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ARMY EDUCATIONAL OUTREACH PROGRAM

Apprenticeship Programs

2018 Annual Program Evaluation Report Findings

August 2019

ARMY EDUCATIONAL OUTREACH PROGRAM

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1 | AEOP Consortium Contacts

U.S. Army Contacts

Matthew Willis, Ph.D.
Director, Laboratory Management
Office of the Deputy Assistant Secretary of the Army for Research and Technology
matthew.p.willis.civ@mail.mil

Andrea Simmons
Army Educational Outreach Program (AEOP) Director
Office of the Deputy Assistant Secretary of the Army for Research and Technology
andrea.e.simmons.ctr@mail.mil

AEOP Cooperative Agreement Manager

Christina Weber
AEOP Cooperative Agreement Manager
U.S. Army Combat Capabilities Development Command (CCDC)
christina.l.weber.civ@mail.mil

Battelle Memorial Institute – Lead Organization

David Burns
Project Director, AEOP CA
Director of STEM Innovation Networks
burnsd@battelle.org

Apprenticeship Program Lead

Pamela Hampton
Apprenticeships Lead
Academy of Applied Science
phampton@aas-world.org

Evaluation Team Contacts – NC State University

Carla C. Johnson, Ed.D.
Evaluation Director, AEOP CA
carlacjohnson@ncsu.edu

Toni A. Sondergeld, Ph.D.
Assistant Director, AEOP CA
tonisondergeld@metriks.com

Janet B. Walton, Ph.D.
Assistant Director, AEOP CA
jwalton2@ncsu.edu

Report APPRENTICESHIP 03_083019 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by NC State University College of Education on behalf of Battelle Memorial Institute (Lead Organization) under award W911 SR-15-2-0001.

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3 | Introduction

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K-college programs and expose participants to Department of Defense (DoD) STEM careers. The consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), supports the AEOP in this mission by engaging non-profit, industry, and academic partners with aligned interests, as well as a management structure that collectively markets the portfolio among members, leverages available resources, and provides expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM goals and objectives.

AEOP Priorities

Goal 1: STEM Literate Citizenry. Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators. Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure. Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

This report documents the evaluation study of the AEOP apprenticeship programs, which include: College Qualified Leaders (CQL); Science and Engineering Apprenticeship Program (SEAP); Research and Engineering Apprenticeship Program (REAP); High School Apprenticeship Program (HSAP); and Undergraduate Research Apprenticeship Program (URAP). In FY18 the apprenticeship programs were managed by the Academy of Applied Science (AAS). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

Army Laboratory-Based Programs

College Qualified Leaders (CQL)

The CQL program, managed by the Academy of Applied Science (AAS), is a program that matches talented college students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es). The use of the term "mentor" throughout this report will refer to the Army S&E working directly with student apprentices. This direct apprentice-mentor relationship provides apprentice training that is unparalleled at most colleges. CQL allows alumni of Gains in the Education of Mathematics and Science

(GEMS) and/or Science and Engineering Apprentice Program (SEAP) to continue their relationships with mentors and/or laboratories, and also allows new college students to enter the program. CQL offers apprentices the opportunity for summer, partial year, or year-round research at Army laboratories, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army research laboratories. CQL fosters desire in its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

In 2018, CQL was guided by the following objectives:

1. To nurture interest and provide STEM research experience for college students and recent graduates contemplating further studies;
2. To provide opportunities for continued association with the DoD laboratories and STEM enrichment for previous SEAP, GEMS, and other AEOP participants as well as allow new college students the opportunity to engage with DoD laboratories;
3. To outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM;
4. To increase participant knowledge in targeted STEM areas and develop their research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research;
5. To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories;
6. To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community; and
7. To provide information to participants about opportunities for STEM enrichment and ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.

Fifteen Army labs accepted applications for CQL apprentices in 2018 (Table 1). Apprentices were hosted at 13 of these sites, an increase over the 12 participating host sites in 2017. A total of 574 students applied for CQL apprenticeships compared to 575 in 2017. Of these applicants, 214 (37%) were placed in apprenticeships, a slight decrease from 2017 when 229 students (39%) were placed.

Table 1. 2018 CQL Site Applicant and Enrollment Numbers

2018 CQL Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Aberdeen Proving Ground, MD	101	48	48%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Adelphi, MD	61	28	46%
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	120	43	36%

U.S. Army Medical Research Institute for Infectious Diseases (USAMRIID) – Ft. Detrick, MD	73	12	16%
U.S. Army Combat Capabilities Development Command (CCDC) - Aviation & Missile Center – Redstone Arsenal, AL	51	15	29%
U.S. Army Combat Capabilities Development Command (CCDC) - Chemical Biological Center – Aberdeen Proving Ground/Edgewood, MD	41	14	34%
U.S. Army Combat Capabilities Development Command (CCDC) - Chemical Biological Center – Rock Island, IL	11	4	36%
U.S. Army Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL) – Champaign, IL	10	6	60%
U.S. Army Center for Environmental Health Research (USACEHR) – Fort Detrick, MD	27	12	44%
Defense Forensic Science Center (DFSC) – Forest Park, GA	33	16	48%
U.S. Army Engineer Research & Development Center (ERDC-MS) – Vicksburg, MS	32	13	41%
U.S. Army Engineer Research & Development Center (ERDC-GRL) – Alexandria, VA	11	2	18%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Orlando, FL	1	0	0%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Austin, TX	1	1	100%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Play Vista, CA	1	0	0%
Total	**574**	**214**	**37%**

Table 2 provides demographic profiles for enrolled CQL apprentices. Slightly less than half (45%) of participants were female, a decrease as compared to 2017 when 54% of CQL apprentices were female. As in 2017, close to two-thirds of CQL apprentices identified themselves as White (64% in 2018; 67% in 2017) while the participation of Asian students remained constant at 2017 levels (14% in both 2017 and 2018). The proportion of CQL participants identifying themselves as Black or African American increased somewhat as compared to 2017 (13% in 2018; 7% in 2017) while participation by students identifying as Hispanic or Latino remained relatively constant (6% in 2018; 5% in 2017). One fifth of 2018 CQL apprentices (20%) met the AEOP definition of students underserved or underrepresented (U2) in STEM.[1]

[1] AEOP's definition of underserved (U2) includes **at least two** of the following: Underserved populations include low-income students (FARMS); students belonging to race and ethnic minorities that are historically underrepresented in STEM (HUR) (i.e., Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders); students with disabilities (ADA); students with English as a second language (ELLs); first-generation college students (1stGEN); students in rural, frontier, or other Federal targeted outreach schools (GEO); and females in certain STEM fields (Gender) (e.g., physical science, computer science, mathematics, or engineering).

Table 2. 2018 CQL Student Participant Profile		
Demographic Category		
Respondent Gender (n=214)		
Female	97	45%
Male	117	55%
Respondent Race/Ethnicity (n=214)		
Asian	30	14%
Black or African American	28	13%
Hispanic or Latino	12	6%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	1	<1%%
White	136	64%
Other race or ethnicity	5	2%
Choose not to report	2	1%
Grade Level (n=214)		
12th grade	7	3%
College freshman	42	20%
College sophomore	50	23%
College junior	62	29%
College senior	53	25%
English is First Language (n=214)		
Yes	207	97%
No	7	3%
One parent/guardian graduated from college (n=214)		
Yes	177	83%
No	35	16%
Choose not to report	2	1%
U2 Classification (n=214)		
Yes	43	20%
No	171	80%

Cost data for 2018 CQL activities are provided in Table 3. The total cost for CQL for FY18 was $1,747,201 with a per student cost of $8,203.

Table 3. 2018 CQL Program Costs	
2018 CQL - Cost Per Participant	
Participant Stipends	$1,596,992
AAS Administrative Costs	$104,317
Overhead	$58,136
AAS Indirect Cost Share	($12,244)
Total Program Cost	**$1,747,201**
Number of Participants	214
Average Cost Per Participant	**$8,164**

Science and Engineering Apprenticeship Program (SEAP)

SEAP is an AEOP pre-collegiate program for talented high school students that matches these students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es) for an eight-week summer apprenticeship at an Army research facility. The use of the term "mentor" throughout this report will therefore refer to the Army S&E. This direct apprentice-mentor relationship provides apprentices with training that is unparalleled at most high schools. SEAP apprentices receive firsthand research experience and exposure to Army research laboratories. The intent of the program is that apprentices will return in future summers and continue their association with their original laboratories and mentors and, upon graduation from high school, participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue that relationship. Through their SEAP experiences, apprentices are exposed to the real world of research, experience valuable mentorship, and learn about education and career opportunities in STEM. SEAP apprentices also learn how their research can benefit the Army as well as the civilian community.

In 2018, SEAP was guided by the following objectives:

1. Acquaint qualified high school students with the activities of DoD laboratories through summer research and engineering experiences;
2. Provide students with opportunities in and exposure to scientific and engineering practices and personnel not available in their school environment;
3. Expose students to DoD research and engineering activities and goals in a way that encourages a positive image and supportive attitude toward our defense community;
4. Establish a pool of students preparing for careers in science and engineering with a view toward potential government service;
5. Prepare these students to serve as positive role models for their peers thereby encouraging other high school students to take more science and math courses; and
6. Involve a larger percentage of students from previously underrepresented segments of our population, such as women, African Americans, and Hispanics, in pursuing science and engineering careers.

Thirteen Army labs accepted applications for SEAP apprentices in 2018 and apprentices were hosted at 11 of these sites. A total of 872 applications were received in 2018, a slight increase (2%) over the 852 applications in 2017. Of these applicants, 114 (13%) were placed in apprenticeships, similar to the 113 (13%) placed in 2017. Table 4 summarizes applicants and final enrollment by site.

Table 4. 2018 SEAP Site Applicant and Enrollment Numbers

2018 SEAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
U.S. Army Combat Capabilities Development Command (CCDC) - Aviation & Missile Center – Redstone Arsenal, AL	10	3	30%
U.S. Army Engineer Research & Development Center – Construction Engineering Research Laboratory (ERDC-CERL) - Champaign, IL	33	12	36%
U.S. Army Combat Capabilities Development Command (CCDC) – Chemical Biological Center – Rock Island, IL	33	4	12%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory - Aberdeen Proving Ground, MD	60	12	20%
U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) – Aberdeen Proving Ground/Edgewood, MD	47	13	28%
U.S. Army Combat Capabilities Development Command (CCDC) – Chemical Biological Center – Aberdeen Proving Ground, MD	35	6	17%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Adelphi, MD	116	22	19%
U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) – Fort Detrick, MD	128	17	13%
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	280	21	8%
U.S. Army Engineer Research & Development Center (ERDC) – Vicksburg, MS	43	4	9%
U.S. Army Engineer Research & Development Center – Geospatial Research Laboratory (ERDC-GRL) – Alexandria, VA	70	0	0%
U.S. Army Combat Capabilities Development Command (CCDC) – Soldier Center- Orlando, FL	7	0	0%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory - Playa Vista, CA	10	0	0%
TOTAL	**872**	**114**	**13%**

†Applicants could apply for up to three locations

Table 5 displays demographic data for enrolled SEAP apprentices. Almost half (48%) of participants were female (compared to 54% in 2017), and the most frequently represented races/ethnicities were White (47%) and Asian (27%). Slightly more students identified as White than in 2017 (42%) and slightly fewer as Asian (32% in 2017). Fewer students identified themselves as Black or African American in 2018 (12%)

than in 2017 (17%) while a similar proportion of students identified themselves as Hispanic or Latino in 2018 (4%) as in 2017 (3%). Most students (71%) attended suburban schools and over half (57%) were in the 11th grade. Slightly over a quarter of apprentices (27%) met the AEOP definition of U2.

Table 5. 2018 SEAP Student Participant Profile		
Demographic Category		
Respondent Gender (n =114)		
Female	60	48%
Male	65	52%
Respondent Race/Ethnicity (n =114)		
Asian	31	27%
Black or African American	14	12%
Hispanic or Latino	4	4%
Native American or Alaska Native	1	<1%
Native Hawaiian or Other Pacific Islander	0	0%
White	54	47%
Other race or ethnicity	5	4%
Choose not to report	5	4%
School Location (n=114)		
Urban (city)	15	13%
Suburban	82	71%
Rural (country)	15	13%
Frontier or tribal School	1	<1%
DoDDS/DoDEA School	0	0%
Home school	1	<1%
Online school	0	0%
Grade Level (n=114)		
9th grade	4	4%
10th grade	21	18%
11th grade	65	57%
12th grade	24	21%
Free or Reduced Price Lunch Recipient (n =114)		
Yes	10	9%
No	98	86%
Choose not to report	6	5%
English is First Language (n =114)		
Yes	108	95%
No	6	5%
One parent/guardian graduated from college (n =114)		
Yes	112	98%
No	2	2%
U2 Classification (n =114)		
Yes	31	27%
No	83	73%

Cost data for 2018 SEAP activities are provided in Table 6. The total cost for SEAP for FY18 was $437,550, with a per student cost of $3,838.

Table 6. 2018 SEAP Program Costs	
2018 SEAP - Cost Per Participant	
Participant Stipends	$354,100
AAS Administrative Costs	$57,954
Overhead	$32,298
AAS Indirect Cost Share	($6,802)
Total Program Cost	**$437,550**
Number of Participants	114
Average Cost Per Participant	**$3,838**

Program Overview

University-Based Programs

Research and Engineering Apprenticeship Program (REAP)

REAP is a paid summer internship program that focuses on developing STEM competencies among high school students from groups underserved in STEM. For more than 30 years, REAP has placed talented high school students in research apprenticeships at colleges and universities throughout the nation. Each REAP student (herein referred to as apprentice) works a minimum of 200 hours (over a 5 to 8-week period) under the direct supervision of a university scientist or engineer on a hands-on research project. REAP apprentices are exposed to the real world of research, experience valuable mentorship, and learn about education and career opportunities in STEM through a challenging STEM experience that is not readily available in high schools.

REAP is guided by the following objectives:

1. Provide high school students from groups historically underrepresented and underserved in STEM, including alumni of AEOP's Unite program, with an authentic science and engineering research experience;
2. Introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP;
3. Provide participants with mentorship from a scientist or engineer for professional and academic development purposes; and,
4. Develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.

In 2018, 949 students applied for the REAP program, a 25% increase over the 709 applicants in 2017. Of those applicants, 138 students were placed in apprenticeships, a 14% increase over the 118 apprentices placed in 2017. A total of 53 colleges and universities participated in REAP in 2018, a 23% increase over the 41 participating institutions in 2017. Of these institutions, 31 (57%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 25 (60%) in 2017. Table7 displays the number of applicants and enrollment at each site in 2018.

Table 7. 2018 REAP Site Applicant and Enrollment Numbers

2018 REAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Alabama State University	23	6	26%
Ball State University	2	1	50%
Caldwell University	9	2	22%
California State University	42	4	10%
City University of New York	12	1	8%
College of Saint Benedict & Saint John's University	10	1	10%
Colorado State University	6	2	33%
Delaware State University	9	2	22%
Fayetteville State University	24	2	8%
Florida A&M University	24	4	17%
Georgia State University Research Foundation	17	2	12%
Iowa State University	2	2	100%
Jackson State University	36	7	19%
Johns Hopkins University	85	4	5%
Loyola University	25	3	12%
Marshall University	5	3	60%
Marshall University School of Pharmacy	2	2	100%
Morgan State University	11	1	9%
New Jersey Institute of Technology	48	4	8%
New Jersey Institute of Technology	42	3	7%
New Mexico State University	6	2	33%
Oakland University	18	4	22%
Purdue University	10	4	40%
Rutgers University	20	2	10%
San Jose State University	22	2	9%
Savannah State University	5	2	40%
South Dakota School of Mines & Technology	10	2	20%
Stevenson University	45	1	2%
Stockton University	13	1	8%
Texas Southern University	45	6	13%
Texas Tech University	8	1	13%

University of Las Vegas, Nevada	3	1	33%
University of Alabama at Huntsville	36	10	28%
University of Alabama at Tuscaloosa	6	2	33%
University of Arkansas at Pine Bluff	5	3	60%
University of California - Berkeley	22	2	9%
University of Central Florida	20	1	5%
University of Houston	36	3	8%
University of Houston - Victoria	5	1	20%
University of Illinois at Urbana-Champaign	9	3	33%
University of Maryland - Baltimore	68	2	3%
University of Massachusetts - Lowell	13	2	15%
University of Missouri	4	1	25%
University of New Hampshire	2	1	50%
University of New Mexico	8	4	50%
University of North Carolina - Charlotte	11	3	27%
University of Northern Iowa	6	3	50%
University of Pennsylvania	24	2	8%
University of Puerto Rico	12	3	25%
University of Texas - El Paso	6	3	50%
University of Texas - Arlington	4	2	50%
West Texas A&M	5	2	40%
Yale University	8	1	13%
Total	**949**	**138**	**15%**

**Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)*

Table 8 displays demographics for enrolled REAP apprentices. As in 2017, over half (62% in 2018; 61% in 2017) of participants were female. The proportions of apprentices identifying themselves as Black or African American (40%) and Hispanic or Latino (22%) increased substantially compared to 2017 enrollment when 29% of students identified as Black or African American and 15% as Hispanic or Latino. The proportion of students identifying themselves as Asian (20%) or White (8%) decreased compared to 2017 when 27% identified as Asian and 19% as White. Most students attended urban (39%) or suburban (43%) schools. A large majority of apprentices (96%) qualified for U2 status under the AEOP definition.

Table 8. 2018 REAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=138)		
Female	85	62%
Male	53	38%
Respondent Race/Ethnicity (n=138)		
Asian	27	20%
Black or African American	55	40%
Hispanic or Latino	31	22%
Native American or Alaska Native	3	2%
Native Hawaiian or Other Pacific Islander	5	4%
White	11	8%
Other race or ethnicity	6	4%
School Location (n=138)		
Urban (city)	54	39%
Suburban	60	43%
Rural (country)	21	15%
Frontier or tribal School	1	1%
DoDDS/DoDEA School	0	0%
Home school	2	1%
Online school	0	0%
Grade Level (n=138)		
9th grade	15	11%
10th grade	39	28%
11th grade	60	43%
12th grade	22	16%
College sophomore	1	<1%
College junior	1	<1%
Free or Reduced Price Lunch Recipient (n=138)		
Yes	76	55%
No	57	41%
Choose not to report	5	4%
English is First Language (n=138)		
Yes	101	73%
No	37	27%
One parent/guardian graduated from college (n=138)		
Yes	86	62%
No	49	36%
Choose not to report	3	2%
U2 Classification (n=138)		
Yes	133	96%
No	5	4%

Cost data for 2018 REAP activities are provided in Table 9. The total cost for REAP for FY18 was $398,640 with a per student cost of $2,889.

Table 9. 2018 REAP Program Costs	
2018 REAP - Cost Per Participant	
Participant Stipends	$298,500
AAS Administrative Costs	$69,545
Overhead	$38,757
AAS Indirect Cost Share	($8,162)
Total Program Cost	**$398,640**
Number of Participants	138
Average Cost Per Participant	**$2,889**

High School Apprenticeship Program (HSAP)

HSAP, managed by the Academy of Applied Science (AAS) and the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for high school students who demonstrate an interest in STEM. Students work as apprentices in Army-funded university or college research laboratories. HSAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced scientists and engineers (S&Es, herein called mentors) during the summer.

Apprentices receive an educational stipend equivalent to $10 per hour, and are allowed to work up to 300 hours total. The apprentices contribute to the laboratory's research while learning research skills and techniques. This hands-on experience gives apprentices a broader view of their fields of interest and shows them what kind of work awaits them in their future careers. At the end of the program, the apprentices prepare abstracts for submission to the ARO's Youth Science Programs office.

In 2018, HSAP was guided by the following priorities:

1. Provide hands-on science and engineering research experience to high school students;
2. Educate students about the Army's interest and investment in science and engineering research and the associated educational opportunities available to students through the AEOP;
3. Provide students with experience in developing and presenting scientific research;
4. Provide students with the benefit of exposure to the expertise of a scientist or engineer as a mentor; and
5. Develop students' skills and background to prepare them for competitive entry to science and engineering undergraduate programs.

In 2018, 559 students applied for the HSAP program, a decrease of 13% as compared to the 629 applicants in 2017. Of these applicants, 48 were placed in apprenticeships, a 13% decrease in enrollment compared to 2017 when 54 apprentices were served. A total of 37 colleges and universities accepted applications from prospective HSAP apprentices; 33 of these placed apprentices, a 9% decrease as compared to 2017 when 36 colleges and universities hosted HSAP apprentices. Thirteen of the 33 host institutions (39%) were HBCU/MSIs, a slight decrease from 2017 when 19 (53%) of the sites were HBCUs/MSIs. Table 10 displays the number of applicants and enrollment at each site in 2018.

Table 10. 2018 HSAP Site Applicant and Enrollment Numbers

2018 HSAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Adams State University*	12	2	17%
Arizona State University*	13	1	8%
Augusta University	4	0	0%
City University of New York*	11	2	18%
Clemson University	6	1	17%
Colorado State	1	0	0%
Columbia University	30	2	7%
Duke University	4	1	25%
Florida International University*	11	4	36%
Louisiana State University*	11	1	9%
NC A&T*	3	2	67%
New York University	44	1	2%
North Carolina State University	17	1	6%
Northwestern University	6	1	17%
Ohio State University	5	1	20%
Purdue University	2	1	50%
Rutgers – Camden Campus*	16	1	6%
Savannah State University*	27	4	15%
Texas State University*	20	1	5%
Tufts University	25	1	4%
University of Alabama	11	1	9%
University of California - Santa Barbara	18	1	6%
University of Central Florida	12	2	17%
University of Chicago	3	0	0%
University of Houston, Victoria*	2	1	50%
University of Illinois	8	2	25%
University of Maryland - College Park*	142	1	1%
University of Massachusetts	20	3	15%
University of North Carolina - Charlotte*	18	1	6%
University of Notre Dame	6	2	33%
University of Rochester	1	1	100%
University of South Florida	5	1	20%

University of Texas - Arlington*	14	1	7%
University of Virgin Island	9	1	11%
Virginia Polytechnic Institute	7	0	0%
Washington State University	3	1	33%
Yale University	12	1	8%
Total	**559**	**48**	**9%**

**Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)*

Table 11 contains an overview of demographic information for enrolled HSAP apprentices. As in 2017, over half of apprentices were female (60% in both 2017 and 2018). HSAP served students from a variety of races and ethnicities. As in 2017, the most commonly reported races/ethnicities were White and Asian, although fewer apprentices identified as White (31% in 2018; 42% in 2017) and more apprentices identified themselves as Asian (33% in 2018; 25% in 2017). As in 2017, 15% of apprentices identified themselves as Black or African American. The percentage of apprentices identifying as Hispanic or Latino was also similar to 2017 enrollment data (15% in 2018; 14% in 2017). A majority of students came from suburban schools (60% in 2018; 48% in 2017) or urban schools (35% in 2018; 43% in 2017) and a large majority of HSAP apprentices (85%) were in the 11th grade. Slightly more than half of apprentices (54%) qualified for U2 status under the AEOP definition.

