A
Sinclair	Home School days	18-Dec-20	Carillon Park (Dayton, OH)	56	N/A
Sinclair	Home School days	19-Dec-20	Carillon Park (Dayton, OH)	46	N/A
Sinclair	Home School days	7-Jan-21	Carillon Park (Dayton, OH)	3	N/A
Sinclair	Community Outreach	8-Jan-21	Discovery Center (Dayton, OH)	3	N/A
Sinclair	Home School days	17-Jan-21	Carillon Park (Dayton, OH)	20	N/A
Sinclair	Home School days	11-Feb-21	Carillon Park (Dayton, OH)	4	N/A
Sinclair	Home School days	12-Feb-21	Carillon Park (Dayton, OH)	6	N/A
Sinclair	Home School days	13-Feb-21	Carillon Park (Dayton, OH)	10	N/A

Sinclair	Drone Racing League/UAS event	20-Feb-21	WPAFB Air Force Museum	591	N/A
Sinclair	Home School days	1-Mar-21	Carillon Park (Dayton, OH)	9	N/A
Sinclair	Home School days	11-Mar-21	Carillon Park (Dayton, OH)	7	N/A
Sinclair	Home School days	12-Mar-21	Carillon Park (Dayton, OH)	11	N/A
OSU	Design challenges directions, videos, and handouts developed by Freeman Gao and Yuto Nakahata were posted to: https://u.osu.edu/tek8/2020-design-challenges/ and FAA KSN site for future use for informal STEM education	1-Apr-21	Webhosted	N/A	N/A
Sinclair	Home School days	8-Apr-21	Carillon Park (Dayton, OH)	35	N/A
Sinclair	Home School days	9-Apr-21	Carillon Park (Dayton, OH)	25	N/A
Sinclair	Home School days	15-Apr-21	Carillon Park (Dayton, OH)	25	N/A
Sinclair	Home School days	22-Apr-21	Carillon Park (Dayton, OH)	62	N/A
Sinclair	Community Outreach	23-Apr-21	Wright Dunbar (Dayton, OH)	0	N/A
Sinclair	Community Outreach	24-Apr-21	Wright Dunbar (Dayton, OH)	27	N/A
Sinclair	Home School days	29-Apr-21	Carillon Park (Dayton, OH)	57	N/A
Sinclair	Home School days	13-May-21	Carillon Park (Dayton, OH)	15	N/A
Sinclair	Home School days	14-May-21	Carillon Park (Dayton, OH)	91	N/A
Sinclair	School outreach event	17-May-21	Troy Junior High (Troy, OH)	90	N/A
Sinclair	School outreach event	18-May-21	Troy Junior High (Troy, OH)	87	N/A
Sinclair	School outreach event	19-May-21	Troy Junior High (Troy, OH)	81	N/A
Sinclair	School outreach event	20-May-21	Van Cleve MS (Troy, OH)	95	N/A
Sinclair	School outreach event	21-May-21	Van Cleve MS (Troy, OH)	182	N/A
Sinclair	Bi Planes ride event	22-May-21	WACO (Troy, OH)	12	N/A
Sinclair	Bi Planes ride event	23-May-21	WACO (Troy, OH)	6	N/A
Sinclair	Home School days	10-Jun-21	Carillon Park (Dayton, OH)	41	N/A
Sinclair	Home School days	11-Jun-21	Carillon Park (Dayton, OH)	4	N/A
UAH	Space Camp for Educators 2021 Sessions	11-Jun-21	Huntsville, AL		11
Sinclair	Student Air Camp	14-Jun-21	Air Camp (Sinclair)	18	N/A
Sinclair	Student Air Camp	15-Jun-21	Air Camp (Sinclair)	18	N/A
Sinclair	Student Air Camp	17-Jun-21	Air Camp (Sinclair)	36	N/A
UAH	Space Camp for Educators 2021 Sessions	18-Jun-21	Huntsville, AL		30
Sinclair	Bi Planes ride event	19-Jun-21	WACO (Troy, OH)	1	N/A
Sinclair	Bi Planes ride event	20-Jun-21	WACO (Troy, OH)	2	N/A
Sinclair	Student Air Camp	21-Jun-21	Air Camp (Sinclair)	16	N/A