Table 11. 2018 HSAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=48)		
Female	29	60%
Male	19	40%
Respondent Race/Ethnicity (n=48)		
Asian	16	33%
Black or African American	7	15%
Hispanic or Latino	7	15%
Native American or Alaska Native	1	2%
Native Hawaiian or Other Pacific Islander	0	0%
White	15	31%
Other race or ethnicity	1	2%
Choose not to report	1	2%
School Location (n=48)		
Urban (city)	17	35%
Suburban	29	60%
Rural (country)	2	4%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Grade Level (n=48)		
9th grade	0	0%
10th grade	6	13%
11th grade	41	85%
12th grade	1	2%
Free or Reduced Price Lunch Recipient (n=48)		
Yes	8	17%
No	39	81%
Choose not to report	1	2%
English is First Language (n=48)		
Yes	41	85%
No	5	10%
Choose not to report	2	4%
One parent/guardian graduated from college (n=48)		
Yes	43	90%
No	4	8%
Choose not to report	1	2%
U2 Classification (n=48)		
Yes	26	54%
No	22	46%

Cost data for 2018 HSAP activities are provided in Table 12. The total cost for HSAP for FY18 was $202,436 with a per student cost of $3,021.

Table 12. 2018 HSAP Program Costs	
2018 HSAP - Cost Per Participant	
Participant Stipends	$143,800
University Overhead Through ARO	$25,256
AAS Administrative Costs	$23,182
Overhead	$12,919
AAS Indirect Cost Share	($2,721)
Total Program Cost	**$202,436**
Number of Participants	48
Average Cost Per Participant	**$4,217**

University Research Apprenticeship Program (URAP)

The Undergraduate Research Apprentice Program (URAP), managed by the U.S. Army Research Office (ARO) and the Academy of Applied Science (AAS), is an AEOP commuter program for undergraduate students who demonstrate an interest in science, technology, engineering, or mathematics (STEM) to gain research experience as an apprentice in an Army-funded university or college research laboratory. URAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced Army-funded scientists and engineers (S&Es, herein called mentors) full-time during the summer or part-time during the school year.

Apprentices receive an educational stipend equivalent to $15 per hour, and are allowed to work up to 300 hours total. The apprentices contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives apprentices a broader view of their fields of interest and shows apprentices what kinds of work awaits them in their future careers. At the end of the program, the apprentices prepare final reports for submission to the U.S. Army Research Office's Youth Science Programs office.

In 2018, URAP was guided by the following priorities:

1. Provide hands-on science and engineering research experience to undergraduates in science or engineering majors;
2. Educate apprentices about the Army's interest and investment in science and engineering research and the associated educational and career opportunities available to apprentices through the Army and the Department of Defense;
3. Provide students with experience in developing and presenting scientific research;

4. Provide apprentices with experience to develop an independent research program in preparation for research fellowships;
5. Develop apprentices' research skills with the intent of preparing them for graduate school and careers in science and engineering research; and,
6. Provide opportunities for apprentices to benefit from the expertise of a scientist or engineer as a mentor.

In 2018, 321 students applied for URAP apprenticeships, a 26% increase in applicants as compared to the 239 students who applied in 2017. Of these applicants, 67 were placed in apprenticeships, a 12% increase in number of students placed compared to 2017 when 59 apprentices were placed. It is noteworthy that although the number of students placed increased, the percentage of applicants placed decreased from 25% in 2017 to 21% in 2018. A total of 48 colleges and universities hosted URAP apprentices in 2018 (6 received applications but hosted no apprentices), a 19% increase over the 39 participating institutions in 2017. Of these institutions, 22 (46%) were HBCUs/MIs, compared to 17 (44%) in 2017. Table 13 displays the number of applicants and enrollment at each site in 2018.

Table 13. 2018 URAP Site Applicant and Enrollment Numbers

2018 URAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Arizona State University*	20	2	10%
Auburn University	1	1	100%
Augusta University	5	2	40%
California Institute of Technology	3	1	33%
City University of New York*	5	2	40%
Clarkson	2	0	0%
Clemson University	2	2	100%
Colorado State	1	0	0%
Columbia University	3	0	0%
Duke University	8	1	13%
Florida International University*	44	5	11%
Georgia State University	8	2	25%
Johns Hopkins University	7	2	22%
Louisiana State University*	3	1	33%
McGill University	1	1	100%
Morgan State University	1	0	0%
New York University	6	2	33%
North Carolina State University	1	1	100%
Northwestern University	2	1	50%
Ohio State University	19	1	5%
Purdue University	7	1	14%
Rutgers, State University - New Jersey*	5	2	40%
Rutgers, State University – Camden*	3	1	33%

Savannah State University	1	1	100%
St. John's University, NY	2	1	50%
Texas State University*	9	2	22%
Tufts University	6	1	17%
University of Alabama	4	2	50%
University of California - Davis	11	1	9%
University of California - Riverside	5	1	20%
University of California - Santa Barbara	6	0	0%
University of Chicago	1	1	100%
University of Delaware*	5	3	60%
University of Houston	6	1	17%
University of Houston - Downtown	8	1	13%
University of Illinois	10	2	20%
University of Maryland - College Park*	16	1	6%
University of Massachusetts - Amherst	9	3	33%
University of Memphis	5	1	20%
University of Minnesota	3	1	33%
University of North Carolina - Charlotte*	1	1	100%
University of Notre Dame	5	1	20%
University of Pittsburgh	9	1	11%
University of Rochester	6	2	33%
University of South Florida	5	1	20%
University of Texas - Arlington*	14	1	7%
University of Virgin Islands	2	1	50%
Vanderbilt University	1	1	100%
Virginia Polytechnic Institute	6	2	33%
Washington State University	6	1	17%
Yale University	2	1	50%
Total	**321**	**67**	**20%**

**Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)*

Table 14 contains an overview of demographic information for enrolled URAP apprentices. A smaller proportion of apprentices were female in 2018 (39%) as compared to 2017 (58%). The proportion of students identifying as White increased as compared to 2017 (64% in 2018; 53% in 2017) while the proportion of students identifying as Asian decreased as compared to 2017 (9% in 2018; 14% in 2017). The proportion of apprentices identifying as Black or African American was similar to in 2017 (9% in 2018; 8% in 2017), and the proportion of apprentices identifying as Hispanic or Latino decreased somewhat as compared to 2017 (10% in 2018; 15% in 2017). Of the enrolled apprentices, 18% met the AEOP definition of U2.

Table 14. 2018 URAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=67)		
Female	26	39%
Male	39	58%
Choose not to report	2	3%
Respondent Race/Ethnicity (n=67)		
Asian	6	9%
Black or African American	6	9%
Hispanic or Latino	7	10%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	43	64%
Other race or ethnicity	3	4%
Choose not to report	2	3%
Grade Level (n=67)		
College freshman	9	13%
College sophomore	27	40%
College junior	22	33%
College senior	8	12%
Other	1	2%
English is First Language (n=67)		
Yes	61	91%
No	4	6%
Choose not to report	2	3%
One parent/guardian graduated from college (n=67)		
Yes	56	83%
No	10	15%
Choose not to report	1	2%
U2 Classification (n=67)		
Yes	12	18%
No	55	82%

**Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)*

Cost data for 2018 URAP activities are provided in Table 15. The total cost for URAP for FY18 was $409,561 with a per student cost of $6,205.

Table 15. 2018 URAP Program Costs	
2018 URAP - Cost Per Participant	
Participant Stipends	$2,689,492
University Overhead Through ARO	$63,391
AAS Administrative Costs	$34,772
Overhead	$19,379
AAS Indirect Cost Share	($4,081)
Total Program Cost	**$409,561**
Number of Participants	67
Average Cost Per Participant	**$6,113**

Overall Apprenticeship Program Participation and Costs

Table 16 summarizes the number of applicants and participants for both army laboratory-based and university-based apprenticeship programs as well as the percentage of apprentices who met the AEOP's definition of U2. Overall, 3,275 students applied for AEOP apprenticeship programs and 581 (18%) were placed in apprenticeships. Of those placed, 42% met the AEOP definition of U2.

Table 16. 2018 Apprenticeship Participation

Type of Program	No. of Applicants	No. of Participants	Percentage of U2
Army Laboratory-Based Programs (CQL, SEAP)	1,446	328	23%
University-Based Programs (REAP, HSAP, URAP)	1,829	253	68%
Total	**3,275**	**581**	**42%**

The total cost of 2018 apprenticeship programs was $3,195,388 including $2,689,492 for participant stipends. The average cost per apprentice for 2018 apprenticeship programs overall was $5,335. Table 17 summarizes these and other 2018 apprenticeship program costs.

Table 17. 2018 Apprenticeship Program Costs	
Total Program Costs	
Total Apprenticeship Stipends	$2,689,492
AAS Administrative Costs	$289,770
Other Operational Costs	$216,126
Total Apprenticeship Program Cost	**$3,195,388**
Total Costs Per Type of Program	
Army Laboratory-Based Programs – Total Cost	**$2,184,751**
University-Based Programs – Total Cost	**$1,010,637**
Cost Per Student Participant	

Army Laboratory-Based Programs - Total Student Participants	328
Cost per participant – Army Laboratory-Based Programs	$6,661
University-Based Programs – Total Student Participants	253
Cost per participant – University-Based Programs	$3,995
Total Cost Per Participant – All Apprenticeship Programs	**$5,499**

4

4 | Evaluation At-A-Glance

Purdue University, in collaboration with AAS, conducted a comprehensive evaluation of the apprenticeship programs. The apprenticeship logic model below presents a summary of the expected outputs and outcomes for the programs in relation to the AEOP and apprenticeship specific priorities. This logic model provided guidance for the overall apprenticeship evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• ARO and AEOP co-sponsorship • ARO providing administration of programs • Operations conducted by 13 Army laboratories and by 95 Army-funded university/ college labs across the U.S. and Canada • 328 apprentices participating in Army laboratory-hosted apprenticeships • 253 apprentices participating in university/college lab-hosted apprenticeships • Apprenticeship funds administered to Army labs and university/college research labs to support apprentice participation • Centralized branding and comprehensive marketing • Centralized evaluation	• Apprentices engage in authentic STEM research experiences through hands-on summer apprenticeships • Army and university/college S&Es supervise and mentor apprentices' research • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of apprentice participants engaged in apprenticeships • Number and diversity of S&Es engaged in apprenticeships • Apprentices, mentors, and ARO contributing to evaluation	• Increased apprentice STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased apprentice interest in future STEM engagement • Increased apprentice awareness of and interest in other AEOP opportunities • Increased apprentice awareness of and interest in STEM research and careers • Increased apprentice awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve apprenticeship programs	• Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased apprentice pursuit of STEM degrees • Increased apprentice pursuit of STEM careers • Increased apprentice pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of apprenticeship programs

The apprenticeship evaluation study gathered information from apprentice and mentor participants about processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives.

Key Evaluation Questions

- What aspects of apprenticeship programs motivate participation?
- What aspects of apprenticeship program structure and processes are working well?
- What aspects of apprenticeship programs could be improved?
- Did participation in apprenticeship programs:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for apprenticeship programs included post-program apprentice and mentor questionnaires, site visits to 2 SEAP and CQL sites, 4 focus groups with SEAP and CQL apprentices, 4 focus groups with SEAP and CQL mentors, 21 phone interviews with apprentices at university-hosted apprenticeship sites and 13 phone interviews with mentors at university-hosted apprenticeship sites. In addition, an Annual Program Report (APR) prepared by AAS using data from all apprenticeship sites. Tables 18-22 outline the information collected in apprentice and mentor questionnaires, focus groups, and interviews as well as information from the APR that is relevant to this evaluation report.

Table 18. 2018 Apprentice Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, grade level, and race/ethnicity
AEOP Goal 1	**Capturing the Apprentice Experience:** In-school vs. In-program experience; mentored research experience and products
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources
	Army/DoD STEM: Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources
AEOP Goals 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies (apprentices respond to a subset)
	Comprehensive Marketing Strategy: How apprentices learn about AEOP, motivating factors for participation, impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 19. 2018 Mentor Questionnaires

Category	Description

Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
AEOP Goal 1	**Capturing the Apprentice Experience:** In-program experience
	STEM Competencies: Gains in their apprentices' Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in their apprentices' 21st Century Skills
	AEOP Opportunities: Efforts to expose apprentices to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice AEOP metrics
	Army/DoD STEM: Efforts to expose apprentices to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Motivating factors for participation, satisfaction with and suggestions for improving programs, benefits to participants

Table 20. 2018 Apprentice Focus Groups and Interviews

Category	Description
Satisfaction & Suggestions	Awareness of apprenticeship programs, motivating factors for participation, satisfaction with and suggestions for improving programs, benefits to participants
AEOP Goals 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which apprentices were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which apprentices were exposed to STEM and Army/DoD STEM jobs

Table 21. 2018 Mentor Focus Groups and Interviews

Category	Description
Satisfaction & Suggestions	Perceived value of apprenticeship programs, benefits to participants, suggestions for improving apprenticeship programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in apprenticeship programs

Table 22. 2018 Annual Program Report

Category	Description
Program	Description of program content, activities, and academic level
AEOP Goal 1 and 2 Program Efforts	**Underserved Populations:** Mechanisms for marketing to and recruitment of apprentices from underserved populations
	Army STEM: Army/DoD STEM Careers –Participation of Army engineers and/or Army research facilities in career fair activities
	Mentor Capacity: Local Educators - University faculty and apprentice involvement

The apprenticeship evaluation included examination of participant outcomes and other areas that would inform program continuous improvement. A focus of the evaluation is on efforts toward the long-term goal of AEOP apprenticeship programs and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. Thus, it is important to consider the factors that motivate students to participate in apprenticeships, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The evaluation also collected data about participant perspectives on program processes, resources, and activities for the purpose of recommending improvements as the program moves forward.

Findings are presented in alignment with the three AEOP priorities. The findings presented herein include several components related to AEOP and program objectives, including impacts on apprentices' 21st Century Skills, STEM knowledge and skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[2] The STEM competencies evaluated are necessary for a STEM-literate citizenry and include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important not only for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The apprenticeship evaluation measured students' self-reported gains in STEM competencies and engagement in opportunities intended to develop critical STEM skills.

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in the appendices. The reader is strongly encouraged to review Appendix A to clarify how data

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[2] The outcomes measured in the evaluation study were informed by the following documents:

Committee on STEM Education. (2013*). Federal Science, Technology, Engineering, and Mathematics (STEM) education 5-year strategic plan: A report from the Committee on STEM Education, National Science and Technology Council.* Washington, DC: The White House, Office of Science and Technology Policy.

National Research Council. (2009). Learning Science in Informal Environments: People, Places, and Pursuits. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* Executive Office of the President.

Report of the Academic Competitiveness Council (ACC). (2007). U.S. Department of Education. Available on the Department's Web site at: http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html.

are summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and footnotes providing results from tests for significance. Focus group and interview protocols are provided in Appendix B (apprentices) and C (mentors). Apprentice and mentor questionnaires for each program are in Appendices D-M, and the instrument used by mentors to assess students' 21st Century Skills is included in Appendix N.

Overall Apprenticeship Programs - Study Sample

Table 23 provides an analysis of apprentice and mentor participation in questionnaires, the response rate, and the margin of error at the 95% confidence level[3] (a measure of how representative the sample is of the population). The margin of error for mentors overall is somewhat larger than is generally acceptable, indicating that the sample may not be representative of the overall population, and therefore conclusions should be interpreted with caution. Note: because some mentors participated in both SEAP and CQL and some in both HSAP and URAP, this figure is not equal to the sum of the mentor participants in each of the program's files. We have accounted for duplicates with data provided from the IPA at AAS and have only counted each mentor once in the Total Participants (Population) column.

Table 23. 2018 Apprenticeship Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[4]
Apprentices	229	581	39%	±5.05%
Mentors	135	492	27%	±7.19%

Army Laboratory-Based Programs

Study Sample and Respondent Profiles

CQL

[3] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, there is a 95% likelihood that between 42% and 52% would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

Table 24 provides an analysis of apprentice and mentor participation in the CQL questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). Questionnaire response rates dropped markedly from 2017 when 47% of apprentices and 22% of mentors responded. In 2018 27% of apprentices and only 8% of mentors responded to the questionnaire. The margin of error for both the mentor and apprentice questionnaires are larger than generally considered acceptable, indicating that the samples may not be representative of their respective populations.

Table 24. 2018 CQL Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[5]
Apprentices	58	214	27.1%	±11.01%
Mentors	17	216	7.9%	±22.87%

Two apprentice focus groups and two mentor focus groups were conducted at two CQL sites. Six apprentices participated in the two apprentice focus groups. Of these apprentices, 1 was male and 5 were female. Five were first time participants and 1 had participated for two years previously. Four were college sophomores, 1 was a college senior, and 1 had recently graduated from college. Seven mentors, all Army S&Es, also participated in two focus groups. Two of these mentors were male and 5 were female. Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire data. They add to the overall narrative of CQL's efforts and impact, and highlight areas for future exploration in programming and evaluation.

CQL Apprentice Respondent Demographics

Demographic information collected from apprentice questionnaire respondents is summarized in Table 25. Slightly more males (57%) completed the survey compared to females (43%). The majority of apprentices reported being White (67%), followed by Black or African American (12%) and Asian (10%). Most apprentices (64%) were college juniors and seniors. A vast majority of apprentices reported speaking English as a first language (96%) and having a parent who had attended college (81%). Only 21% of survey respondents can be classified as underrepresented by AEOP criteria (U2). Respondent demographics are similar to the demographic distribution for the overall population of CQL apprentices, suggesting that the apprentice sample is representative of the overall population of CQL apprentices.

Table 25. 2018 CQL Apprentice Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n=58)		
Female	25	43%
Male	33	57%
Respondent Race/Ethnicity (n=58)		
Asian	6	10%
Black or African American	7	12%
Hispanic or Latino	3	5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	39	67%
Other race or ethnicity	2	4%
Choose not to report	1	2%
Respondent Grade Level (n=58)		
College freshman	6	10%
College sophomore	12	21%
College junior	17	29%
College senior	20	35%
Choose not to report	0	0%
Other	3	5%
First Generation Status (n=58)		
Yes	10	17%
No	47	81%
Choose not to report	1	2%
English as First Language (n=58)		
Yes	56	96%
No	1	2%
Choose not to report	1	2%
U2 Classification (n=58)		
Yes	12	21%
No	46	79%

CQL Mentor Respondent Demographics

Demographic data for mentors responding to the questionnaire are summarized in Table 26. Considerably more male mentors (65%) than females (35%) responded. More than three-quarters of the mentors (82%)

reported being White. A majority of mentors reported being scientists, engineers, or mathematicians in practice (41%) or in training (35%).

Table 26. 2018 CQL Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 17)		
Female	11	35%
Male	6	65%
Choose Not to Report	0	0%
Respondent Race/Ethnicity (n = 17)		
Asian	0	0%
Black or African American	1	6%
Hispanic or Latino	1	6%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	14	82%
Other race or ethnicity	1	6%
Choose not to report	0	0%
Respondent Occupation (n = 17)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	6	35%
Scientist, Engineer, or Mathematics professional	7	41%
Other	4	24%
Respondent Primary Area of Research (n = 17)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	3	17.5%
Biological science	1	6%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	0	0%
Computer science	2	12%
Technology	0	0%
Engineering	3	17.5%
Mathematics or statistics	1	6%
Medical, health, or behavioral science	3	17.5%
Social Science (psychology, sociology, anthropology)	1	6%
Other, (specify):	3	17.5%

SEAP

Table 27 shows SEAP apprentice and mentor participation in the questionnaire, the response rate, and the margin of error. The apprentice response rate (31%) decreased as compared to 2017 (54%). Likewise, the mentor response rate (13%) decreased as compared to 2017 (29%). The margin of error for both the apprentice and mentor questionnaires is larger than generally acceptable, indicating that the samples may not be representative of their respective populations.

Table 27. 2018 SEAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	35	114	31%	±13.85%
Mentors	20	150	13%	±20.47%

Two apprentice focus groups and two mentor focus groups were conducted at two SEAP sites. Thirteen apprentices participated in the two apprentice focus groups. Of these apprentices, 6 were male and 7 were female. Ten apprentices were first time participants, 2 had participated for two previous years, and 1 had participated once previously. Thirteen Army S&Es serving as mentors also participated in two focus groups. Eight of the mentors were male and 5 were female. Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire data. They add to the overall narrative of SEAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

SEAP Apprentice Respondent Demographics

Demographic information for apprentices who responded to the questionnaire is summarized in Table 28. Approximately the same proportions of females (51%) and males (49%) completed the FY18 questionnaire. While 71% of responding apprentice participants identified themselves as White and 14% as Asian, 9% of responding apprentices identified with the Black or African American racial/ethnic category and 3% as Hispanic or Latino. Most responding apprentices were 11th grade students (48%) followed by 10th (26%) and 12th (26%) grade students. Most students (77%) reported attending suburban schools, not receiving free or reduced lunch (86%), having English as a primary language (97%), and having a parent who attended college (100%). Only 29% of SEAP apprentices who responded to the questionnaire were classified as underprivileged according to AEOP U2 standards. Overall, these data are similar to demographic data for SEAP participants, with the exception that a substantially larger proportion of students identifying as White responded to the questionnaire as compared to the overall population (71% of respondents versus 47% overall).

Table 28. 2018 SEAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=35)		
Female	18	51%
Male	17	49%
Respondent Race/Ethnicity (n=35)		
Asian	5	14%
Black or African American	3	9%
Hispanic or Latino	1	3%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	25	71%
Other race or ethnicity	1	3%
Choose not to report	0	0%
Respondent Grade Level (n=35)		
10th	9	26%
11th	17	48%
12th	9	26%
Choose not to report	0	0%
Other	0	0%
School Location (n=35)		
Urban	1	3%
Suburban	27	77%
Rural	7	20%
First Generation Status (n=35)		
Yes	0	0%
No	35	100%
Choose not to report	0	0%
English as First Language (n=35)		
Yes	34	97%
No	1	3%
Choose not to report	0	0%
Free or Reduced Lunch Price Recipient (n=35)		
Yes	4	11%
No	30	86%
Choose not to report	1	3%
U2 Classification (n=35)		
Yes	10	29%
No	25	71%

SEAP Mentor Respondent Demographics

Demographic information for mentors who responded to the 2018 questionnaire is summarized in Table 29. The majority of responding mentors were scientists, engineers, or mathematics professionals (85%) and white (60%). Reported gender was equivalent between males (40%) and females (40%). Nearly all identified themselves as research mentors (95%).

Table 29. 2018 SEAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 20)		
Female	8	40%
Male	8	40%
Choose not to report	4	20%
Respondent Race/Ethnicity (n = 20)		
Asian	2	10%
Black or African American	0	0%
Hispanic or Latino	0	0%
Native American or Alaskan Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	12	60%
Other	0	0%
Choose not to report	6	30%
Respondent Occupation (n = 20)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	17	85%
Other, (specify) †	3	15%
Role in SEAP (n = 20)		
Research Mentor	19	95%
Other (Research Civil Engineer)	1	5%

†molecular biologist, librarian, Software Project Manager

University-Based Programs

Study Sample and Respondent Profiles

REAP

Table 30 provides an analysis of apprentice and mentor participation in the REAP questionnaires, the response rate, and the margin of error. There was a decrease in apprentice participation in the questionnaire in 2018 as compared to 2017 (60% in 2018; 77% in 2017). Mentor participation remained at approximately 2017 levels with 57% of mentors responding as compared to 59% of mentors in 2017.

The margin of error for both the apprentice and mentor questionnaires is larger than generally acceptable, indicating that the sample may not be representative of the overall population.

Table 30. 2018 REAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	83	138	60%	±6.82%
Mentors	67	117	57%	±7.86%

Phone interviews were conducted with 9 apprentices and 4 mentors. The interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice and mentor questionnaire data. They add to the overall narrative of REAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

REAP Apprentice Respondent Demographics

REAP apprentice respondents' demographic information is provided in Table 31. More females (65%) than males (35%) completed the questionnaire. More responding apprentices identified with the race/ethnicity of Black or African American (35%) than any other single race/ethnicity category, and over a quarter identified themselves as Hispanic/Latino (27%). Most apprentices completing the questionnaire were either high school seniors (46%) or juniors (35%). School location was diverse: suburban (48%), urban (30%), and rural (20%). Most students indicated they had a parent who went to college (65%) and spoke English as their first language (71%). Approximately half of responding apprentices reported receiving free or reduced lunch in school (47%). Overall, three-quarters (75%) of REAP apprentices were classified as underrepresented according to AEOP U2 standards. The demographics of questionnaire respondents are similar to the population of participating apprentices, suggesting that the apprentice sample is representative of the overall population of REAP apprentices.

Table 31. 2018 REAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=66)		
Female	43	65%
Male	23	35%
Respondent Race/Ethnicity (n=66)		
Asian	13	20%
Black or African American	23	35%
Hispanic or Latino	18	27%
Native American or Alaska Native	1	2%
Native Hawaiian or Other Pacific Islander	3	5%
White	5	8%
Other race or ethnicity	3	5%
Respondent Grade Level (n=83)		
High school freshman	1	1%
High school sophomore	9	11%
High school junior	29	35%
High school senior	38	46%
Other	6	7%
School Location (n=66)		
Urban	20	30%
Suburban	32	48%
Rural	13	20%
Home	1	2%
First Generation Status (n=66)		
Yes	22	65%
No	43	33%
Choose not to report	1	2%
English as First Language (n=66)		
Yes	47	71%
No	19	29%
Free or Reduced Lunch Price Recipient (n=66)		
Yes	31	47%
No	32	48%
Choose not to report	3	5%
U2 Classification (n=83)		
Yes	62	75%
No	21	25%

Note. While 83 apprentices completed the REAP survey, not all provided information for each demographic item.

REAP Mentor Respondent Demographics

Demographics for mentors who responded to the questionnaire are presented in Table 32. Fewer females (27%) responded than males (73%). Most responding mentors reported being either White (40%), Asian (29%), or Black/African American (22%). Mentors' primary areas of research interest were wide-spread with physical sciences (40%) and engineering (27%) being the most frequently reported research areas.

Table 32. 2018 REAP Mentor Respondent Profiles		
Demographic Category	**Questionnaire Respondents**	
Gender (n = 67)		
Female	18	27%
Male	49	73%
Race/Ethnicity (n = 67)		
Asian	19	29%
Black or African American	15	22%
Hispanic or Latino	2	3%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	27	40%
Choose not to report	4	6%
Other race or ethnicity	0	0%
Primary Area of Research (n = 67)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	27	40%
Biological science	3	4%
Earth, atmospheric, or oceanic science	2	3%
Environmental science	5	7%
Computer science	2	3%
Technology	1	2%
Engineering	18	27%
Mathematics or statistics	4	6%
Medical, health, or behavioral science	1	2%
Social Science (psychology, sociology, anthropology)	1	2%
Other	3	4%

HSAP

Table 33 provides an analysis of apprentice and mentor participation in the HSAP questionnaires, the response rate, and the margin of error. The percentage of both apprentice and mentor respondents declined substantially as compared to 2017. In 2018, 40% of apprentices and 8% of mentors responded to the questionnaire as compared to 57% and 60% respectively in 2017. The margin of error for both apprentices and mentors is larger than generally acceptable indicating that the samples may not be representative of their respective populations.

Table 33. 2018 HSAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	19	48	40%	±17.66%
Mentors	4	53	8%	±47.57%

Individual interviews were conducted with 6 apprentices and 5 mentors. The interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire data. They add to the overall narrative of HSAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

HSAP Apprentice Respondent Demographics

Demographic information about HSAP apprentices who completed the questionnaire is provided in Table 34. More males (59%) completed the survey than females (41%). Participant race/ethnicity was reported to be largely Asian (34%) followed by Black or African American (18%), White (18%), and Hispanic or Latino (12%). Most respondents reported being high school seniors (63%), attending a suburban school (61%), speaking English as a first language (75%), having a parent who went to college (86%), and not receiving free or reduced lunch (86%). Among HSAP students who completed the questionnaire, 43% are classified as underrepresented according to AEOP U2 standards. These respondent demographics are similar to the demographic data for all HSAP apprentices, although a somewhat larger proportion of apprentices identifying themselves as Asian responded to the questionnaire (47%) as compared to the overall population of HSAP apprentices (35%) and a somewhat smaller proportion of students identifying as White (18%) responded to the questionnaire as compared to the overall population of HSAP apprentices (31%). In addition, a smaller proportion of U2 apprentices (43%) responded as compared to the overall population (54%).

Table 34. 2018 HSAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=17)		
Female	10	41%
Male	7	59%
Respondent Race/Ethnicity (n=17)		
Asian	8	47%
Black or African American	3	18%
Hispanic or Latino	2	12%
Native American or Alaska Native	1	5%
Native Hawaiian or Other Pacific Islander	0	0%
White	3	18%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Respondent Grade Level (n=19)		
High school freshman	0	0%
High school sophomore	1	5%
High school junior	5	27%
High school senior	12	63%
Choose not to report	0	0%
Other	1	5%
School Location (n=28)*		
Urban	9	32%
Suburban	17	61%
Rural	0	0%
Choose not to report	2	7%
First Generation Status (n=28)*		
Yes	1	3%
No	24	86%
Choose not to report	3	11%
English as First Language (n=28)*		
Yes	21	75%
No	4	14%
Choose not to report	3	11%
Free or Reduced Lunch Price Recipient (n=28)*		
Yes	1	3%
No	24	86%
Choose not to report	3	11%
U2 Classification (n=28)*		
Yes	12	43%
No	16	57%

*some items (grade level, U2) were data collected at registration – therefore the number of respondents will differ from the actual evaluation survey which had an n=19. Additionally, not all participants provided information on each demographic item.

HSAP Mentor Respondent Demographics

Table 35 summarizes demographic data for HSAP mentor questionnaire respondents. It should be noted that only 4 mentors provided this information. Of those who responded, half were female and half were male. Three respondents (75%) identified themselves as White while 1 (25%) identified as Asian.

Table 35. 2018 HSAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 4)		
Female	2	50%
Male	2	50%
Respondent Race/Ethnicity (n = 4)		
Asian	1	25%
Black or African American	0	0%
Hispanic or Latino	0	0%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	3	75%
Choose not to report	0	0%
Respondent Occupation (n = 4)		
University educator	2	50%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	1	25%
Teacher	0	0%
Other	1	25%

URAP

Table 36 provides an analysis of apprentice and mentor participation in the URAP questionnaires, the response rates, and the margin of error. The response rate for both apprentices and mentors declined as compared to 2017. In 2018, 51% of apprentices and 40% of mentors responded to the questionnaire as compared to 54% of apprentices and 69% of mentors in 2017. The margin of error for both apprentices and mentors is larger than is generally acceptable, indicating that the samples may not be representative of their respective populations.

Table 36. 2018 URAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	34	67	51%	±11.88%
Mentors	27	68	40%	±18.81%

Six phone interviews were conducted with apprentices and 4 with mentors. Interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire data. They add to the overall narrative of URAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

URAP Apprentice Respondent Demographics

Demographic data collected from URAP apprentices who responded to the questionnaire are summarized in Table 37. More females (59%) than males (38%) completed the questionnaire. More responding apprentices identified with the racial/ethnic category of White (56%) than any other single race/ethnicity, followed by Hispanic or Latino (14%), Black or African American (12%), and Asian (9%). College grade level varied greatly with most students being sophomores (35%) or juniors (35%). Most apprentices reported that at least one of their parents had attended college (73%) and English was their first language (88%). Approximately one quarter (24%) or URAP apprentices who responded to the questionnaire were classified as underrepresented according to AEOP U2 standards. Demographics of responding apprentices are generally similar to those of all enrolled apprentices, although a somewhat larger percentage of females (59%) responded to the questionnaire than are represented in the overall population (39% females) and the proportion of apprentices meeting the AEOP's definition of U2 responding (24%) was somewhat larger than in the overall population (18%).

Table 37. 2018 URAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=34)		
Female	13	59%
Male	20	38%
Choose not to report	1	3%
Respondent Race/Ethnicity (n=34)		
Asian	3	9%
Black or African American	4	12%
Hispanic or Latino	5	14%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	19	56%
Other race or ethnicity	2	6%
Choose not to report	1	3%
Respondent Grade Level (n=34)		
College freshman	4	12%
College sophomore	12	35%
College junior	12	35%
College senior	5	15%
Choose not to report	1	3%
Other	0	0%
First Generation Status (n=34)		
Yes	6	18%
No	25	73%
Choose not to report	3	9%
English as First Language (n=34)		
Yes	30	88%
No	1	3%
Choose not to report	3	9%
U2 Classification (n=34)		
Yes	8	24%
No	26	76%

URAP Mentor Respondent Demographics

Table 38 summarizes URAP demographics for mentors who responded to the questionnaire. More responding mentors were male (89%) than female (11%). Responding mentors self-identified as being either White (59%) or Asian (41%). Mentors primarily identified as university educators (59%), and 81% reported that they served as research mentors.

Table 38. 2018 URAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 27)		
Female	3	11%
Male	24	89%
Respondent Race/Ethnicity (n = 27)		
Asian	11	41%
Black or African American	0	0%
Hispanic or Latino	0	0%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	16	59%
Choose not to report	0	0%
Other race or ethnicity, (specify):	0	0%
Respondent Occupation (n = 27)		
University educator	16	59%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	6	22%
Scientist, Engineer, or Mathematics professional	4	15%
Other, (specify):	1	4%
Respondent Role in URAP (n = 27)		
Research Mentor	22	81%
Research Team Member but not a Principal Investigator	5	19%
Other, (specify)	0	0%

5 | Priority #1 Findings

Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

Assessed Growth in 21st Century Skills – Overall

The FY18 evaluation included the 21st Century Skills Assessment, an objective assessment by each apprentices' mentor regarding their progress toward mastery of important 21st Century Skills (Johnson & Sondergeld, 2016). Mentors assessed each participant in a pre/post manner. The first assessment was completed in the first days of the program (pre). The second assessment was completed at the end of the program (post). The assessment was used to determine the growth toward mastery for each participant during their time in the apprenticeship program. Mentors rated each participants' skills in six domains of 21st Century Skills: The assessment tool can be found in the Appendix.

1. Creativity and Innovation
2. Critical Thinking and Problem Solving
3. Communication, Collaboration, Social, and Cross-Cultural Skills
4. Information, Media, & Technological Literacy
5. Flexibility, Adaptability, Initiative, and Self-Direction
6. Productivity, Accountability, Leadership, and Responsibility

Assessed Growth in 21st Century Skills – Level and Setting

A total of 34 apprentices across programs had pre and post observations completed by their mentors. Composite scores were calculated for each of the six 21st Century Skills and were used to test whether there were differences in apprentice skills experiences by program level (high school vs. undergraduate) and setting (army lab vs. university-based). Regardless of the group, positive growth was seen from pre to post in each skill set. While no significant differences in any skill set were found by setting, there were significant differences in both Information, Media, and Technological Literacy ($p<.05$) and Flexibility, Adaptability, Initiative, and Self-Direction ($p<.01$) by grade level. For both of these skill sets, a 2-Between, 2-Within Repeated-Measures ANOVA revealed that high school students were significantly lower than undergraduate students at both pre and post-observation. However, high school students grew more than undergraduate students over time in each area. See Table 39 for descriptive and inferential statistics.

Table 39. Overall 21st Century Skill Set Observation Pre-Post Results by Grade Level and Setting

Skill Set / *Group*	n	Observation Time: Pre-M(SD)	Observation Time: Post-M(SD)	Pre-Post Change	*F*-Stat
Creativity & Innovation					
Level					
High School	21	1.95(.31)	2.46(.40)	+0.51	0.52
Undergraduate	10	2.13(.23)	2.61(.49)	+0.48	
Setting					
Army-Based	9	2.04(.36)	2.60(.38)	+0.56	0.02
University-Based	22	2.00(.27)	2.47(.45)	+0.47	
Critical Thinking & Problem Solving					
Level					
High School	22	1.84(.48)	2.44(.38)	+0.60	1.26
Undergraduate	9	2.08(.31)	2.13(.36)	+0.05	
Setting					
Army-Based	8	1.92(.43)	2.34(.51)	+0.42	1.86
University-Based	23	1.91(.46)	2.59(.42)	+0.68	
Communication, Collaboration, Social, & Cross-Cultural					
Level					
High School	23	1.99(.34)	2.59(.39)	+0.60	1.13
Undergraduate	10	2.13(.36)	2.85(.31)	+0.72	
Setting					
Army-Based	9	1.89(.37)	2.67(.35)	+0.78	3.03
University-Based	24	2.09(.33)	2.68(.40)	+0.59	
Information, Media, & Technological Literacy					
Level					
High School	20	2.01(.38)	2.57(.38)	+0.56	7.48*
Undergraduate	8	2.49(.36)	2.76(.34)	+0.27	
Setting					
Army-Based	8	2.24(.65)	2.56(.40)	+0.32	0.00
University-Based	20	2.12(.32)	2.66(.37)	+0.54	
Flexibility, Adaptability, Initiative, & Self-Direction					
Level					
High School	23	1.98(.43)	2.51(.43)	+0.53	8.80**
Undergraduate	10	2.35(.27)	2.87(.31)	+0.52	
Setting					
Army-Based	9	2.06(.54)	2.68(.36)	+0.62	0.02
University-Based	24	2.10(.37)	2.61(.46)	+0.51	
Productivity, Accountability, Leadership, & Responsibility					
Level					
High School	20	2.05(.44)	2.36(.32)	+0.31	1.54
Undergraduate	10	2.03(.11)	2.68(.37)	+0.65	
Setting					
Army-Based	8	1.81(.37)	2.48(.28)	+0.67	2.33
University-Based	22	2.13(.33)	2.45(.41)	+0.32	

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

ARMY EDUCATIONAL OUTREACH PROGRAM

CQL

Only 3 apprentices were assessed for the skills related to each of the domains areas at pre and post. Table 40 presents an overall summary of mentors' observation assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 1. Caution must be used when interpreting results of these tests or trying to extrapolate findings to the broader population of CQL apprentices since the sample size is so low.

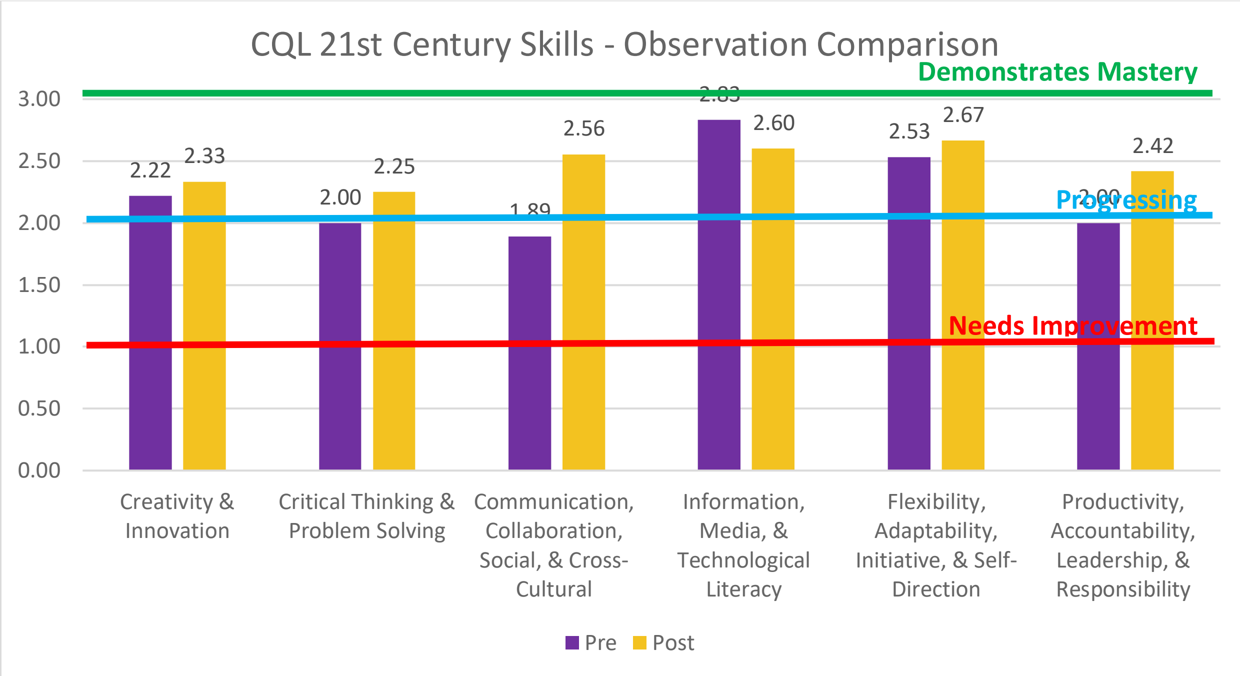
In all areas except Information, Media, & Technological Literacy the 3 students assessed showed positive growth (see Table 40). Apprentices demonstrated the most growth (statistically significant, $p<.05$) in the skill set of Communication, Collaboration, Social, & Cross-Cultural. Chart 1 shows that on average, mentors initially rated apprentices' skills in Creativity, Critical Thinking, Communication, and Productivity at approximately the Progressing level, and final observations resulted in skill ratings between the Progressing and Demonstrates Mastery level. At pre-observation, apprentices were rated higher in both Information and Flexibility subscales (average approaching Mastery level).

Table 40. Overall 21st Century Skill Set Assessment Pre-Post Results

Skill Set	*n*	Assessment Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	3	2.22(0.38)	2.33(0.57)	+0.11	1.00
Critical Thinking & Problem Solving	3	2.00(0)	2.25(0.86)	+0.25	0.50
Communication, Collaboration, Social, & Cross-Cultural	3	1.88(0.19)	2.55(0.50)	+0.67	3.46*
Information, Media, & Technological Literacy	3	2.83(0.28)	2.60(0.52)	-0.23	1.61
Flexibility, Adaptability, Initiative, & Self-Direction	3	2.53(0.17)	2.66(0.57)	+0.13	0.33
Productivity, Accountability, Leadership, & Responsibility	3	2.00(0.00)	2.41(0.38)	+0.42	1.89

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with $*p<.05$, $**p<.01$, $***p<.001$

Chart 1. CQL 21st Century Skill Set Assessment Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Assessed

Paired samples t-tests at the item level could not be conducted for CQL since there were only 3 students. Some apprentices had no observation for an item or all participants had the same rating leaving no variance in a measure.

SEAP

Between 5 and 6 apprentices were assessed for the skills related to each of the domains areas at pre and post. Table 41 presents an overall summary of mentors' assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 2.

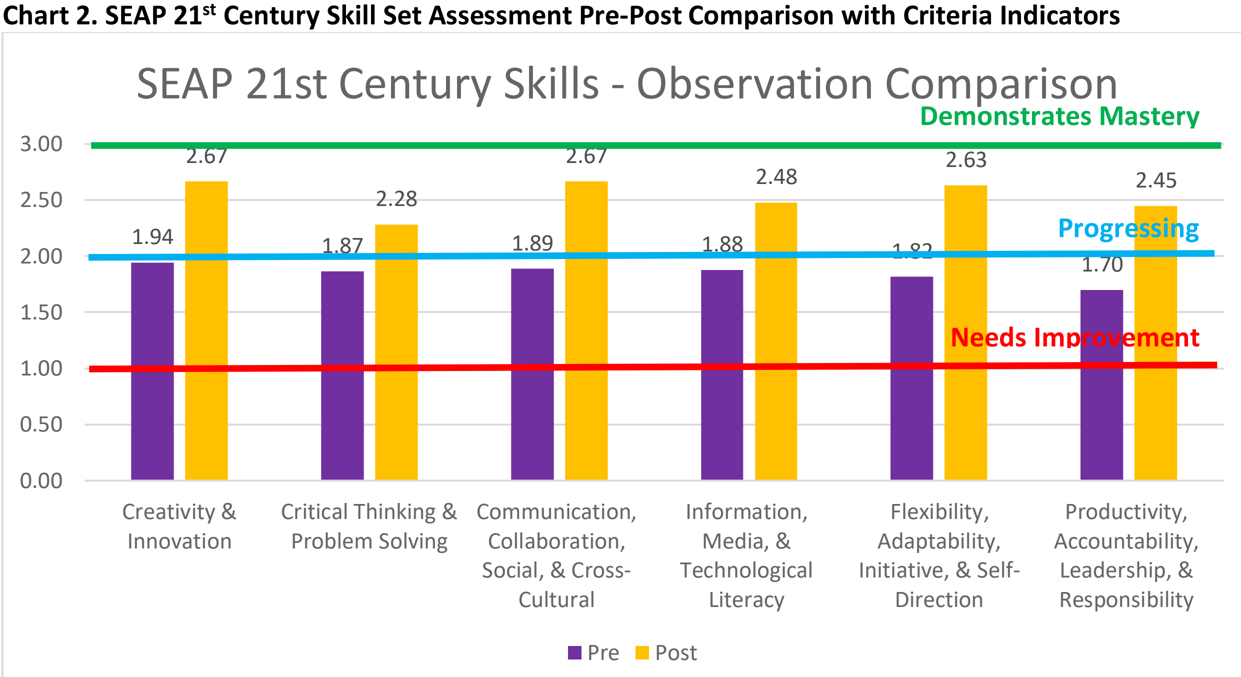
There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their SEAP experiences for five of the six skill sets ($p<.05$-$.001$) of 21st Century Skills (see Table 41). Apprentices demonstrated the most growth in the skill set of Flexibility, Adaptability, Initiative, & Self-Direction. Chart 2 shows that, on average, mentors initially rated apprentices' skills slightly below the Progressing level, and final observations resulted in skill ratings at, on average, an approaching Demonstrates Mastery level (approximately 2.50). The only exception was Critical Thinking & Problem Solving where apprentice final observations were only slightly above Progressing (2.28).