Sinclair	Student Air Camp	22-Jun-21	Air Camp (Sinclair)	16	N/A
Sinclair	Teacher Air Camp	23-Jun-21	Teacher Camp (Sinclair)	35	N/A
UAH	Space Camp for Educators 2021 Sessions	25-Jun-21	Huntsville, AL		25
Sinclair	School outreach event	1-Jul-21	Air Camp (Sinclair)	36	N/A
Sinclair	STEM outreach	9-Jul-21	WACO (Troy, OH)	17	N/A
Sinclair	Gold Star STEM for Future Leaders	9-13 Jul 21	SOFWOLF (Provo, UT)	15	N/A
Sinclair	Student Air Camp	12-Jul-21	Air Camp (Sinclair)	36	N/A
NMSU	Summer Camp - Drones for Beginners (separate AM and PM sessions - 9 or 10 students per session)	July 12-16, 2021	Las Cruces, NM	19	
Sinclair	Teacher Air Camp	14-Jul-21	Air Camp (Sinclair)	35	N/A
UAH	Space Camp for Educators 2021 Sessions (2020 State Teachers of the Year)	16-Jul-21	Huntsville, AL		50
NMSU	Summer Camp - Drones for Beginners (AM session, 8 students) and Drones for Advanced Flyers (PM session, 4 students)	July 12-16, 2021	Las Cruces, NM	12	
Sinclair	Dayton Early College Academy STEM	20-22 Jul 21	DECA (Sinclair)	12	N/A
UAH	Space Camp for Educators 2021 Sessions (2021 State Teachers of the Year)	23-Jul-21	Huntsville, AL		35
UCD	UCD Summer Drone Academy	Aug 2-6, 2021	UC Davis campus	16	
Sinclair	WACO Drone Camp	Aug 3-5, 2021	WACO (Troy, OH)	15	N/A
UAF	UAF Drone Camp	Aug 9-13, 2021	UAF campus	20	
Sinclair	Middle School outreach event	2-Sep-21	Talawanda Middle school	82	N/A
Sinclair	Middle School outreach event (all match)	Sept 9-10, 2021	Ankeney MS (Greene County)	224	N/A
Sinclair	Bi Planes ride event	Sept 18-19, 2021	WACO (Troy, OH)	75	N/A
Sinclair	Middle School outreach event	Sept 20-21, 2021	Kettering MS (Kettering, OH)	286	N/A
UAF	Galena Schools	Sep 23-25 2021	Galena, Alaska	45	3
Sinclair	Community Outreach	24-Sep-21	Arcade (Dayton, OH)	47	N/A
Sinclair	Community Outreach	25-Sep-21	Festival of Flight (Dayton, OH)	56	N/A
NMSU	Las Cruces Wings 'n Wheels Fest '21	25-Sep-21	Las Cruces, NM	190	N/A
Sinclair	Middle School outreach event (all match)	Sept 27-28, 2021	Coy MS (Greene County)	343	N/A
Sinclair	Bi Planes ride event	Oct 16-17, 2021	WACO (Troy, OH)	3	N/A
Sinclair	Middle School outreach event (all match)	25-Oct-21	Greene County ESC (Bellbrook)	6	N/A
Sinclair	Middle School outreach event (all match)	28-Oct-21	Greene ESC (Greene County)	19	N/A

UAF	Nikiski Middle/High School	Nov 3-4 2021	Nikiski, Alaska	60	3
UAF	Challenger Learning Center of Alaska	Nov 4 2021	Kenai, Alaska	15	4
Sinclair	Community Outreach	Nov 4-5, 2021	Dayton library (Dayton, OH)	950	N/A
OSU	Undergraduate student Mitchell Wong, supervised by Prof. Kiran D'Souza, led a design challenge with Metro Early College Middle School students. Challenge was related to UAS engine ingestion research and airfoil durability.	16-Nov-21	Columbus, Ohio	30	5
OSU	Undergraduate student Lexi Moore, supervised by Dr. Matt McCrink, led a design challenge with a Metro Early College Middle School students. Challenge was related to design of aircraft and UAS.	30-Nov-21	Columbus, Ohio	30	5
Sinclair	Middle School outreach event	2-Dec-21	Trotwood MS (Trotwood, OH)	300	N/A
Sinclair	Middle School outreach event (all match)	10-Dec-21	Mills Lawn (Greene County)	44	N/A
Sinclair	Middle School outreach event (all match)	28-Jan-22	Cedar Cliff MS (Greene County)	66	N/A
UAF	Rogers Park Elementary	Jan 26 2022	Anchorage, Alaska	62	5
Sinclair	Drone Racing League/UAS event	Feb 25-27, 2022	WPAFB Air Force Museum	206	N/A
OSU	Design challenges directions, videos, and handouts developed by Mitchell Wong and Lexi Moore were posted to: https://u.osu.edu/tek8/2021-design-challenges/ and FAA KSN site for future use for informal STEM education	15-Feb-22	Webhosted	N/A	N/A
Sinclair	Greenview Middle School UAS STEM outreach	19-Apr-22	Greene County	97	
Sinclair	Warner Middle School UAS STEM outreach	27-29 Apr 22	Greene County	242	
Sinclair	Dayton Metro Library Grand Opening	4-May-22	Dayton, OH	53	
UAF	Great Alaska Aviation Gathering with AK DOT	May 6-8 2022	Palmer, Alaska	20	10
UAF	Challenger DRONE Camp	May 18 2022	Nenana, AK	15	2
UAF	GI Open House	May 19 2022	Fairbanks, Alaska	25	10
Sinclair	Aviation Invasion, Van Cleve Middle School	23-24 May 22	Troy, OH	316	
UAH	Space Camp for Educators AUSOME Demos	3-Jun-22	Huntsville, AL		36
UAF	LARS Birthday Bash	Jun 4 2022	Fairbanks, Alaska	25	15
NMSU	Summer Camp - Drones for Beginners (separate AM and PM sessions, students entering grades 6-9 from the Gadsden Independent School District)	June 6 -10, 2022	Las Cruces, NM	24	N/A
UAF	Camp Fire Alaska, Camp K	Jun 8 2022	Cooper Landing, Alaska	80	7
UAH	Space Camp for Educators AUSOME Demos	10-Jun-22	Huntsville, AL		40
Sinclair	Elementary School Air Camp UAS STEM outread	13-14 June 22	Dayton, OH	37	
UAH	Civil Air Patrol Alabama Wing Summer Encampment: UAS Aerospace Education Activity to include an "sUAS Solo Achievement"	14-Jun-22	Marion, AL	N/A	75