Table 41. Overall 21st Century Skill Set Assessment Pre-Post Results

Skill Set	*n*	Assessment Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	6	1.94(0.34)	2.66(0.21)	+0.72	4.38***
Critical Thinking & Problem Solving	5	1.86(0.55)	2.28(0.29)	+0.42	1.92
Communication, Collaboration, Social, & Cross-Cultural	6	1.88(0.45)	2.66(0.29)	+0.78	4.72***
Information, Media, & Technological Literacy	5	1.88(0.52)	2.48(0.38)	+0.60	3.16**
Flexibility, Adaptability, Initiative, & Self-Direction	6	1.81(0.49)	2.63(0.26)	+0.82	3.29**
Productivity, Accountability, Leadership, & Responsibility	5	1.70(0.44)	2.45(0.16)	+0.75	2.85*

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

Chart 2. SEAP 21st Century Skill Set Assessment Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Assessed

Table 42 displays findings for each of the 24 specific skills associated with the six areas of 21st Century Skills. Among these items, four could not be tested for pre-post change (17%) due to insufficient data. All tested skills showed an increase from pre- to post-observations (100%), and 13 of the specific skills observed (65%) significantly increased from pre- to post-observation. While apprentices improved in all tested 21st Century Skills over time, skills associated with creativity, communication, and independence saw the largest increases from pre- to post- observations.

Table 42. Overall 21st Century Skill Set Assessment Pre-Post Results

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time Pre - *M*(*SD*)	 Post - *M*(*SD*)	Pre-Post Change	*t*-stat
Creativity & Innovation					
Think creatively	5	1.60(0.54)	2.40(0.54)	+0.80	4.00**
Work creatively with others	4	2.00(0.00)	2.75(0.50)	+0.75	3.00*
Implement innovations	5	2.20(0.44)	3.00(0.00)	+0.80	4.00**
Critical Thinking & Problem Solving					
Reason effectively	3	1.66(0.57)	2.33(0.57)	+0.67	2.00
Use systems thinking	2	2.00(1.41)	2.00(0.00)	+0.00	0.00
Make judgments and decisions	4	1.50(0.57)	2.00(0.00)	+0.50	1.73
Solve problems	5	1.80(0.44)	2.40(0.54)	+0.60	2.45*
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	5	1.80(0.44)	2.40(0.54)	+0.60	2.45*
Communicate with others	5	1.80(0.44)	2.60(0.54)	+0.80	4.00**
Interact effectively with others	6	2.00(0.63)	3.00(0)	+1.00	3.87**
Information, Media, & Technological Literacy					
Access and evaluate information	4	1.75(0.5)	2.50(0.57)	+0.75	3.00*
Use and manage information	3	NA	NA	NA	NA
Analyze media	0	NA	NA	NA	NA
Create media products	2	NA	NA	NA	NA
Apply technology effectively	3	2.00(1.00)	2.66(0.57)	+0.67	2.00
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	4	2.00(0.81)	2.75(0.50)	+0.75	1.19
Be flexible	4	2.25(0.50)	2.75(0.50)	+0.50	1.73
Manage goals and time	4	1.75(0.50)	2.75(0.50)	+1.00	2.45*
Work independently	6	1.83(0.40)	2.83(0.40)	+1.00	3.87**
Be a self-directed learner	5	1.60(0.54)	2.2(0.44)	+0.60	2.45*
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	2	1.50(.71)	2.00(.00)	+0.50	1.00

Produce results	4	1.75(.50)	2.75(.50)	+1.00	2.45*
Guide and lead others	3	NA	NA	NA	NA
Be responsible to others	5	2.00(.71)	2.60(.55)	+0.60	2.45*

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

Assessed Growth in 21st Century Skills – University-Based Programs

REAP

For REAP, between 10 and 11 apprentices were assessed for skills related to each of the domains areas at pre and post observation. Table 42 presents an overall summary of mentors' assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 3.

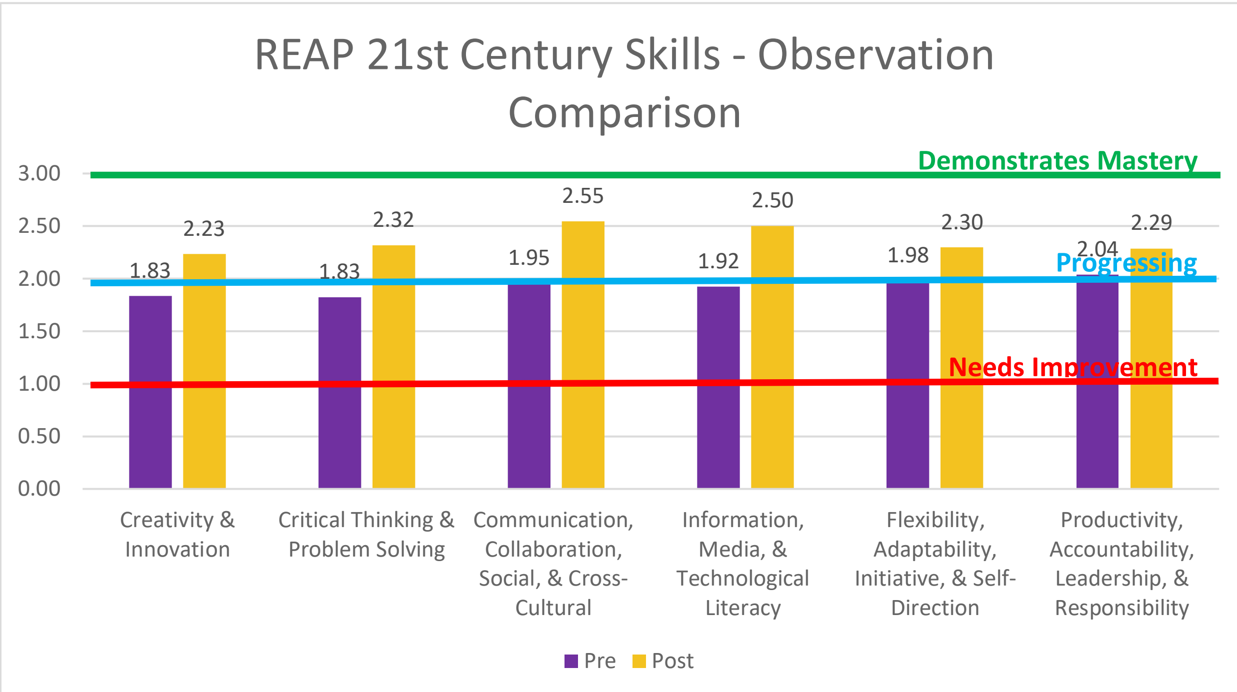
There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their REAP experiences (p<.05-.001) for all six skill sets of 21st Century Skills (see Table 43). Apprentices demonstrated the most growth in the Communication, Collaboration, Social, & Cross-Cultural and the Information, Media, & Technological Literacy skill sets. Chart 2 shows that, on average, mentors initially rated apprentices' skills at approximately the Progressing level, and final observations resulted in skill ratings at, on average, above Progressing and moving towards Approaching Mastery (2.50).

Table 43. Overall 21st Century Skill Set Assessment Pre-Post Results

Skill Set	*n*	Observation Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	10	1.83(0.23)	2.23(0.38)	+0.40	2.57**
Critical Thinking & Problem Solving	11	1.82(0.34)	2.31(0.27)	+0.49	4.53***
Communication, Collaboration, Social, & Cross-Cultural	11	1.95(0.29)	2.54(0.42)	+0.59	3.74***
Information, Media, & Technological Literacy	11	1.92(0.13)	2.50(0.42)	+0.58	4.10***
Flexibility, Adaptability, Initiative, & Self-Direction	11	1.98(0.35)	2.29(0.47)	+0.31	1.99*
Productivity, Accountability, Leadership, & Responsibility	11	2.03(0.23)	2.28(0.41)	+0.25	2.85**

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

Chart 3. REAP 21st Century Skill Set Assessment Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Assessed

Table 44 displays findings for each of the 24 specific skills associated with the six areas of 21st Century Skills. All tested skills showed an increase from pre- to post-observations (100%), and 18 of the specific skills observed (75%) significantly increased from pre- to post-observation. While apprentices improved in all tested 21st Century Skills over time, skills associated with technology, creativity, and independence saw the largest increases from pre- to post- observations.

Table 44. Overall 21st Century Skill Set Assessment Pre-Post Results

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time Pre - *M*(*SD*)	 Post - *M*(*SD*)	Pre-Post Change	*t*-stat
Creativity & Innovation					
Think creatively	8	1.75(0.46)	2.25(0.46)	+0.50	2.65*
Work creatively with others	10	1.90(0.31)	2.40(0.51)	+0.50	2.24*
Implement innovations	7	1.71(0.48)	2.28(0.48)	+0.57	1.92*
Critical Thinking & Problem Solving					
Reason effectively	10	2.00(0)	2.4(0.51)	+0.40	2.45*
Use systems thinking	9	1.77(0.44)	2.44(0.52)	+0.67	2.83*

Make judgments and decisions	9	1.88(0.33)	2.33(0.50)	+0.44	2.53*
Solve problems	11	1.81(0.40)	2.18(0.40)	+0.36	2.39*
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	10	1.80(0.42)	2.40(0.51)	+0.60	2.71*
Communicate with others	11	2.00(0.44)	2.72(0.46)	+0.73	3.73**
Interact effectively with others	11	2.09(0.3)	2.54(0.52)	+0.45	2.19*
Information, Media, & Technological Literacy					
Access and evaluate information	10	2.10(0.31)	2.40(0.51)	+0.30	1.41
Use and manage information	10	1.80(0.42)	2.50(0.70)	+0.70	2.69*
Analyze media	4	1.75(0.50)	2.50(0.57)	+0.75	3.00*
Create media products	5	1.8(0.44)	2.60(0.54)	+0.80	2.14*
Apply technology effectively	8	2.00(0.00)	2.62(0.51)	+0.63	3.42**
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	10	2.10(0.31)	2.60(0.51)	+0.50	3.00**
Be flexible	8	2.12(0.35)	2.75(0.46)	+0.63	3.42**
Manage goals and time	8	2.25(0.70)	2.37(0.51)	+0.13	0.56
Work independently	10	1.80(0.42)	2.30(0.48)	+0.50	3.00**
Be a self-directed learner	10	1.70(0.67)	2.10(0.73)	+0.40	1.18
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	5	2.00(0.70)	2.2(0.44)	+0.20	1.00
Produce results	6	2.00(0.63)	2.66(0.51)	+0.67	3.16*
Guide and lead others	7	2.00(0.57)	2.14(0.69)	+0.14	1.00
Be responsible to others	10	2.2(0.42)	2.4(0.51)	+0.20	1.50

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

HSAP

For HSAP, between 4 and 6 apprentices were assessed for skills related to each of the domains areas at pre and post observation. Table 45 presents an overall summary of mentors' assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 4.

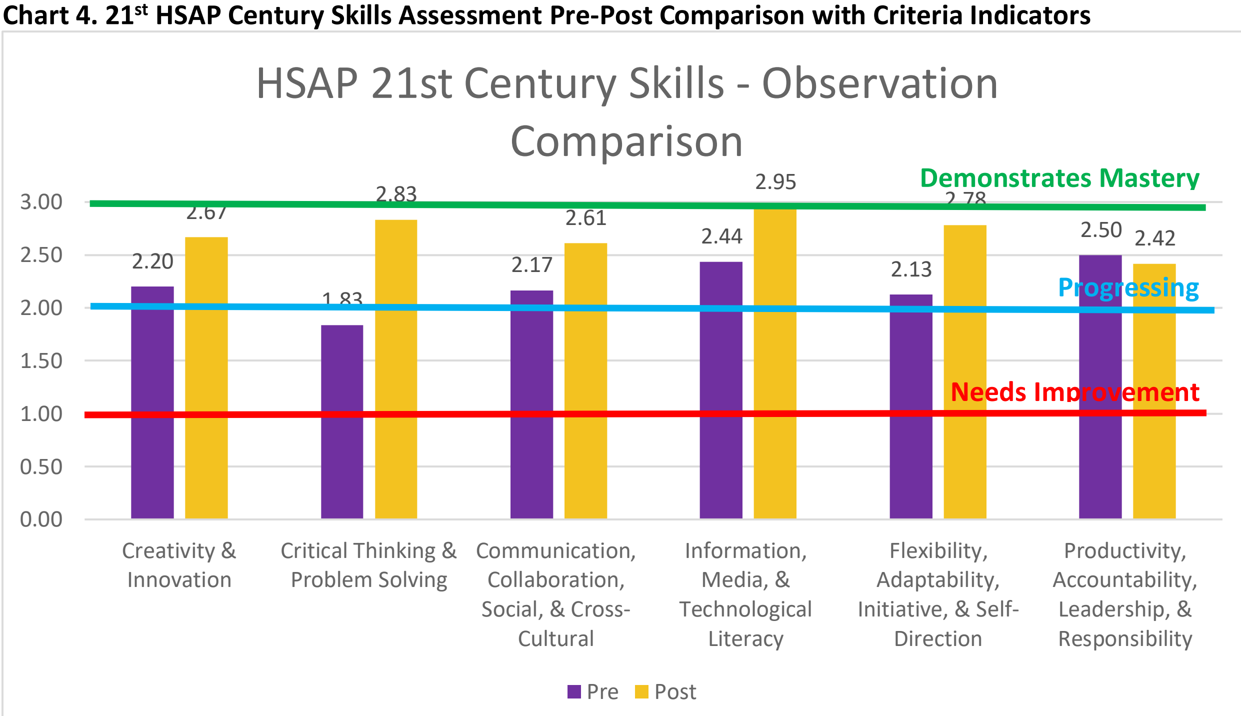
There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their HSAP experiences ($p<.05$-.01) for all but two skill sets of 21st Century Skills (see Table 39). There was positive growth for items related to Information, but it was not significant, and items related to productivity had a slight non-significant negative change from pre to post. Apprentices demonstrated the most growth in the skill sets related to critical thinking. Chart 4 shows that on average, mentors initially rated apprentices' skills above the Progressing level, with the exception of Critical Thinking items. At final observations skill ratings, on average, were close to the Demonstrates Mastery level.

Table 45. Overall 21st Century Skill Set Assessment Pre-Post Results

Skill Set	*n*	Observation Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	5	2.2(0.29)	2.66(0.47)	+0.47	2.75*
Critical Thinking & Problem Solving	6	1.83(0.68)	2.83(0.4)	+1.00	4.47**
Communication, Collaboration, Social, & Cross-Cultural	6	2.16(0.27)	2.61(0.44)	+0.44	2.00*
Information, Media, & Technological Literacy	4	2.43(0.42)	2.95(0.1)	+0.51	1.98
Flexibility, Adaptability, Initiative, & Self-Direction	6	2.12(0.49)	2.78(0.27)	+0.66	2.98*
Productivity, Accountability, Leadership, & Responsibility	4	2.5(0.57)	2.41(0.2)	-0.08	0.30

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

Chart 4. 21st HSAP Century Skills Assessment Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Assessed

Table 46 displays findings for each of the 24 specific skills associated with the six areas of 21st Century Skills. Among these items, two could not be tested for pre-post change (8%) due to insufficient data. Most tested skills showed an increase from pre- to post-observations (86%), and six of the specific skills observed (65%) significantly increased from pre- to post-observation. While apprentices improved in most tested 21st Century Skills over time, skills associated with critical thinking saw the largest increases from pre- to post- observations.

Table 46. Overall 21st Century Skill Set Observation Pre-Post Results

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time Pre - *M*(*SD*)	 Post - *M*(*SD*)	Pre-Post Change	*t*-stat
Creativity & Innovation					
Think creatively	5	2.2(0.44)	2.6(0.54)	+0.40	1.63
Work creatively with others	4	2.5(0.57)	3(0)	+0.50	1.73
Implement innovations	5	2(0)	2.6(0.54)	+0.60	2.45*
Critical Thinking & Problem Solving					
Reason effectively	4	2.5(0.57)	3(0)	+0.50	1.73
Use systems thinking	5	2(0.7)	3(0)	+1.00	3.16*
Make judgments and decisions	4	1.75(0.95)	3(0)	+1.25	2.61*
Solve problems	3	NA	NA	NA	NA
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	5	2(0)	2.6(0.54)	+0.60	2.45*
Communicate with others	6	2.16(0.4)	2.5(0.54)	+0.33	1.00
Interact effectively with others	6	2.33(0.51)	2.66(0.51)	+0.33	1.58
Information, Media, & Technological Literacy					
Access and evaluate information	4	2.5(0.57)	3(0)	+0.50	1.73
Use and manage information	3	2.33(0.57)	3(0)	+0.67	2.00
Analyze media	2	NA	NA	NA	NA
Create media products	2	2.5(0.7)	2.5(0.7)	0.00	0.00
Apply technology effectively	4	2.5(0.57)	3(0)	+0.50	1.73
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	4	2.25(0.5)	2.75(0.5)	+0.50	1.73
Be flexible	4	2.25(0.5)	3(0)	+0.75	3.00*
Manage goals and time	3	2.66(0.57)	2.66(0.57)	+0.00	0.00
Work independently	5	2(0.7)	2.6(0.54)	+0.60	2.45*
Be a self-directed learner	4	2.25(0.5)	2.5(0.57)	+0.25	0.52
Productivity, Accountability, Leadership, & Responsibility					

Manage projects	2	2.5(0.7)	2(0)	-0.50	1.00
Produce results	3	2.33(0.57)	2(0)	-0.33	1.00
Guide and lead others	3	2.33(0.57)	2.33(0.57)	+0.00	0.00
Be responsible to others	4	2.5(0.57)	2.75(0.5)	+0.25	1.00

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with **p*<.05, ***p*<.01, ****p*<.001

URAP

Between 5 and 7 apprentices were assessed for skills related to each of the domains areas at pre and post observation. Table 47 presents an overall summary of mentors' assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 5.

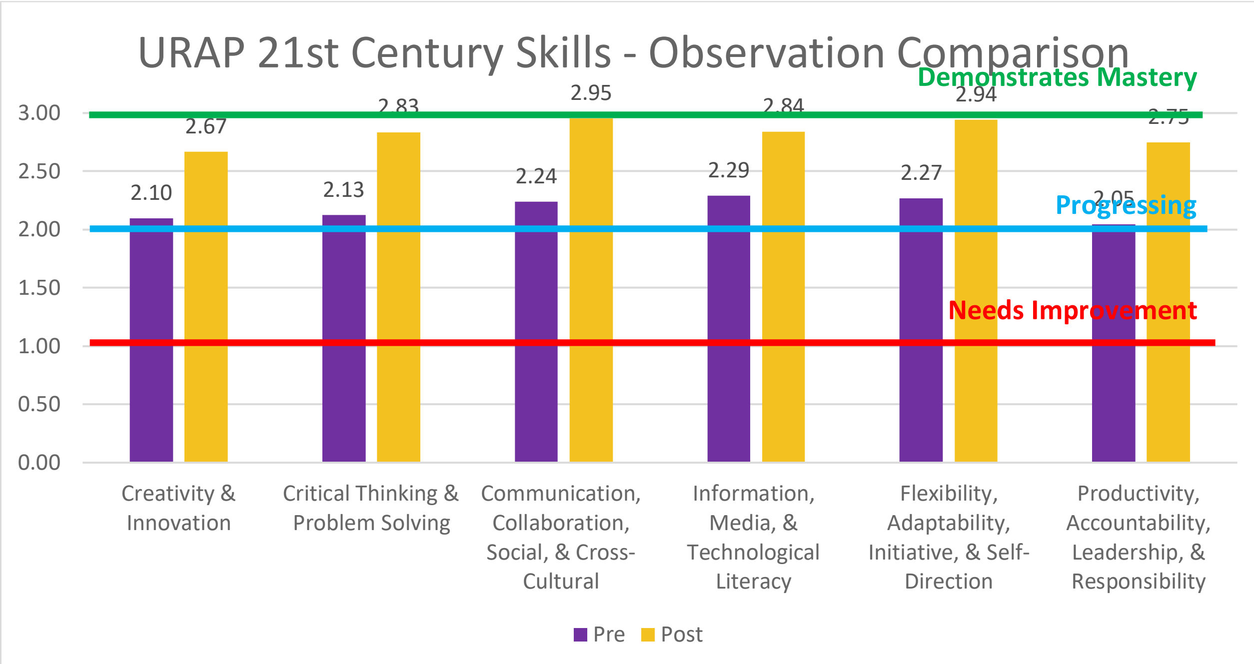
There were significant increases in apprentices observed skills from the beginning (pre) to the end (post) of their URAP experiences (p<.05-.001) for all six skill sets of 21st Century Skills (see Table 47). Apprentices demonstrated the most growth in the skill sets related to Critical Thinking, Communication, and Productivity. Chart 2 shows that on average, mentors initially rated apprentices' skills slightly above the Progressing level. At final observations skill ratings were, on average, close to the Demonstrates Mastery level.

Table 47. Overall 21st Century Skill Set Observation Pre-Post Results

		Assessment Time			
Skill Set	***n***	**Pre - *M*(*SD*)**	**Post - *M*(*SD*)**	**Pre-Post Change**	***t*-stat**
Creativity & Innovation	7	2.09(0.16)	2.66(0.47)	+0.57	3.62**
Critical Thinking & Problem Solving	6	2.12(0.37)	2.83(0.4)	+0.71	7.06***
Communication, Collaboration, Social, & Cross-Cultural	7	2.23(0.37)	2.95(0.12)	+0.71	5.30***
Information, Media, & Technological Literacy	5	2.29(0.22)	2.84(0.26)	+0.55	3.20*
Flexibility, Adaptability, Initiative, & Self-Direction	7	2.26(0.26)	2.94(0.15)	+0.68	7.40***
Productivity, Accountability, Leadership, & Responsibility	7	2.04(0.12)	2.75(0.35)	+0.70	5.53***

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with **p*<.05, ***p*<.01, ****p*<.001

Chart 5. URAP 21st Century Skill Set Observation Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Assessed

Table 48 displays findings for each of the 24 specific skills associated with the six areas of 21st Century Skills. Among these items, two could not be tested for pre-post change (8%) due to insufficient data. All tested skills showed an increase from pre- to post-observations (100%), and 15 of the specific skills observed (68%) significantly increased from pre- to post-observation. While apprentices improved in all tested 21st Century Skills over time, skills associated with independence, responsibility, and critical thinking saw the largest increases from pre- to post- observations.

Table 48. Overall 21st Century Skill Set Assessment Pre-Post Results

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time		Pre-Post Change	*t*-stat
		Pre - *M(SD)*	Post - *M(SD)*		
Creativity & Innovation					
Think creatively	5	NA	NA	NA	NA
Work creatively with others	6	2.00(0.00)	2.83(0.40)	+0.83	5.00**
Implement innovations	6	2.33(0.51)	2.66(0.51)	+0.33	1.58
Critical Thinking & Problem Solving					
Reason effectively	6	2.50(0.54)	2.83(0.40)	+0.33	1.58

Use systems thinking	5	2.20(0.44)	3.00(0.00)	+0.80	4.00**
Make judgments and decisions	5	NA	NA	NA	NA
Solve problems	6	2.00(0.63)	2.83(0.40)	+0.83	5.00**
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	5	2.20(0.44)	2.80(0.44)	+0.60	2.45*
Communicate with others	6	2.33(0.81)	3.00(0.00)	+0.67	2.00*
Interact effectively with others	7	2.28(0.48)	3.00(0.00)	+0.71	3.87**
Information, Media, & Technological Literacy					
Access and evaluate information	5	2.20(0.44)	2.80(0.44)	+0.60	2.45*
Use and manage information	5	2.60(0.54)	3.00(0.00)	+0.40	1.63
Analyze media	5	2.00(0.70)	2.60(0.54)	+0.60	1.50
Create media products	4	2.00(0.81)	2.75(0.50)	+0.75	1.57
Apply technology effectively	5	2.60(0.54)	3.00(0.00)	+0.40	1.63
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	5	2.40(0.54)	3.00(0.00)	+0.60	2.45*
Be flexible	6	2.16(0.40)	3.00(0.00)	+0.83	5.00**
Manage goals and time	5	2.40(0.54)	3.00(0.00)	+0.60	2.45*
Work independently	7	2.14(0.37)	2.85(0.37)	+0.71	3.87**
Be a self-directed learner	5	2.40(0.54)	3.00(0.00)	+0.60	2.45*
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	5	2.00(0.00)	2.80(0.44)	+0.80	4.00**
Produce results	6	2.00(0.00)	2.83(0.40)	+0.83	5.00**
Guide and lead others	4	NA	NA	NA	NA
Be responsible to others	6	2.16(0.40)	2.83(0.40)	+0.67	3.16*

NOTE. Statistical significance levels for one-tailed tests provided in table by asterisks with *$p<.05$, **$p<.01$, ***$p<.001$

STEM Practices – Overall

STEM practices are specific activities that are associated with inquiry and communication in STEM. These include activities such as working on real-world problems with colleagues, designing and conducting investigations, analyzing findings and communicating about them, and interacting with other researchers. Apprentices in all programs reported engaging in STEM practices in their apprenticeship experiences.

STEM Practices – Level and Setting Comparisons

Apprentices were asked to indicate how often they engaged in various STEM practices during their AEOP apprenticeship. A composite score[4] was calculated for apprentice STEM Engagement in each program.[5] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items the scale was calculated. Composite scores were used to test whether there were differences in apprentice STEM Engagement experiences by program level (high school vs. undergraduate) and setting (army lab vs. university-based). No statistically significant differences in STEM Engagement were found by program level or setting.

STEM Practices – Army Laboratory-Based Programs

CQL

Overall results indicate that apprentices were actively engaged in STEM practices during their apprenticeship experiences (Table 49). The majority of apprentices reported participating in all activities at least monthly with the exception of presenting their STEM research to a panel of judges (22%) and building/making a computer model (47%). STEM practices apprentices reported being engaged in most frequently (weekly or every day) during CQL were interacting with STEM researchers (98%), identifying questions or problems to investigate (93%), and working with a STEM researcher or company on a real-world STEM research project (91%).

Table 49. Apprentice Engagement in STEM Practices in CQL (n=58)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	3.4%	3.4%	1.7%	12.1%	79.3%	
	2	2	1	7	46	**58**
Work with a STEM researcher on a research project of your own choosing	27.6%	19.0%	8.6%	3.4%	41.4%	
	16	11	5	2	24	**58**

[4] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.

[5] The Cronbach's alpha reliability for these 12 items was 0.820.

Design my own research or investigation based on my own question(s)	27.6%	20.7%	8.6%	13.8%	29.3%	
	16	12	5	8	17	**58**
Present my STEM research to a panel of judges from industry or the military	19.0%	58.6%	10.3%	6.9%	5.2%	
	11	34	6	4	3	**58**
Interact with STEM researchers	1.7%	0.0%	0.0%	8.6%	89.7%	
	1	0	0	5	52	**58**
Use laboratory procedures and tools	15.5%	8.6%	0.0%	10.3%	65.5%	
	9	5	0	6	38	**58**
Identify questions or problems to investigate	3.4%	1.7%	1.7%	29.3%	63.8%	
	2	1	1	17	37	**58**
Design and carry out an investigation	8.6%	10.3%	8.6%	15.5%	56.9%	
	5	6	5	9	33	**58**
Analyze data or information and draw conclusions	5.2%	1.7%	6.9%	20.7%	65.5%	
	3	1	4	12	38	**58**
Work collaboratively as part of a team	1.7%	6.9%	1.7%	22.4%	67.2%	
	1	4	1	13	39	**58**
Build or make a computer model	39.7%	13.8%	5.2%	13.8%	27.6%	
	23	8	3	8	16	**58**
Solve real world problems	3.4%	10.3%	5.2%	19.0%	62.1%	
	2	6	3	11	36	**58**

Composite scores for STEM Engagement in CQL were used to test whether there were differences in apprentice experiences by overall U2 classification and all individual components. There were no significant differences in composite scores by U2 classification, gender, first generation college status, or English as a first language. There was, however, a significant difference in STEM Engagement by race/ethnic group with non-Minority apprentices reporting significantly greater engagement on average compared to Minority apprentices (effect size is medium with $d = 0.681$).[6]

[6] Independent Samples t-test for CQL STEM Engagement by race/ethnicity: $t(53)=2.48$, $p=.016$.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 50). These responses were also combined into a composite variable[7] parallel to the STEM Engagement in CQL variable. Chart 6 shows that apprentices' engagement in STEM practices in CQL were significantly higher than their engagement in the same practices in school (effect size is extremely large with d = 2.15).[8] These data indicate that CQL provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 50. Apprentice Engagement in STEM Practices in School (n=58)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	56.9%	15.5%	3.4%	12.1%	12.1%	
	33	9	2	7	7	**58**
Work with a STEM researcher on a research project of your own choosing	62.1%	8.6%	3.4%	13.8%	12.1%	
	36	5	2	8	7	**58**
Design my own research or investigation based on my own question(s)	43.1%	34.5%	5.2%	10.3%	6.9%	
	25	20	3	6	4	**58**
Present my STEM research to a panel of judges from industry or the military	67.2%	27.6%	3.4%	0.0%	1.7%	
	39	16	2	0	1	**58**
Interact with STEM researchers	19.0%	10.3%	13.8%	22.4%	34.5%	
	11	6	8	13	20	**58**
Use laboratory procedures and tools	15.5%	6.9%	13.8%	36.2%	27.6%	
	9	4	8	21	16	**58**
Identify questions or problems to investigate	8.6%	20.7%	15.5%	22.4%	32.8%	
	5	12	9	13	19	**58**
Design and carry out an investigation	19.0%	34.5%	6.9%	22.4%	17.2%	
	11	20	4	13	10	**58**
	8.6%	6.9%	24.1%	34.5%	25.9%	

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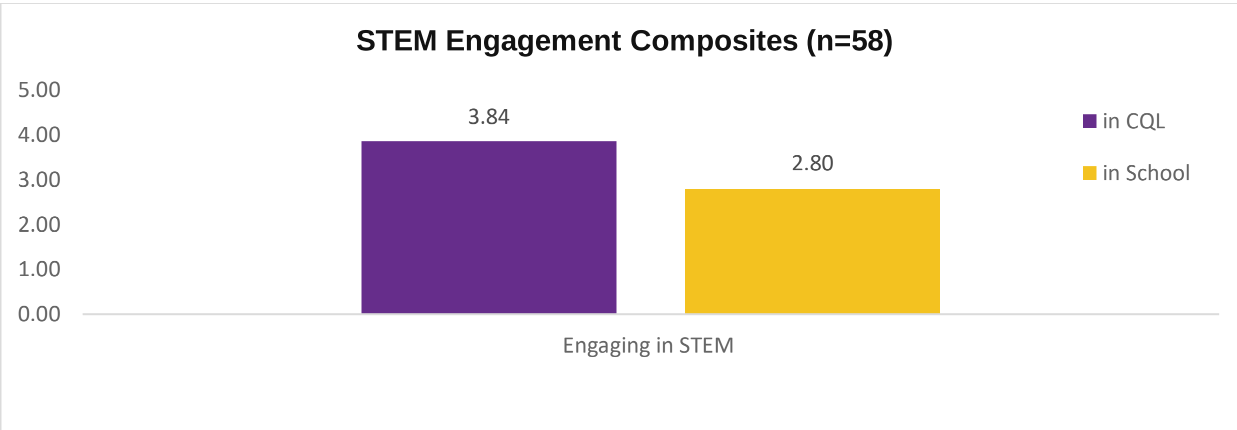
[7] Cronbach's alpha reliability for these 12 items was 0.882.

[8] Dependent Samples t-test for STEM Engagement: t(57)=8.10, p<.001.

Analyze data or information and draw conclusions	5	4	14	20	15	**58**
Work collaboratively as part of a team	5.2%	1.7%	15.5%	43.1%	34.5%	
	3	1	9	25	20	**58**
Build or make a computer model	41.4%	20.7%	12.1%	17.2%	8.6%	
	24	12	7	10	5	**58**
Solve real world problems	19.0%	32.8%	15.5%	17.2%	15.5%	
	11	19	9	10	9	**58**

Chart 6. Apprentices' Engagement in STEM Practices in CQL Versus in School



Apprentices participating in focus groups were asked to comment on how their CQL experiences compared to their typical school experiences. Participants indicated that CQL provided unique experiences in real-life, hands-on lab research that that they typically do not have in their school settings. Participants noted that CQL gave them opportunities to explore real-world applications of their learning and to appreciate the open-ended nature of scientific research that stands in sharp contrast to labs associated with their coursework; as one participant noted "The study of science is very different than the practice of science."

SEAP

SEAP Apprentices were also asked how often they engaged in various STEM practices during their program (Table 51). The majority of apprentices reported participating in all activities at least monthly with the exception of presenting their STEM research to a panel of judges (14%) and building/making a computer model (46%). STEM practices apprentices reported being engaged in most frequently (weekly or every day) during SEAP were interacting with STEM researchers (92%) and working with a STEM researcher or company on a real-world STEM research project (92%).

Table 51. Apprentice Engagement in STEM Practices in SEAP (n=35)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	2.9%	5.7%	0.0%	8.6%	82.9%	
	1	2	0	3	29	**35**
Work with a STEM researcher on a research project of your own choosing	22.9%	14.3%	5.7%	11.4%	45.7%	
	8	5	2	4	16	**35**
Design my own research or investigation based on my own question(s)	28.6%	14.3%	8.6%	22.9%	25.7%	
	10	5	3	8	9	**35**
Present my STEM research to a panel of judges from industry or the military	40.0%	45.7%	5.7%	5.7%	2.9%	
	14	16	2	2	1	**35**
Interact with STEM researchers	2.9%	2.9%	2.9%	8.6%	82.9%	
	1	1	1	3	29	**35**
Use laboratory procedures and tools	20.0%	0.0%	5.7%	8.6%	65.7%	
	7	0	2	3	23	**35**
Identify questions or problems to investigate	0.0%	14.3%	2.9%	28.6%	54.3%	
	0	5	1	10	19	**35**
Design and carry out an investigation	14.3%	20.0%	5.7%	17.1%	42.9%	
	5	7	2	6	15	**35**
Analyze data or information and draw conclusions	2.9%	5.7%	8.6%	28.6%	54.3%	
	1	2	3	10	19	**35**
Work collaboratively as part of a team	5.7%	14.3%	2.9%	22.9%	54.3%	
	2	5	1	8	19	**35**
Build or make a computer model	42.9%	11.4%	2.9%	14.3%	28.6%	
	15	4	1	5	10	**35**
Solve real world problems	8.6%	17.1%	5.7%	5.7%	62.9%	
	3	6	2	2	22	**35**

Composite scores for STEM Engagement in SEAP were used to test whether there were differences in apprentice experiences by overall U2 classification and all individual components. No significant differences in composite scores were found by overall U2 classification or any components of U2 status.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 52). These responses were also combined into a composite variable parallel to the STEM Engagement in SEAP variable. Chart 7 shows that apprentices' engagement in STEM practices in SEAP were significantly higher than their engagement in the same practices in school (effect size is extremely large with d = 2.15).[9] These data indicate that SEAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

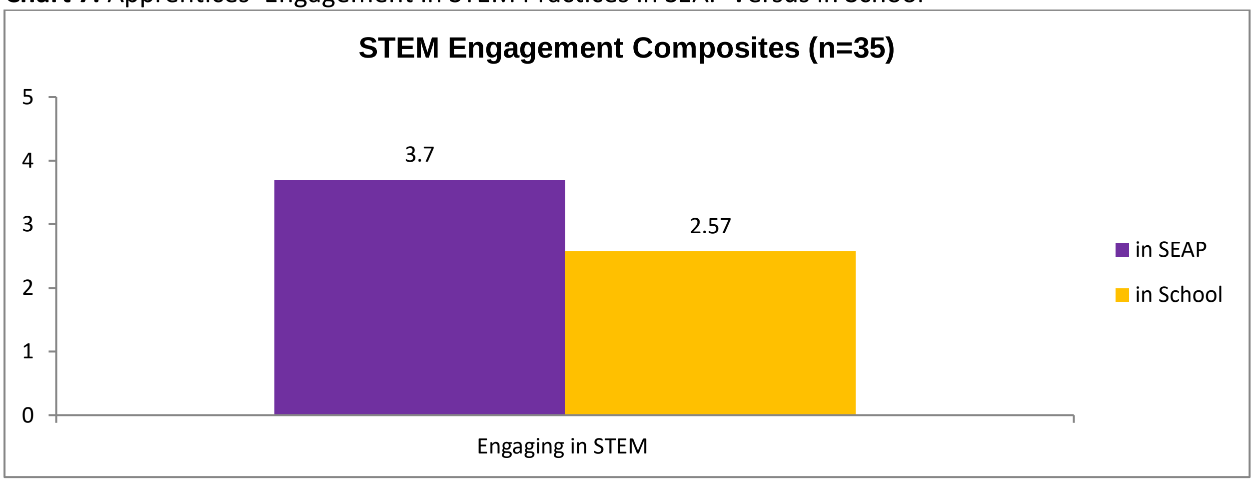
Table 52. Apprentice Engagement in STEM Practices in School (n=61)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	71.4%	5.7%	0.0%	8.6%	14.3%	
	25	2	0	3	5	**35**
Work with a STEM researcher on a research project of your own choosing	68.6%	8.6%	2.9%	5.7%	14.3%	
	24	3	1	2	5	**35**
Design my own research or investigation based on my own question(s)	42.9%	40.0%	5.7%	5.7%	5.7%	
	15	14	2	2	2	**35**
Present my STEM research to a panel of judges from industry or the military	77.1%	20.0%	2.9%	0.0%	0.0%	
	27	7	1	0	0	**35**
Interact with STEM researchers	51.4%	22.9%	2.9%	5.7%	17.1%	
	18	8	1	2	6	**35**
Use laboratory procedures and tools	14.3%	8.6%	25.7%	37.1%	14.3%	
	5	3	9	13	5	**35**
Identify questions or problems to investigate	5.7%	25.7%	17.1%	34.3%	17.1%	
	2	9	6	12	6	**35**
	17.1%	22.9%	28.6%	25.7%	5.7%	

[9] Dependent Samples t-test for STEM Engagement: t(34)=7.34, p<.001.

Design and carry out an investigation	6	8	10	9	2	**35**
Analyze data or information and draw conclusions	5.7%	8.6%	22.9%	51.4%	11.4%	
	2	3	8	18	4	**35**
Work collaboratively as part of a team	0.0%	5.7%	11.4%	51.4%	31.4%	
	0	2	4	18	11	**35**
Build or make a computer model	57.1%	17.1%	5.7%	8.6%	11.4%	
	20	6	2	3	4	**35**
Solve real world problems	22.9%	28.6%	20.0%	14.3%	14.3%	
	8	10	7	5	5	**35**

Chart 7. Apprentices' Engagement in STEM Practices in SEAP Versus in School



SEAP apprentices participating in focus groups indicated that their learning in SEAP differed from their school experiences. Apprentices noted that SEAP offers more applied learning opportunities and deeper learning than they typically experience in their STEM experiences in school. Furthermore, students noted that they had substantially more hands-on lab experience and greater access to technology and equipment in SEAP as compared to school. For example:

> *"Application is a good word [to describe SEAP activities], because a lot of the procedures that we're doing in our lab, like PCR, and sequencing, and all that, it's stuff that's come up in school in the curriculum. Then, actually doing it, you get to learn in more detail how it works. Another thing I've noticed is that there's a lot of things where I can just read the procedure and I think I know it, but then my mentor will ask me a question like, "OK, but why are we adding this?" Or, "Why are we*

doing this stuff? What does it do?" That's made me change my approach to what I'm doing a little bit more, because then I have to think about each step and really understand for this process, why is this important?" (SEAP Apprentice]

"At school, most of what we're taught is theoretical. You don't actually get to apply it to anything. Here, it's a lot more hands on. You get the actual experience that goes along with the theories that you're learning at school." (SEAP Apprentice)

STEM Practices – University-Based Programs

REAP

REAP Apprentices were also asked how often they engaged in various STEM practices during their program (Table 53). The majority of apprentices reported participating in all activities at least monthly with the exception of presenting their STEM research to a panel of judges (16%) and building/making a computer model (33%). STEM practices apprentices reported being engaged in most frequently (weekly or every day) during REAP were using laboratory procedures and tools (87%) and working with a STEM researcher or company on a real-world STEM research project (87%).

Table 53. Apprentice Engagement in STEM Practices in REAP (n=83)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	4.8%	6.0%	2.4%	10.8%	75.9%	
	4	5	2	9	63	**83**
Work with a STEM researcher on a research project of your own choosing	32.5%	12.0%	2.4%	10.8%	42.2%	
	27	10	2	9	35	**83**
Design my own research or investigation based on my own question(s)	31.3%	18.1%	2.4%	16.9%	31.3%	
	26	15	2	14	26	**83**
Present my STEM research to a panel of judges from industry or the military	56.6%	27.7%	2.4%	7.2%	6.0%	
	47	23	2	6	5	**83**
Interact with STEM researchers	2.4%	7.2%	6.0%	12.0%	72.3%	
	2	6	5	10	60	**83**
Use laboratory procedures and tools	2.4%	9.6%	1.2%	15.7%	71.1%	
	2	8	1	13	59	**83**

Identify questions or problems to investigate	4.8%	8.4%	3.6%	20.5%	62.7%	
	4	7	3	17	52	**83**
Design and carry out an investigation	8.4%	14.5%	4.8%	14.5%	57.8%	
	7	12	4	12	48	**83**
Analyze data or information and draw conclusions	3.6%	7.2%	3.6%	14.5%	71.1%	
	3	6	3	12	59	**83**
Work collaboratively as part of a team	2.4%	8.4%	3.6%	9.6%	75.9%	
	2	7	3	8	63	**83**
Build or make a computer model	55.4%	12.0%	2.4%	9.6%	20.5%	
	46	10	2	8	17	**83**
Solve real world problems	12.0%	14.5%	3.6%	14.5%	55.4%	
	10	12	3	12	46	**83**

Composite scores for STEM Engagement in REAP were used to test whether there were differences in apprentice experiences by overall U2 classification and all individual components. No significant differences in composite scores were found by overall U2 classification or any components of U2 status.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 54). These responses were also combined into a composite variable parallel to the STEM Engagement in REAP variable. Chart 8 shows that apprentices' engagement in STEM practices in REAP were significantly higher than their engagement in the same practices in school (effect size is extremely large with d = 2.79).[10] These data indicate that REAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

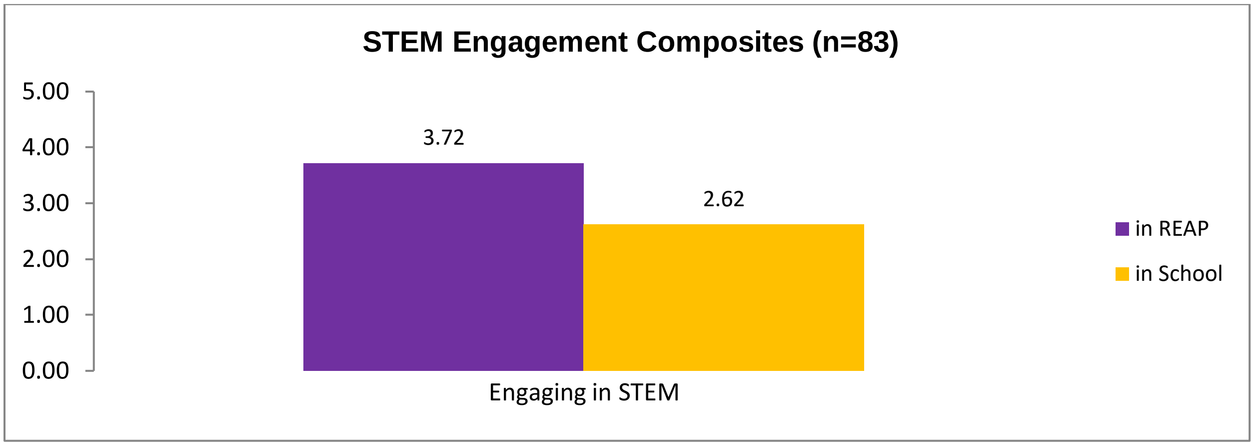
Table 54. Apprentice Engagement in STEM Practices in School (n=83)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	53.0%	16.9%	4.8%	8.4%	16.9%	
	44	14	4	7	14	**83**
	59.0%	19.3%	2.4%	7.2%	12.0%	

[10] Dependent Samples t-test for STEM Engagement: $t(82)=10.07$, $p<.001$.