UAF	Camp Fire Alaska	Jun 14-22 2022	Anchorage, Alaska	120	8
UAH	Space Camp for Educators AUSOME Demos	17-Jun-22	Huntsville, AL		40
NMSU	Summer Camp - Drones for Beginners (AM session, 13 students) and Drones for Advanced Flyers (PM session, 12 students)	June 20 -24, 2022	Las Cruces, NM	25	N/A
UAH	Space Camp for Educators AUSOME Demos	24-Jun-22	Huntsville, AL		40
UAF	Dimond High School	Jan 27 2022	Anchorage, Alaska	246	10
Sinclair	High School Air Camp	29-Jun-22	Dayton, OH	50	6
Sinclair	Elementary Air Camp	11-Jul-22	Dayton, OH	17	6
Sinclair	Elementary Air Camp	12-Jul-22	Dayton, OH	16	6
UAF	Delta Junction Summer School "Delta RC Flyers"	Jul 12 2022	Delta Junction, Alaska	6	2
Sinclair	Middle School Air Camp	13-Jul-22	Dayton, OH	48	6
UAF	Summer Crime and Law Camp	Jul 13 2022	Fairbanks, Alaska	25	1
UAF	Summer Sessions "Explore Alaska Design Studio"	July 13 2022	Fairbanks, Alaska	45	15
UAH	Space Camp for Educators AUSOME Demos	15-Jul-22	Huntsville, AL		40
UAF	Drone Camp	Jul 18-22 2022	Fairbanks, Alaska	20	0
Sinclair	Teacher Air Camp UAS STEM outreach	19-Jul-22	Dayton, OH	40	6
Sinclair	Wright Brothers Institute UAS STEM outreach	19-21 July 22	Dayton, OH	8	N/A
Sinclair	Middle School Air Camp UAS STEM outreach	20-Jul-22	Dayton, OH	49	N/A
UAH	Space Camp for Educators AUSOME Demos	22-Jul-22	Huntsville, AL		40
Sinclair	Dayton Early College Academy UAS STEM outreach Camp	26-28 July 22	Dayton, OH	14	N/A
UAF	Ben Eielson JHS "STEMKAMP"	Jul 29 2022	Eielson AFB, Salcha Alaska	80	30
UAF	UAF Day at the Fair	August 2 2022	Fairbanks, Alaska	50	0
Sinclair	WACO Aviation Learning Center UAS STEM outreach Camp	2-4 August 22	Troy, OH	16	N/A
UAF	Hermon Hutches, Communtiy Center, Valdez PD.	Aug 29-31 2022	Valdez, Alaska	115	30
UAF	Pearl Creek Elemantry	Sep 8 2022	Fairbanks, Alaska	120	10
			Total	11622	897

Planned - All events will be reassessed based on COVID-19 impacts - Dates below subject to change					
School	Accomplishment	Date Planned	Location	Estimated Number of Students	Estimated Number of Educators
OSU	Undergraduate student Keaton Nichols, supervised by Prof. Kiran D'Souza is conducting research on UAS ingestion into engines and will develop a design challenge to be delivered to Metro middle school students in the fall based on his research experience.	Oct/Nov 2022	Columbus, Ohio	30	5
OSU	Undergraduate Evan Kaullen, supervised by Dr. Matt McCrink, will conduct research related to design and flight-testing of UAS and will develop a design challenge to be delivered to Metro middle school students in the fall based on his research experience	Oct/Nov 2022	Columbus, Ohio	30	5
OSU	Design challenges directions, videos, and handouts developed by Keaton Nichols and Evan Kaullen will be posted to: https://u.osu.edu/tek8/2022-design-challenges/ and FAA KSN site for future use for informal STEM education	Feb/Mar 2023	Webhosted	N/A	N/A
				Total	60
					10