Work with a STEM researcher on a research project of your own choosing	49	16	2	6	10	**83**
Design my own research or investigation based on my own question(s)	37.3%	28.9%	13.3%	12.0%	8.4%	
	31	24	11	10	7	**83**
Present my STEM research to a panel of judges from industry or the military	75.9%	19.3%	1.2%	3.6%	0.0%	
	63	16	1	3	0	**83**
Interact with STEM researchers	41.0%	28.9%	9.6%	7.2%	13.3%	
	34	24	8	6	11	**83**
Use laboratory procedures and tools	10.8%	15.7%	20.5%	36.1%	16.9%	
	9	13	17	30	14	**83**
Identify questions or problems to investigate	8.4%	21.7%	22.9%	21.7%	25.3%	
	7	18	19	18	21	**83**
Design and carry out an investigation	13.3%	28.9%	15.7%	22.9%	19.3%	
	11	24	13	19	16	**83**
Analyze data or information and draw conclusions	7.2%	15.7%	16.9%	31.3%	28.9%	
	6	13	14	26	24	**83**
Work collaboratively as part of a team	6.0%	10.8%	22.9%	22.9%	37.3%	
	5	9	19	19	31	**83**
Build or make a computer model	65.1%	14.5%	6.0%	8.4%	6.0%	
	54	12	5	7	5	**83**
Solve real world problems	30.1%	26.5%	8.4%	16.9%	18.1%	
	25	22	7	14	15	**83**

Chart 8. Apprentices' Engagement in STEM Practices in REAP Versus in School



HSAP

HSAP apprentices were also asked how often they engaged in various STEM practices during their program (Table 55). The majority of apprentices reported participating in all activities at least monthly with a few exceptions: presenting their STEM research to a panel of judges (11%); designing their own research or investigation based on their own questions (37%); working with a STEM researcher on a research project of their own choosing (42%); and building/making a computer model (47%). STEM practices apprentices reported being engaged in most frequently (weekly or every day) during HSAP were: working with a STEM researcher or company on a real-world STEM research project (100%); interacting with STEM researchers (95%); identifying questions or problems to investigate (90%); and analyzing data or information and drawing conclusions (90%).

Table 55. Apprentice Engagement in STEM Practices in HSAP (n=19)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	0.0%	0.0%	0.0%	21.1%	78.9%	
	0	0	0	4	15	**19**
Work with a STEM researcher on a research project of your own choosing	47.4%	10.5%	5.3%	15.8%	21.1%	
	9	2	1	3	4	**19**
Design my own research or investigation based on my own question(s)	36.8%	26.3%	5.3%	10.5%	21.1%	
	7	5	1	2	4	**19**
	73.7%	15.8%	0.0%	0.0%	10.5%	

Present my STEM research to a panel of judges from industry or the military	14	3	0	0	2	**19**
Interact with STEM researchers	0.0%	0.0%	5.3%	15.8%	78.9%	
	0	0	1	3	15	**19**
Use laboratory procedures and tools	10.5%	0.0%	5.3%	5.3%	78.9%	
	2	0	1	1	15	**19**
Identify questions or problems to investigate	0.0%	5.3%	5.3%	26.3%	63.2%	
	0	1	1	5	12	**19**
Design and carry out an investigation	15.8%	0.0%	5.3%	10.5%	68.4%	
	3	0	1	2	13	**19**
Analyze data or information and draw conclusions	0.0%	0.0%	10.5%	26.3%	63.2%	
	0	0	2	5	12	**19**
Work collaboratively as part of a team	5.3%	10.5%	5.3%	10.5%	68.4%	
	1	2	1	2	13	**19**
Build or make a computer model	36.8%	15.8%	5.3%	31.6%	10.5%	
	7	3	1	6	2	**19**
Solve real world problems	5.3%	15.8%	10.5%	21.1%	47.4%	
	1	3	2	4	9	**19**

Composite scores for STEM Engagement in HSAP were used to test whether there were differences in apprentice experiences by overall U2 classification and all individual components. No significant differences in composite scores were found by overall U2 classification or any individual demographic components of U2 status.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 56). These responses were also combined into a composite variable parallel to the STEM Engagement in HSAP variable. Chart 9 shows that apprentices' engagement in STEM practices in HSAP were significantly higher than their engagement in the same practices in school (effect size is extremely large with d = 2.88).[11] These

[11] Dependent Samples t-test for STEM Engagement: $t(27)=7.49$, $p<.001$.

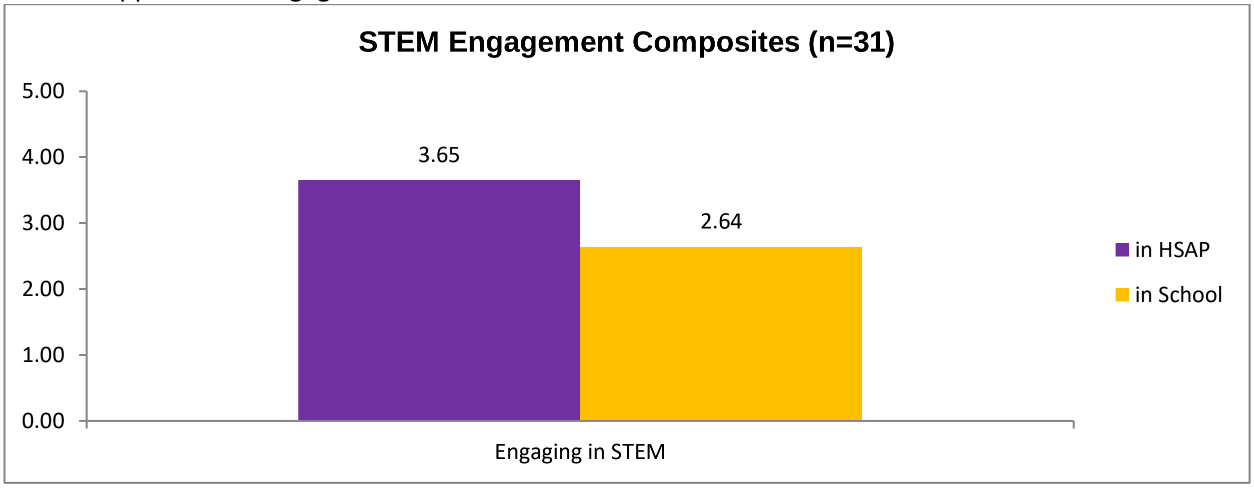
data indicate that HSAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 56. Apprentice Engagement in STEM Practices in School (n=19)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	78.9%	10.5%	5.3%	0.0%	5.3%	
	15	2	1	0	1	**19**
Work with a STEM researcher on a research project of your own choosing	78.9%	15.8%	0.0%	0.0%	5.3%	
	15	3	0	0	1	**19**
Design my own research or investigation based on my own question(s)	42.1%	42.1%	15.8%	0.0%	0.0%	
	8	8	3	0	0	**19**
Present my STEM research to a panel of judges from industry or the military	89.5%	5.3%	0.0%	0.0%	5.3%	
	17	1	0	0	1	**19**
Interact with STEM researchers	57.9%	26.3%	0.0%	10.5%	5.3%	
	11	5	0	2	1	**19**
Use laboratory procedures and tools	0.0%	21.1%	21.1%	52.6%	5.3%	
	0	4	4	10	1	**19**
Identify questions or problems to investigate	5.3%	15.8%	21.1%	42.1%	15.8%	
	1	3	4	8	3	**19**
Design and carry out an investigation	10.5%	31.6%	36.8%	15.8%	5.3%	
	2	6	7	3	1	**19**
Analyze data or information and draw conclusions	0.0%	15.8%	42.1%	21.1%	21.1%	
	0	3	8	4	4	**19**
Work collaboratively as part of a team	5.3%	10.5%	26.3%	21.1%	36.8%	
	1	2	5	4	7	**19**
Build or make a computer model	42.1%	31.6%	5.3%	10.5%	10.5%	
	8	6	1	2	2	**19**
Solve real world problems	31.6%	36.8%	0.0%	21.1%	10.5%	

	6	7	0	4	2	**19**

Chart 9. Apprentices' Engagement in STEM Practices in HSAP Versus in School



Apprentices participating in interviews indicated that their HSAP experience differed substantially from their typical in-school STEM experiences in terms of the depths of their learning, their hands-on laboratory experiences, the opportunity to experience application of their learning to real-world problems, the opportunity to learn from experts in the field with fewer time constraints than they experience in school, and their access to specialized equipment and technology. Apprentices said, for example:

> *"[In HSAP] you have to follow your intuition and you have to really put yourself out there in order to find the results that you're getting. At times you might not know what you're getting into, or exactly what you're doing. You can use the science concepts and the math concepts in order to get those results. It's more intuitive and you think past what procedures that you're given in school."* (HSAP Apprentice)

> *"At school, we don't really get the opportunity to work in a lab or to work with materials in a lab. ... We also don't get the opportunity to work so close to one person or one adult."* (HSAP Apprentice)

> *"It was cool to see everything I've learned in chemistry and biology. Those are the two science classes I've taken so far in high school. Zoology as well, but not as much. It was cool to see those concepts we've learned being applied here in a real lab setting."* (HSAP Apprentice)

URAP

URAP apprentices were also asked how often they engaged in various STEM practices during their program (Table 57). The majority of apprentices reported participating in all activities at least monthly with three exceptions: presenting their STEM research to a panel of judges (9%); designing their own research or investigation based on their own questions (38%); and working with a STEM researcher on a research project of their own choosing (41%). STEM practices apprentices reported being engaged in most frequently (weekly or every day) during URAP were: working with a STEM researcher or company on a real-world STEM research project (100%); interacting with STEM researchers (88%) and interacting with STEM researchers (88%).

Table 57. Apprentice Engagement in STEM Practices in URAP (n=34)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	0.0%	8.8%	2.9%	8.8%	79.4%	
	0	3	1	3	27	**34**
Work with a STEM researcher on a research project of your own choosing	38.2%	20.6%	8.8%	8.8%	23.5%	
	13	7	3	3	8	**34**
Design my own research or investigation based on my own question(s)	38.2%	23.5%	5.9%	8.8%	23.5%	
	13	8	2	3	8	**34**
Present my STEM research to a panel of judges from industry or the military	70.6%	20.6%	2.9%	0.0%	5.9%	
	24	7	1	0	2	**34**
Interact with STEM researchers	0.0%	5.9%	5.9%	8.8%	79.4%	
	0	2	2	3	27	**34**
Use laboratory procedures and tools	8.8%	8.8%	0.0%	5.9%	76.5%	
	3	3	0	2	26	**34**
Identify questions or problems to investigate	2.9%	11.8%	0.0%	26.5%	58.8%	
	1	4	0	9	20	**34**
Design and carry out an investigation	8.8%	8.8%	5.9%	20.6%	55.9%	
	3	3	2	7	19	**34**
Analyze data or information and draw conclusions	2.9%	11.8%	0.0%	23.5%	61.8%	
	1	4	0	8	21	**34**

Work collaboratively as part of a team	2.9%	8.8%	2.9%	14.7%	70.6%	
	1	3	1	5	24	**34**
Build or make a computer model	26.5%	23.5%	8.8%	8.8%	32.4%	
	9	8	3	3	11	**34**
Solve real world problems	5.9%	17.6%	14.7%	2.9%	58.8%	
	2	6	5	1	20	**34**

Composite scores for STEM Engagement in URAP were used to test whether there were differences in apprentice experiences by overall U2 classification and all individual components. No significant differences in composite scores were found by overall U2 classification or any individual demographic component of U2 status.

To examine how apprentices' engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 58). These responses were also combined into a composite variable parallel to the STEM Engagement in URAP variable. Chart 10 shows that apprentices' engagement in STEM practices in URAP were significantly higher than their engagement in the same practices in school (effect size is large with d = 1.87).[12] These data indicate that URAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

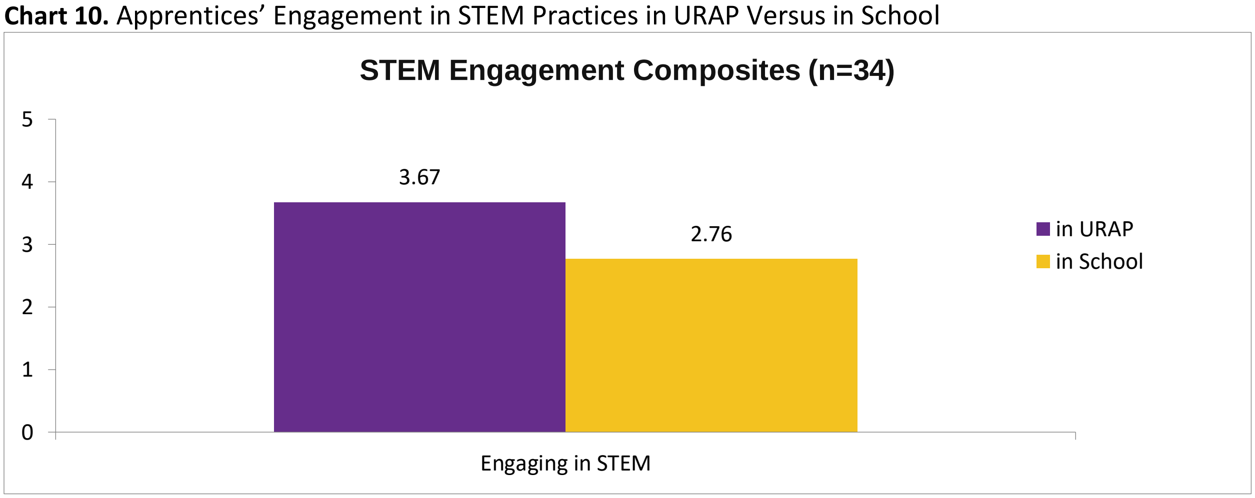
Table 58. Apprentice Engagement in STEM Practices in School (n=34)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	38.2%	14.7%	2.9%	14.7%	29.4%	
	13	5	1	5	10	**34**
Work with a STEM researcher on a research project of your own choosing	64.7%	11.8%	5.9%	5.9%	11.8%	
	22	4	2	2	4	**34**
Design my own research or investigation based on my own question(s)	50.0%	26.5%	8.8%	11.8%	2.9%	
	17	9	3	4	1	**34**
	91.2%	5.9%	0.0%	0.0%	2.9%	

[12] Dependent Samples t-test for STEM Engagement: $t(33)=5.38$, $p<.001$.

Present my STEM research to a panel of judges from industry or the military	31	2	0	0	1	**34**
Interact with STEM researchers	8.8%	8.8%	11.8%	29.4%	41.2%	
	3	3	4	10	14	**34**
Use laboratory procedures and tools	14.7%	14.7%	14.7%	26.5%	29.4%	
	5	5	5	9	10	**34**
Identify questions or problems to investigate	20.6%	17.6%	5.9%	38.2%	17.6%	
	7	6	2	13	6	**34**
Design and carry out an investigation	32.4%	23.5%	11.8%	23.5%	8.8%	
	11	8	4	8	3	**34**
Analyze data or information and draw conclusions	14.7%	11.8%	14.7%	35.3%	23.5%	
	5	4	5	12	8	**34**
Work collaboratively as part of a team	2.9%	11.8%	11.8%	35.3%	38.2%	
	1	4	4	12	13	**34**
Build or make a computer model	41.2%	14.7%	14.7%	26.5%	2.9%	
	14	5	5	9	1	**34**
Solve real world problems	26.5%	26.5%	11.8%	20.6%	14.7%	
	9	9	4	7	5	**34**

Chart 10. Apprentices' Engagement in STEM Practices in URAP Versus in School



ARMY EDUCATIONAL OUTREACH PROGRAM

Apprentices participating in interviews were also asked to reflect on how their URAP experiences compared with their typical coursework experiences in STEM. These apprentices noted that URAP provided them with substantially more hands-on and mentored work experience than their school lab experiences, that they had more independence in their research in URAP, and that they were able to apply their learning to real-world problems in unique ways in URAP. For example,

> *"In undergrad, a lot of times we're coddled, we're hand held and things are done for us. [My mentor] has done an amazing job with saying, 'This is what I want you to do. You can figure out whatever way you want to do it, but I need you to get it done.'"* (URAP Apprentice)

> *"In school, there's more theory. With my experience in URAP, it's totally applied logic. I'm not so invested into the mathematics. I'm not so invested into traditional problem solving with physics equations. I'm more concerned [with] learning how to use the equipment, learning to see if anything goes wrong with the equipment. I'm learning how to use computer programs."* (URAP Apprentice)

STEM Knowledge and Skills - Overall

A goal of AEOP apprenticeship programs is to expose students to STEM content and provide opportunities for apprentices to practice skills related to STEM. The evaluation therefore assessed apprentices' perceptions of their gains in knowledge of STEM topics, research, and how scientists work. Likewise, the evaluation assessed apprentics' self-reports of gains in various skills such as defining problems, using knowledge and creativity to propose solutions, creating models, carrying out various research-related activities, communicating information about research, and presenting data in various formats. Apprentices were also asked to report their gains in various 21st Century Skills associated with perseverance, flexibility, collaboration, and communication. Apprentices in all programs reported gains in their STEM knowledge and skills.

STEM Knowledge and Skills – Level and Setting Comparisons

Apprentices were asked to report their gains in STEM knowledge, STEM competencies, and 21st Century Skills during their AEOP apprenticeship. A composite score was calculated for each construct.[13] Response categories were converted to a scale of 1 = "No gain" to 4 = "Large gain" and the average across all items in each scale was calculated. Composite scores were used to test whether there were differences in apprentices' gains in STEM knowledge, STEM competencies, and 21st Century Skills by program level (high school vs. undergraduate) and setting (army lab vs. university-based). No statistically significant differences in any scale were found by setting. However, there was a significant difference in reported

[13] Cronbach's alpha reliabilities for: STEM knowledge (0.864), STEM competencies (0.944), and 21st Century Skills (0.895).

STEM knowledge gains and 21st Century Skills gains by program level with high school apprentices reporting greater gains compared to university level apprentices on both scales (STEM knowledge effect size is small with d = 0.294; 21st Century Skills effect size is small with d = 0.270).[14]

CQL

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in CQL, with more than 80% indicating some gains or large gains in each area of STEM knowledge (Table 59). For example, nearly all apprentices reported at least some gain in their in-depth knowledge of STEM topics (93%) and knowledge of research conducted in STEM fields (93%). STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. No significant differences existed by overall U2 classification. The only demographic differences in STEM knowledge gains found was by race/ethnicity with non-Minority students reporting significantly greater gains than Minority students (effect size is medium with d = 0.604).[15]

Table 59. Student Report of Impacts on STEM Knowledge (n=58)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	1.7%	5.2%	41.4%	51.7%	
	1	3	24	30	**58**
Knowledge of research conducted in a STEM topic or field	1.7%	5.2%	25.9%	67.2%	
	1	3	15	39	**58**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.4%	13.8%	41.4%	41.4%	
	2	8	24	24	**58**
Knowledge of how scientists and engineers work on real problems in STEM	1.7%	8.6%	34.5%	55.2%	
	1	5	20	32	**58**
Knowledge of what everyday research work is like in STEM	1.7%	8.6%	20.7%	69.0%	
	1	5	12	40	**58**

[14] Independent Samples t-test for STEM knowledge by program level: t(236)=2.26, p=.025; 21st Century Skills by program level: t(236)=2.08, p=.038.
[15] Independent Samples t-test for STEM knowledge by race/ethnicity: t(53)=2.20, p=.032.

Apprentices were also asked about CQL's impacts on their STEM competencies (Table 60). Two-thirds or more of the responding apprentices reported at least some in all competencies. For example, approximately 80% of apprentices reported some gains or large gains in areas such as communicating about their experiments and explanations in different ways (81%) and considering different interpretations of data when deciding how the data answer a question (79%). STEM competency composites were used to test for differential impacts by overall U2 and specific demographics that contribute to U2 status. No significant differences in STEM competencies were found by overall U2. The only demographic variable where significant differences in STEM competencies gains were found was college first generation status. Students who reported being a first generation college student indicated greater gains in STEM competencies compared to students who had a parent who attended college (effect size is medium with d = 0.639).[16]

Table 60. Apprentices Reporting Gains in Their STEM Competencies (n=58)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	5.2%	20.7%	34.5%	39.7%	
	3	12	20	23	**58**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	6.9%	19.0%	29.3%	44.8%	
	4	11	17	26	**58**
Considering different interpretations of data when deciding how the data answer a question	1.7%	19.0%	32.8%	46.6%	
	1	11	19	27	**58**
Supporting an explanation for an observation with data from experiments	3.4%	22.4%	25.9%	48.3%	
	2	13	15	28	**58**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	3.4%	22.4%	27.6%	46.6%	
	2	13	16	27	**58**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	3.4%	24.1%	22.4%	50.0%	
	2	14	13	29	**58**
Defending an argument that conveys how an explanation best describes an observation	5.2%	25.9%	31.0%	37.9%	
	3	15	18	22	**58**

[16] Independent Samples t-test for STEM competencies by first generation status: $t(55)=2.37$, $p=.021$.

Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	5.2%	19.0%	29.3%	46.6%	
	3	11	17	27	**58**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	6.9%	24.1%	27.6%	41.4%	
	4	14	16	24	**58**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	3.4%	15.5%	27.6%	53.4%	
	2	9	16	31	**58**

Apprentices were asked to report on CQL's impact on their 21st Century Skills – skills such as problem solving and communication that are necessary across a wide variety of fields (Table 61). More than three-quarters of apprentices reported some gains or large gains on each item. Items with the greatest endorsement of some or large gains were: communicating effectively with others (88%); sticking with a task until it is finished (88%); and learning to work independently (88%). Composites from the 21st Century Skills section of the questionnaire were used to test for differential impacts by overall U2 status and subgroups. Significant differences in 21st Century Skills gains were not found by overall U2. College first generation status was the only demographic variable where significant differences were found with students who reported being a first generation college student indicated greater gains in 21st Century Skills gains compared to students who had a parent that attended college (effect size is medium with d = 0.758).[17]

Table 61. Apprentice Report of Impacts on 21st Century Skills (n=58)

	No gain	A little gain	Some gain	Large gain	Response Total
Learning to work independently	5.2%	6.9%	36.2%	51.7%	
	3	4	21	30	**58**
Setting goals and reflecting on performance	6.9%	10.3%	25.9%	56.9%	
	4	6	15	33	**58**
Sticking with a task until it is finished	1.7%	10.3%	27.6%	60.3%	
	1	6	16	35	**58**

[17] Independent Samples t-test for 21st Century Skills by first generation status: $t(55)=2.81$, $p=.007$.

Making changes when things do not go as planned	1.7%	13.8%	15.5%	69.0%	
	1	8	9	40	**58**
Working well with people from all backgrounds	6.9%	17.2%	22.4%	53.4%	
	4	10	13	31	**58**
Including others' perspectives when making decisions	3.4%	15.5%	25.9%	55.2%	
	2	9	15	32	**58**
Communicating effectively with others	0.0%	12.1%	27.6%	60.3%	
	0	7	16	35	**58**
Viewing failure as an opportunity to learn	5.2%	12.1%	24.1%	58.6%	
	3	7	14	34	**58**

SEAP

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in SEAP, with 80% or more indicating some gains or large gains in each area of STEM knowledge (Table 62). For example, more than 90% of apprentices reported at least some gain in their knowledge of how scientists and engineers work on real problems in STEM (91%) and knowledge of what everyday research work is like in STEM (91%). STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 62. Student Report of Impacts on STEM Knowledge (n=35)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	14.3%	22.9%	62.9%	
	0	5	8	22	**35**
Knowledge of research conducted in a STEM topic or field	0.0%	11.4%	25.7%	62.9%	
	0	4	9	22	**35**
Knowledge of research processes, ethics, and rules for conduct in STEM	2.9%	17.1%	28.6%	51.4%	
	1	6	10	18	**35**
	0.0%	8.6%	25.7%	65.7%	

Knowledge of how scientists and engineers work on real problems in STEM	0	3	9	23	**35**
Knowledge of what everyday research work is like in STEM	0.0%	8.6%	14.3%	77.1%	
	0	3	5	27	**35**

Apprentices were also asked about SEAP's impacts on their STEM competencies (Table 63). Sixty percent or more of the responding apprentices reported at least some gains on all items presented in this section. Items with approximately three-quarters or more of apprentices reporting some gains or large gains were communicating about their experiments and explanations in different ways (74%) and supporting an explanation with relevant STEM knowledge (77%). STEM competency composites were used to test for differential impacts by overall U2 and specific demographics that contribute to U2 status. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 63. Apprentices Reporting Gains in Their STEM Competencies (n=35)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	20.0%	8.6%	34.3%	37.1%	
	7	3	12	13	**35**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	17.1%	20.0%	40.0%	22.9%	
	6	7	14	8	**35**
Considering different interpretations of data when deciding how the data answer a question	11.4%	17.1%	28.6%	42.9%	
	4	6	10	15	**35**
Supporting an explanation for an observation with data from experiments	8.6%	20.0%	28.6%	42.9%	
	3	7	10	15	**35**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	5.7%	17.1%	42.9%	34.3%	
	2	6	15	12	**35**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	17.1%	20.0%	31.4%	31.4%	
	6	7	11	11	**35**
Defending an argument that conveys how an explanation best describes an observation	22.9%	14.3%	25.7%	37.1%	
	8	5	9	13	**35**
	14.3%	20.0%	25.7%	40.0%	

Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	5	7	9	14	**35**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	14.3%	25.7%	25.7%	34.3%	
	5	9	9	12	**35**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	11.4%	14.3%	34.3%	40.0%	
	4	5	12	14	**35**

Apprentices were asked to report on SEAP's impact on their 21st Century Skills (Table 64). More than three-quarters of apprentices reported some gains or large gains on each item. Items with the greatest endorsement of some or large gains were learning to work independently (92%) and making changes when things do not go as planned (89%). Composites from the 21st Century Skills section of the survey were used to test for differential impacts by overall U2 status and subgroups. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 64. Apprentice Report of Impacts on 21st Century Skills (n=35)

	No gain	**A little gain**	**Some gain**	**Large gain**	**Response Total**
Learning to work independently	5.7%	2.9%	22.9%	68.6%	
	2	1	8	24	**35**
Setting goals and reflecting on performance	2.9%	14.3%	37.1%	45.7%	
	1	5	13	16	**35**
Sticking with a task until it is finished	0.0%	14.3%	37.1%	48.6%	
	0	5	13	17	**35**
Making changes when things do not go as planned	2.9%	8.6%	20.0%	68.6%	
	1	3	7	24	**35**
Working well with people from all backgrounds	5.7%	8.6%	25.7%	60.0%	
	2	3	9	21	**35**
Including others' perspectives when making decisions	5.7%	8.6%	34.3%	51.4%	
	2	3	12	18	**35**
Communicating effectively with others	2.9%	17.1%	28.6%	51.4%	

	1	6	10	18	**35**
Viewing failure as an opportunity to learn	8.6%	8.6%	31.4%	51.4%	
	3	3	11	18	**35**

STEM Knowledge and Skills - University-Based Programs

REAP

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in REAP, with approximately 90% or more indicating some gains or large gains in each area of STEM knowledge (Table 65). For example, nearly all apprentices reported at least some gain in their in-depth knowledge of STEM topics (95%); knowledge of research conducted in STEM fields (96%); and knowledge of what everyday research work is like in STEM (98%). STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. No significant differences existed by overall U2 classification. The only demographic differences in STEM knowledge gains found was by gender with males reporting significantly greater gains than females (effect size is extremely large with d = 0.673).[18]

Table 65. Apprentice Report of Impacts on STEM Knowledge (n=83)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	4.8%	33.7%	61.4%	
	0	4	28	51	**83**
Knowledge of research conducted in a STEM topic or field	0.0%	3.6%	24.1%	72.3%	
	0	3	20	60	**83**
Knowledge of research processes, ethics, and rules for conduct in STEM	2.4%	8.4%	21.7%	67.5%	
	2	7	18	56	**83**
Knowledge of how scientists and engineers work on real problems in STEM	1.2%	6.0%	27.7%	65.1%	
	1	5	23	54	**83**
	0.0%	2.4%	20.5%	77.1%	

[18] Independent Samples t-test for STEM knowledge by gender: t(62)=2.65, p=.010.

Knowledge of what everyday research work is like in STEM	0	2	17	64	**83**

Apprentices were also asked about REAP's impacts on their STEM competencies (Table 66). Approximately three-quarters or more of the responding apprentices reported at least some gains on all items presented in this section. For example, approximately 90% of apprentices reported some gains or large gains in areas such as: asking a question that can be answered with one or more scientific experiments (90%); supporting an explanation for an observation with data from experiments (92%); and supporting an explanation with relevant scientific STEM knowledge (92%). STEM competency composites were used to test for differential impacts by overall U2 and specific demographics that contribute to U2 status. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 66. Apprentices Reporting Gains in STEM Competencies (n=83)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	1.2%	8.4%	43.4%	47.0%	
	1	7	36	39	**83**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	3.6%	19.3%	30.1%	47.0%	
	3	16	25	39	**83**
Considering different interpretations of data when deciding how the data answer a question	3.6%	7.2%	34.9%	54.2%	
	3	6	29	45	**83**
Supporting an explanation for an observation with data from experiments	1.2%	7.2%	36.1%	55.4%	
	1	6	30	46	**83**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	0.0%	8.4%	32.5%	59.0%	
	0	7	27	49	**83**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	2.4%	10.8%	41.0%	45.8%	
	2	9	34	38	**83**
Defending an argument that conveys how an explanation best describes an observation	9.6%	18.1%	28.9%	43.4%	
	8	15	24	36	**83**
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	0.0%	18.1%	36.1%	45.8%	
	0	15	30	38	**83**
	2.4%	14.5%	34.9%	48.2%	

ARMY EDUCATIONAL OUTREACH PROGRAM

Integrating information from technical or scientific texts and other media to support your explanation of an observation	2	12	29	40	**83**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	1.2%	10.8%	28.9%	59.0%	
	1	9	24	49	**83**

Apprentices were asked to report on REAP's impact on their 21st Century Skills (Table 67). Approximately 90% or more of apprentices reported some gains or large gains on each item. Items Apprentices most frequently reported some or large gains in communicating effectively with others (96%) and sticking with a task until it is finished (95%). Composites from the 21st Century Skills section of the survey were used to test for differential impacts by overall U2 status and subgroups. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 67. Apprentice Report of Impacts on 21st Century Skills (n=83)

	No gain	A little gain	Some gain	Large gain	Response Total
Learning to work independently	2.4%	7.2%	25.3%	65.1%	
	2	6	21	54	**83**
Setting goals and reflecting on performance	0.0%	12.0%	21.7%	66.3%	
	0	10	18	55	**83**
Sticking with a task until it is finished	0.0%	4.8%	26.5%	68.7%	
	0	4	22	57	**83**
Making changes when things do not go as planned	1.2%	4.8%	25.3%	68.7%	
	1	4	21	57	**83**
Working well with people from all backgrounds	2.4%	6.0%	19.3%	72.3%	
	2	5	16	60	**83**
Including others' perspectives when making decisions	1.2%	9.6%	24.1%	65.1%	
	1	8	20	54	**83**
Communicating effectively with others	1.2%	2.4%	20.5%	75.9%	
	1	2	17	63	**83**
Viewing failure as an opportunity to learn	1.2%	4.8%	19.3%	74.7%	
	1	4	16	62	**83**

HSAP

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in HSAP, with 90% or more indicating some gains or large gains in each area of STEM knowledge (Table 68). All apprentices reported at least some gain in their knowledge of research conducted in STEM fields (100%) and knowledge of how scientists and engineers work on real problems in STEM. STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 68. Apprentice Report of Impacts on STEM Knowledge (n=19)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	10.5%	31.6%	57.9%	
	0	2	6	11	**19**
Knowledge of research conducted in a STEM topic or field	0.0%	0.0%	31.6%	68.4%	
	0	0	6	13	**19**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	10.5%	26.3%	63.2%	
	0	2	5	12	**19**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	36.8%	63.2%	
	0	0	7	12	**19**
Knowledge of what everyday research work is like in STEM	0.0%	5.3%	10.5%	84.2%	
	0	1	2	16	**19**

Apprentices were also asked about HSAP's impacts on their STEM competencies (Table 69). More than half of the responding apprentices reported at least some gains in all STEM competencies. For example, approximately 90% or more of apprentices reported some gains or large gains in areas such as communicating about their experiments and explanations in different ways (95%) and identifying the strengths and limitations of explanations in terms of how well they describe or predict observations (89%). STEM competency composites were used to test for differential impacts by overall U2 and specific demographics that contribute to U2 status. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

Table 69. Apprentice Report of Gains in STEM Competencies (n=19)

	No gain	Small gain	Medium gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	5.3%	31.6%	26.3%	36.8%	
	1	6	5	7	19
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	5.3%	26.3%	21.1%	47.4%	
	1	5	4	9	19
Considering different interpretations of data when deciding how the data answer a question	0.0%	21.1%	36.8%	42.1%	
	0	4	7	8	19
Supporting an explanation for an observation with data from experiments	5.3%	10.5%	36.8%	47.4%	
	1	2	7	9	19
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	0.0%	21.1%	31.6%	47.4%	
	0	4	6	9	19
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	5.3%	5.3%	52.6%	36.8%	
	1	1	10	7	19
Defending an argument that conveys how an explanation best describes an observation	10.5%	36.8%	15.8%	36.8%	
	2	7	3	7	19
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	10.5%	26.3%	21.1%	42.1%	
	2	5	4	8	19
Integrating information from technical or scientific texts and other media to support your explanation of an observation	10.5%	15.8%	36.8%	36.8%	
	2	3	7	7	19
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	0.0%	5.3%	36.8%	57.9%	
	0	1	7	11	19

Apprentices were asked to report on HSAP's impact on their 21st Century Skills (Table 70). More than two-thirds of apprentices reported some gains or large gains on each item. Items with the greatest endorsement of some or large gains were: sticking with a task until it is finished (95%); viewing failure as an opportunity to learn (95%); and setting goals and reflecting on performance (90%). Composites from the 21st Century Skills section of the survey were used to test for differential impacts by overall U2 status and subgroups. Significant differences in 21st Century Skills gains were found by overall U2 with underrepresented students indicating significantly greater gains than non-underrepresented students (effect size is large with d = 1.04).[19] No significant differences existed by individual demographics investigated.

Table 70. Apprentice Report of Impacts on 21st Century Skills (n=19)

	No gain	Small gain	Medium gain	Large gain	Response Total
Learning to work independently	0.0%	15.8%	42.1%	42.1%	
	0	3	8	8	**19**
Setting goals and reflecting on performance	5.3%	5.3%	42.1%	47.4%	
	1	1	8	9	**19**
Sticking with a task until it is finished	0.0%	5.3%	26.3%	68.4%	
	0	1	5	13	**19**
Making changes when things do not go as planned	0.0%	10.5%	21.1%	68.4%	
	0	2	4	13	**19**
Working well with people from all backgrounds	5.3%	26.3%	15.8%	52.6%	
	1	5	3	10	**19**
Including others' perspectives when making decisions	15.8%	15.8%	21.1%	47.4%	
	3	3	4	9	**19**
Communicating effectively with others	0.0%	26.3%	15.8%	57.9%	
	0	5	3	11	**19**
Viewing failure as an opportunity to learn	0.0%	5.3%	36.8%	57.9%	
	0	1	7	11	**19**

URAP

A large majority of apprentices reported gains in their STEM knowledge as a result of participating in URAP, with more than 85% indicating some gains or large gains in each area of STEM knowledge (Table 71). For example, nearly all apprentices reported at least some gain in their knowledge of research conducted in a STEM topic or field (91%) and knowledge of what everyday research work is like in STEM

[19] Independent Samples t-test for 21st Century Skills by U2 classification: t(26)=2.65, p=.013.

(91%). STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. No significant differences existed by overall U2 classification. The only demographic differences in STEM knowledge gains found was by first generation status with students of parents who went to college reporting significantly greater gains compared to first generation students (effect size is medium with d = 0.787).[20]

Table 71. Apprentice Report of Impact on STEM Knowledge (n=34)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	14.7%	44.1%	41.2%	
	0	5	15	14	**34**
Knowledge of research conducted in a STEM topic or field	0.0%	8.8%	29.4%	61.8%	
	0	3	10	21	**34**
Knowledge of research processes, ethics, and rules for conduct in STEM	5.9%	8.8%	32.4%	52.9%	
	2	3	11	18	**34**
Knowledge of how scientists and engineers work on real problems in STEM	5.9%	5.9%	35.3%	52.9%	
	2	2	12	18	**34**
Knowledge of what everyday research work is like in STEM	5.9%	2.9%	17.6%	73.5%	
	2	1	6	25	**34**

Apprentices were also asked about URAP's impacts on their STEM competencies (Table 72). Two-thirds or more of the responding apprentices reported at least some gains on all items presented in this section. Apprentices reported the most gains (some or large gains) in areas such as: communicating about their experiments and explanations in different ways (85%); supporting an explanation with relevant STEM knowledge (77%); identifying the strengths and limitations of explanations in terms of how well they describe or predict observations (77%); and defending an argument that conveys how an explanation best describes an observation (77%). STEM competency composites were used to test for differential impacts by overall U2 and specific demographics that contribute to U2 status. No significant differences existed by overall U2 classification or any of the individual demographics investigated.

[20] Independent Samples t-test for STEM knowledge by first generation status: t(53)=2.20, p=.032.

Table 72. Apprentices Reporting Gains in Their STEM Competencies (n=34)

	No gain	Small gain	Medium gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	17.6%	8.8%	38.2%	35.3%	
	6	3	13	12	**34**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	8.8%	23.5%	26.5%	41.2%	
	3	8	9	14	**34**
Considering different interpretations of data when deciding how the data answer a question	11.8%	14.7%	38.2%	35.3%	
	4	5	13	12	**34**
Supporting an explanation for an observation with data from experiments	5.9%	17.6%	38.2%	38.2%	
	2	6	13	13	**34**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	5.9%	17.6%	32.4%	44.1%	
	2	6	11	15	**34**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	5.9%	17.6%	44.1%	32.4%	
	2	6	15	11	**34**
Defending an argument that conveys how an explanation best describes an observation	5.9%	17.6%	44.1%	32.4%	
	2	6	15	11	**34**
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	8.8%	23.5%	35.3%	32.4%	
	3	8	12	11	**34**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	8.8%	20.6%	32.4%	38.2%	
	3	7	11	13	**34**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	2.9%	11.8%	47.1%	38.2%	
	1	4	16	13	**34**

Apprentices were asked to report on URAP's impact on their 21st Century Skills (Table 73). More than three-quarters of apprentices reported some gains or large gains on each item. Many items had at least 80% endorsement, the following are a few: making changes when things do not go as planned (88%); sticking with a task until it is finished (82%); and learning to work independently (82%). Composites from the 21st Century Skills section of the survey were used to test for differential impacts by overall U2 status and subgroups. Significant differences in 21st Century Skills gains were not found by overall U2 or any demographic variables tested.

Table 73. Apprentice Reports of Impacts on 21st Century Skills (n=34)

	No gain	Small gain	Medium gain	Large gain	Response Total
Learning to work independently	8.8%	8.8%	26.5%	55.9%	
	3	3	9	19	**34**
Setting goals and reflecting on performance	5.9%	14.7%	35.3%	44.1%	
	2	5	12	15	**34**
Sticking with a task until it is finished	5.9%	11.8%	26.5%	55.9%	
	2	4	9	19	**34**
Making changes when things do not go as planned	2.9%	8.8%	26.5%	61.8%	
	1	3	9	21	**34**
Working well with people from all backgrounds	2.9%	17.6%	32.4%	47.1%	
	1	6	11	16	**34**
Including others' perspectives when making decisions	8.8%	8.8%	26.5%	55.9%	
	3	3	9	19	**34**
Communicating effectively with others	8.8%	8.8%	32.4%	50.0%	
	3	3	11	17	**34**
Viewing failure as an opportunity to learn	5.9%	14.7%	23.5%	55.9%	
	2	5	8	19	**34**

STEM Identity and Confidence – Overall

Since STEM identity, or seeing oneself as capable of succeeding in STEM, has been linked to future interest and participation in STEM as a field of study and career choice,[21] apprenticeship programs in the AEOP portfolio emphasize supporting participants' STEM identities. Because of this, the apprentice

[21] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.

questionnaire included a series of items intended to measure the impact of their apprenticeship experience on apprentices' STEM identities and confidence.

STEM Identity and Confidence – Level and Setting Comparisons

Apprentices were asked to report the gains in STEM identity they experienced as a result of participating in their AEOP apprenticeship. A composite score was calculated for apprentice STEM identity.[22] Response categories were converted to a scale of 1 = "No gain" to 4 = "Large gain" and the average across all items the scale was calculated. Composite scores were used to test whether there were differences in apprentice STEM identity gains by program level (high school vs. undergraduate) and setting (army lab vs. university-based). No statistically significant differences in STEM identity were found by grade level or setting.

CQL

More than three-quarters of CQL apprentices reported some gains or large gains on all items associated with STEM identity (Table 74). For example, large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (91%) and feeling prepared for more challenging STEM activities (86%). STEM identity composite scores were used to evaluate differences by overall U2 status and demographic variables contributing to U2. No significant differences existed by overall U2 classification. The only demographic differences in STEM identity gains found was by first generation status with first generation students reporting significantly greater gains compared to students of parents who went to college (effect size is medium with d = 0.599).[23]

Table 74. Apprentice Report of Impacts on STEM Identity (n=58)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	8.6%	15.5%	31.0%	44.8%	
	5	9	18	26	**58**
Deciding on a path to pursue a STEM career	8.6%	15.5%	27.6%	48.3%	
	5	9	16	28	**58**
Sense of accomplishing something in STEM	1.7%	12.1%	25.9%	60.3%	
	1	7	15	35	**58**

[22] Cronbach's alpha reliability for STEM identity composite was 0.889.
[23] Independent Samples t-test for STEM identity by first generation status: t(55)=2.22, p=.030.

Feeling prepared for more challenging STEM activities	3.4%	10.3%	17.2%	69.0%	
	2	6	10	40	**58**
Confidence to try out new ideas or procedures on my own in a STEM project	1.7%	12.1%	19.0%	67.2%	
	1	7	11	39	**58**
Patience for the slow pace of STEM research	3.4%	13.8%	31.0%	51.7%	
	2	8	18	30	**58**
Desire to build relationships with mentors who work in STEM	1.7%	6.9%	22.4%	69.0%	
	1	4	13	40	**58**
Connecting a STEM topic or field to my personal values	6.9%	10.3%	20.7%	62.1%	
	4	6	12	36	**58**

SEAP

More than two-thirds of SEAP apprentices reported some gains or large gains on all items associated with STEM identity (Table 75). For example, large majorities of apprentices reported at least some gain in their sense of accomplishing something in STEM (94%) and feeling prepared for more challenging STEM activities (92%). STEM identity composite scores were used to evaluate differences by overall U2 status and demographic variables contributing to U2. No significant differences existed by overall U2 classification or individual demographic variables tested.

Table 75. Apprentice Report of Impacts on STEM Identity (n=35)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	14.3%	17.1%	25.7%	42.9%	
	5	6	9	15	**35**
Deciding on a path to pursue a STEM career	8.6%	8.6%	37.1%	45.7%	
	3	3	13	16	**35**
Sense of accomplishing something in STEM	0.0%	5.7%	37.1%	57.1%	
	0	2	13	20	**35**
Feeling prepared for more challenging STEM activities	0.0%	8.6%	22.9%	68.6%	
	0	3	8	24	**35**

Confidence to try out new ideas or procedures on my own in a STEM project	2.9%	11.4%	28.6%	57.1%	
	1	4	10	20	**35**
Patience for the slow pace of STEM research	2.9%	25.7%	31.4%	40.0%	
	1	9	11	14	**35**
Desire to build relationships with mentors who work in STEM	0.0%	14.3%	25.7%	60.0%	
	0	5	9	21	**35**
Connecting a STEM topic or field to my personal values	17.1%	11.4%	22.9%	48.6%	
	6	4	8	17	**35**

STEM Identity and Confidence – University-Based Programs

REAP

More than three-quarters of REAP apprentices reported some gains or large gains on all items associated with STEM identity (Table 76). For example, large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (94%) and feeling prepared for more challenging STEM activities (94%). STEM identity composite scores were used to evaluate differences by overall U2 status and demographic variables contributing to U2. No significant differences existed by overall U2 classification. The only demographic differences in STEM identity gains found was by race/ethnicity with Minority students reporting significantly greater gains compared to non-Minority students (effect size is medium with d = 0.531).[24]

Table 76. Apprentice Report of Impacts on STEM Identity (n=83)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	6.0%	7.2%	30.1%	56.6%	
	5	6	25	47	**83**
Deciding on a path to pursue a STEM career	2.4%	15.7%	33.7%	48.2%	
	2	13	28	40	**83**
	0.0%	10.8%	20.5%	68.7%	

[24] Independent Samples t-test for STEM identity by race/ethnicity: t(59)=2.04, p=.046.

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Sense of accomplishing something in STEM	0	9	17	57	**83**
Feeling prepared for more challenging STEM activities	0.0%	6.0%	22.9%	71.1%	
	0	5	19	59	**83**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	8.4%	27.7%	63.9%	
	0	7	23	53	**83**
Patience for the slow pace of STEM research	1.2%	7.2%	30.1%	61.4%	
	1	6	25	51	**83**
Desire to build relationships with mentors who work in STEM	1.2%	4.8%	18.1%	75.9%	
	1	4	15	63	**83**
Connecting a STEM topic or field to my personal values	1.2%	12.0%	30.1%	56.6%	
	1	10	25	47	**83**

HSAP

More than two-thirds of HSAP apprentices reported some gains or large gains on all items associated with STEM identity (Table 77). For example, large majorities of apprentices reported at least some gain in the following areas: feeling prepared for more challenging STEM activities (90%); their sense of accomplishing something in STEM (90%); and connecting a STEM topic or field to their personal values (90%). STEM identity composite scores were used to evaluate differences by overall U2 status and demographic variables contributing to U2. No significant differences existed by overall U2 classification or individual demographic variables tested.

Table 77. Apprentice Report of Impacts on STEM Identity (n=19)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	10.5%	15.8%	15.8%	57.9%	
	2	3	3	11	**19**
Deciding on a path to pursue a STEM career	10.5%	15.8%	15.8%	57.9%	
	2	3	3	11	**19**
Sense of accomplishing something in STEM	0.0%	10.5%	21.1%	68.4%	
	0	2	4	13	**19**

Feeling prepared for more challenging STEM activities	0.0%	10.5%	26.3%	63.2%	
	0	2	5	12	**19**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	15.8%	52.6%	31.6%	
	0	3	10	6	**19**
Patience for the slow pace of STEM research	5.3%	26.3%	21.1%	47.4%	
	1	5	4	9	**19**
Desire to build relationships with mentors who work in STEM	0.0%	15.8%	15.8%	68.4%	
	0	3	3	13	**19**
Connecting a STEM topic or field to my personal values	5.3%	5.3%	31.6%	57.9%	
	1	1	6	11	**19**

URAP

More than two-thirds of URAP apprentices reported some gains or large gains on all items associated with STEM identity (Table 78). For example, more than 80% of apprentices reported at least some gain in the following areas: their desire to build relationships with mentors who work in STEM (82%); their sense of accomplishing something in STEM (82%); and feeling prepared for more challenging STEM activities (85%). STEM identity composite scores were used to evaluate differences by overall U2 status and demographic variables contributing to U2. No significant differences existed by overall U2 classification or individual demographic variables tested.

Table 78. Apprentice Report of Impacts on STEM Identity (n=34)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
Interest in a new STEM topic	11.8%	8.8%	41.2%	38.2%	
	4	3	14	13	**34**
Deciding on a path to pursue a STEM career	20.6%	11.8%	32.4%	35.3%	
	7	4	11	12	**34**
Sense of accomplishing something in STEM	8.8%	8.8%	41.2%	41.2%	
	3	3	14	14	**34**
	5.9%	8.8%	29.4%	55.9%	

Feeling prepared for more challenging STEM activities	2	3	10	19	**34**
Confidence to try out new ideas or procedures on my own in a STEM project	5.9%	14.7%	23.5%	55.9%	
	2	5	8	19	**34**
Patience for the slow pace of STEM research	17.6%	11.8%	32.4%	38.2%	
	6	4	11	13	**34**
Desire to build relationships with mentors who work in STEM	8.8%	8.8%	20.6%	61.8%	
	3	3	7	21	**34**
Connecting a STEM topic or field to my personal values	2.9%	23.5%	23.5%	50.0%	
	1	8	8	17	**34**

6

6 | Priority #2 Findings

Support and empower educators with unique Army research and technology resources.

Mentor Strategies and Support – Overall

Mentors play a critical role in the apprenticeship programs. Mentors supervise and support apprentices' work, advise apprentices on educational and career paths, and generally serve as STEM role models for apprentices.

Mentors were asked whether or not they used a number of strategies when working with their apprentices (note: the questionnaires used the term "students"; consequently, the data in this section are reported using that term as well). These strategies comprised five main areas of effective mentoring:[25]

1. Establishing the relevance of learning activities;
2. Supporting the diverse needs of students as learners;
3. Supporting students' development of collaboration and interpersonal skills;
4. Supporting students' engagement in "authentic" STEM activities; and
5. Supporting students' STEM educational and career pathways.

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[25] Mentoring strategies examined in the evaluation were best practices identified in various articles including:

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877-907.

Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation (2005-51-Ornstein). *Journal of Science Education and Technology*, *15*(3-4), 285-297.

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

Mentor Strategies and Support – Army-Based Laboratory Programs

CQL

Large proportions of CQL mentors reported using several strategies to help make learning activities relevant to students (Table 79). For example, nearly all reported becoming familiar with their students' backgrounds and interests (94%) and giving students real-life problems to investigate or solve (100%). Strategies used somewhat less frequently were encouraging students to suggest new readings, activities, or projects (53%); selecting readings or activities that related to students' backgrounds (65%); and asking students to relate real-life events or activities to topics covered in CQL (65%).

Table 79. Mentors Using Strategies to Establish Relevance of Learning Activities (n=17)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the CQL experience	94.1%	5.9%	
	16	1	**17**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	17	0	**17**
Selecting readings or activities that relate to students' backgrounds	64.7%	35.3%	
	11	6	**17**
Encouraging students to suggest new readings, activities, or projects	52.9%	47.1%	
	9	8	**17**
Helping students become aware of the role(s) that STEM plays in their everyday lives	76.5%	23.5%	
	13	4	**17**
Helping students understand how STEM can help them improve their own community	76.5%	23.5%	
	13	4	**17**
Asking students to relate real-life events or activities to topics covered in CQL	64.7%	35.3%	
	11	6	**17**

Similarly, CQL mentors reported using a variety of strategies to support the diverse needs of students as learners (Table 80). Nearly 90% of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (88%); direct students to other individuals or programs for additional support as needed (88%); and interact with students and other personnel the same way regardless of their background (88%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (47%).

Table 80. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=17)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the CQL experience	82.4%	17.6%	
	14	3	**17**
Interact with students and other personnel the same way regardless of their background	88.2%	11.8%	
	15	2	**17**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	88.2%	11.8%	
	15	2	**17**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	70.6%	29.4%	
	12	5	**17**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	70.6%	29.4%	
	12	5	**17**
Directing students to other individuals or programs for additional support as needed	88.2%	11.8%	
	15	2	**17**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	47.1%	52.9%	
	8	9	**17**

Most mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 81). Over three-quarters of mentors (82%-100%) reported using all strategies except having students explain difficult ideas to each other (71%).

Table 81. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=17)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	94.1%	5.9%	
	16	1	**17**

Having my student(s) explain difficult ideas to others	70.6%	29.4%	
	12	5	**17**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	17	0	**17**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	94.1%	5.9%	
	16	1	**17**
Having my student(s) give and receive constructive feedback with others	82.4%	17.6%	
	14	3	**17**
Having students work on collaborative activities or projects as a member of a team	82.4%	17.6%	
	14	3	**17**
Allowing my student(s) to resolve conflicts and reach agreement within their team	82.4%	17.6%	
	14	3	**17**

When asked about strategies to support students' engagement in authentic STEM activities (Table 82), more than three-quarters (82%-88%) of CQL mentors reported using all strategies except one. Only 47% of mentors indicated they had their students search for and review technical research to support their work.

Table 82. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=17)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	82.4%	17.6%	
	14	3	**17**
Having my student(s) search for and review technical research to support their work	47.1%	52.9%	
	8	9	**17**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	82.4%	17.6%	
	14	3	**17**
Supervising my student(s) while they practice STEM research skills	82.4%	17.6%	
	14	3	**17**
	88.2%	11.8%	

Providing my student(s) with constructive feedback to improve their STEM competencies	15	2	**17**
Allowing students to work independently to improve their self-management abilities	88.2%	11.8%	
	15	2	**17**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	82.4%	17.6%	
	14	3	**17**
Encouraging students to seek support from other team members	88.2%	11.8%	
	15	2	**17**

The last series of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 83). All (100%) responding mentors reported asking students about their educational and career interests. Most also provided guidance about educational pathways that will prepare students for a STEM career (94%) and discussed STEM career opportunities within the DoD or other government agencies (88%). Less than half of mentors reported helping students with their resume, application, personal statement, and/or interview preparations (41%).

Table 83. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=17)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	100.0%	0.0%	
	17	0	**17**
Recommending extracurricular programs that align with students' goals	70.6%	29.4%	
	12	5	**17**
Recommending Army Educational Outreach Programs that align with students' goals	70.6%	29.4%	
	12	5	**17**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	94.1%	5.9%	
	16	1	**17**
Discussing STEM career opportunities within the DoD or other government agencies	88.2%	11.8%	
	15	2	**17**
Discussing STEM career opportunities in private industry or academia	64.7%	35.3%	
	11	6	**17**

Discussing the economic, political, ethical, and/or social context of a STEM career	70.6%	29.4%	
	12	5	**17**
Recommending student and professional organizations in STEM to my student(s)	58.8%	41.2%	
	10	7	**17**
Helping students build a professional network in a STEM field	52.9%	47.1%	
	9	8	**17**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	41.2%	58.8%	
	7	10	**17**

SEAP

Two-thirds or more of SEAP mentors reported using several strategies to help make learning activities relevant to students (Table 84). For example, all reported becoming familiar with their students' backgrounds and interests (100%) and giving students real-life problems to investigate or solve (100%). Strategies used somewhat less frequently were helping students understand how STEM can help them improve their own community (65%); selecting readings or activities that related to students' backgrounds (70%); and helping students become aware of the role(s) that STEM plays in their everyday lives (70%).

Table 84. Mentors Using Strategies to Establish Relevance of Learning Activities (n=20)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the SEAP experience	100.0%	0.0%	
	20	0	**20**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	20	0	**20**
Selecting readings or activities that relate to students' backgrounds	70.0%	30.0%	
	14	6	**20**
Encouraging students to suggest new readings, activities, or projects	75.0%	25.0%	
	15	5	**20**
Helping students become aware of the role(s) that STEM plays in their everyday lives	70.0%	30.0%	
	14	6	**20**

Helping students understand how STEM can help them improve their own community	65.0%	35.0%	
	13	7	**20**
Asking students to relate real-life events or activities to topics covered in SEAP	75.0%	25.0%	
	15	5	**20**

Similarly, two-thirds or more of SEAP mentors reported using most strategies to support the diverse needs of students as learners (Table 85). For example, all mentors used a variety of teaching/mentoring activities to meet the needs of all students (100%); interact with students and other personnel the same way regardless of their background (80%); and direct students to other individuals or programs for additional support as needed (80%). Fewer mentors reported integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (35%) and highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (40%).

Table 85. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=20)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the SEAP experience	65.0%	35.0%	
	13	7	**20**
Interact with students and other personnel the same way regardless of their background	80.0%	20.0%	
	16	4	**20**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	20	0	**20**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	35.0%	65.0%	
	7	13	**20**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	70.0%	30.0%	
	14	6	**20**
Directing students to other individuals or programs for additional support as needed	80.0%	20.0%	
	16	4	**20**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	40.0%	60.0%	
	8	12	**20**

Most mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 86). Three-quarters of SEAP mentors or more (65%-95%) reported using all strategies except allowing students to resolve conflicts and reach agreement within their team (65%).

Table 86. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=20)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	90.0%	10.0%	
	18	2	**20**
Having my student(s) explain difficult ideas to others	95.0%	5.0%	
	19	1	**20**
Having my student(s) listen to the ideas of others with an open mind	95.0%	5.0%	
	19	1	**20**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	85.0%	15.0%	
	17	3	**20**
Having my student(s) give and receive constructive feedback with others	85.0%	15.0%	
	17	3	**20**
Having students work on collaborative activities or projects as a member of a team	85.0%	15.0%	
	17	3	**20**
Allowing my student(s) to resolve conflicts and reach agreement within their team	65.0%	35.0%	
	13	7	**20**

When asked about strategies to support students' engagement in authentic STEM activities (Table 87), more than three-quarters (80%-100%) of SEAP mentors reported using all strategies but one. Only 70% of mentors indicated they had their students search for and review technical research to support their work.

Table 87. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=20)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	80.0%	20.0%	
	16	4	**20**

Having my student(s) search for and review technical research to support their work	70.0%	30.0%	
	14	6	**20**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	20	0	**20**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	20	0	**20**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	20	0	**20**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	20	0	**20**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	80.0%	20.0%	
	16	4	**20**
Encouraging students to seek support from other team members	90.0%	10.0%	
	18	2	**20**

The last series of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 88). All (100%) responding mentors reported asking students about their educational and career interests. Most also provided guidance about educational pathways that will prepare students for a STEM career (85%) and discussed STEM career opportunities in private industry or academia (80%). Strategies SEAP mentors used least include discussing the economic, political, ethical, and/or social context of a STEM career (35%) and recommending student and professional organizations in STEM to their students (35%).

Table 88. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=20)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	100.0%	0.0%	
	20	0	**20**
Recommending extracurricular programs that align with students' goals	55.0%	45.0%	
	11	9	**20**
	40.0%	60.0%	

Recommending Army Educational Outreach Programs that align with students' goals	8	12	**20**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	85.0%	15.0%	
	17	3	**20**
Discussing STEM career opportunities within the DoD or other government agencies	75.0%	25.0%	
	15	5	**20**
Discussing STEM career opportunities in private industry or academia	80.0%	20.0%	
	16	4	**20**
Discussing the economic, political, ethical, and/or social context of a STEM career	35.0%	65.0%	
	7	13	**20**
Recommending student and professional organizations in STEM to my student(s)	35.0%	65.0%	
	7	13	**20**
Helping students build a professional network in a STEM field	60.0%	40.0%	
	12	8	**20**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	40.0%	60.0%	
	8	12	**20**

Mentor Strategies and Support – University-Based Programs

REAP

Approximately three-quarters or more of REAP mentors (73%-93%) reported using several strategies to help make learning activities relevant to students (Table 89). For example, nearly all reported becoming familiar with their students' backgrounds and interests (93%) and giving students real-life problems to investigate or solve (91%).

Table 89. Mentors Using Strategies to Establish Relevance of Learning Activities (n=67)

	Yes - I used this strategy	**No - I did not use this strategy**	**Response Total**
Become familiar with my student(s) background and interests at the beginning of the REAP experience	92.5%	7.5%	
	62	5	**67**

Giving students real-life problems to investigate or solve	91.0%	9.0%	
	61	6	**67**
Selecting readings or activities that relate to students' backgrounds	79.1%	20.9%	
	53	14	**67**
Encouraging students to suggest new readings, activities, or projects	77.6%	22.4%	
	52	15	**67**
Helping students become aware of the role(s) that STEM plays in their everyday lives	82.1%	17.9%	
	55	12	**67**
Helping students understand how STEM can help them improve their own community	73.1%	26.9%	
	49	18	**67**
Asking students to relate real-life events or activities to topics covered in REAP	77.6%	22.4%	
	52	15	**67**

Similarly, a majority of mentors reported using all strategies to support the diverse needs of students as learners (Table 90). More than 80% of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (91%); interacting with students and other personnel the same way regardless of their background (85%); and providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (84%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (55%) and identifying different learning styles students may have (58%).

Table 90. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=67)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the HSAP experience	58.2%	41.8%	
	39	28	**67**
Interact with students and other personnel the same way regardless of their background	85.1%	14.9%	
	57	10	**67**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	91.0%	9.0%	
	61	6	**67**
	67.2%	32.8%	

Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	45	22	**67**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	83.6%	16.4%	
	56	11	**67**
Directing students to other individuals or programs for additional support as needed	79.1%	20.9%	
	53	14	**67**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	55.2%	44.8%	
	37	30	**67**

Most mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 91). More than three-quarters or more of mentors (76%-87%) reported using all strategies except allowing students to resolve conflicts and reach agreement within their team (72%).

Table 91. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=67)

	Yes - I used this strategy	**No - I did not use this strategy**	**Response Total**
Having my student(s) tell other people about their backgrounds and interests	76.1%	23.9%	
	51	16	**67**
Having my student(s) explain difficult ideas to others	79.1%	20.9%	
	53	14	**67**
Having my student(s) listen to the ideas of others with an open mind	86.6%	13.4%	
	58	9	**67**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	77.6%	22.4%	
	52	15	**67**
Having my student(s) give and receive constructive feedback with others	79.1%	20.9%	
	53	14	**67**
Having students work on collaborative activities or projects as a member of a team	85.1%	14.9%	
	57	10	**67**
Allowing my student(s) to resolve conflicts and reach agreement within their team	71.6%	28.4%	
	48	19	**67**

When asked about strategies to support students' engagement in authentic STEM activities (Table 92), more than three-quarters (81%-97%) of REAP mentors reported using all strategies. Strategies reportedly used the most were teaching (or assigning readings) about specific STEM subject matter (97%) and allowing students to work independently to improve their self-management abilities (96%).

Table 92. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=67)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	97.0%	3.0%	
	65	2	**67**
Having my student(s) search for and review technical research to support their work	80.6%	19.4%	
	54	13	**67**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	91.0%	9.0%	
	61	6	**67**
Supervising my student(s) while they practice STEM research skills	92.5%	7.5%	
	62	5	**67**
Providing my student(s) with constructive feedback to improve their STEM competencies	91.0%	9.0%	
	61	6	**67**
Allowing students to work independently to improve their self-management abilities	95.5%	4.5%	
	64	3	**67**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	85.1%	14.9%	
	57	10	**67**
Encouraging students to seek support from other team members	82.1%	17.9%	
	55	12	**67**

The last series of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 93). Nearly all (99%) responding mentors reported asking students about their educational and career interests. Most also provided guidance about educational pathways that will prepare students for a STEM career (88%) and discussed STEM career opportunities within the DoD or other government agencies (81%). Less than half of mentors reported helping students with their resume, application, personal statement, and/or interview preparations (48%).

Table 93. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=67)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	98.5%	1.5%	
	66	1	**67**
Recommending extracurricular programs that align with students' goals	73.1%	26.9%	
	49	18	**67**
Recommending Army Educational Outreach Programs that align with students' goals	65.7%	34.3%	
	44	23	**67**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	88.1%	11.9%	
	59	8	**67**
Discussing STEM career opportunities within the DoD or other government agencies	67.2%	32.8%	
	45	22	**67**
Discussing STEM career opportunities in private industry or academia	80.6%	19.4%	
	54	13	**67**
Discussing the economic, political, ethical, and/or social context of a STEM career	52.2%	47.8%	
	35	32	**67**
Recommending student and professional organizations in STEM to my student(s)	61.2%	38.8%	
	41	26	**67**
Helping students build a professional network in a STEM field	64.2%	35.8%	
	43	24	**67**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	47.8%	52.2%	
	32	35	**67**

HSAP

Either four of four or three of four HSAP mentors reported using all strategies to help make learning activities relevant to students (Table 94). The only two strategies that all four mentors did not report using were helping students understand how STEM can help them improve their own community (75%) and asking students to relate real-life events or activities to topics covered in HSAP (75%).

Table 94. Mentors Using Strategies to Establish Relevance of Learning Activities (n=24)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the HSAP experience	100.0%	0.0%	
	4	0	**4**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	4	0	**4**
Selecting readings or activities that relate to students' backgrounds	100.0%	0.0%	
	4	0	**4**
Encouraging students to suggest new readings, activities, or projects	100.0%	0.0%	
	4	0	**4**
Helping students become aware of the role(s) that STEM plays in their everyday lives	100.0%	0.0%	
	4	0	**4**
Helping students understand how STEM can help them improve their own community	75.0%	25.0%	
	3	1	**4**
Asking students to relate real-life events or activities to topics covered in HSAP	75.0%	25.0%	
	3	1	**4**

Again, all mentors or all but one mentor reported using each strategies to support the diverse needs of students as learners (Table 95). The only two items with 75% of mentors (3 of 4 mentors) reporting they used the strategy were: identifying different learning styles that students have as well as integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM.

Table 95. Mentors Using Strategies to Support the Diverse needs of Students as Learners (n=4)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the HSAP experience	75.0%	25.0%	
	3	1	**4**
Interact with students and other personnel the same way regardless of their background	100.0%	0.0%	
	4	0	**4**

Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	4	0	**4**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	75.0%	25.0%	
	3	1	**4**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	100.0%	0.0%	
	4	0	**4**
Directing students to other individuals or programs for additional support as needed	100.0%	0.0%	
	4	0	**4**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	100.0%	0.0%	
	4	0	**4**

Similarly, all mentors or all but one indicated using each strategy to support student development of collaboration and interpersonal skills (Table 96). One mentor reported not using the strategy of allowing students to resolve conflicts and reach agreement within their team.

Table 96. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=4)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	100.0%	0.0%	
	4	0	**4**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	4	0	**4**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	4	0	**4**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	100.0%	0.0%	
	4	0	**4**
Having my student(s) give and receive constructive feedback with others	100.0%	0.0%	
	4	0	**4**
	100.0%	0.0%	

Having students work on collaborative activities or projects as a member of a team	4	0	**4**
Allowing my student(s) to resolve conflicts and reach agreement within their team	75.0%	25.0%	
	3	1	**4**

All four HSAP mentors who responded to the survey indicated using each strategy to support student engagement in authentic STEM activities (Table 97).

Table 97. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=4)

	Yes - I used this strategy	**No - I did not use this strategy**	**Response Total**
Teaching (or assigning readings) about specific STEM subject matter	100.0%	0.0%	
	4	0	**4**
Having my student(s) search for and review technical research to support their work	100.0%	0.0%	
	4	0	**4**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	4	0	**4**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	4	0	**4**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	4	0	**4**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	4	0	**4**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	4	0	**4**
Encouraging students to seek support from other team members	100.0%	0.0%	
	4	0	**4**

The last series of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 98). Responding mentors (75%-100%) indicated using all STEM educational and career pathways strategies. Two out of the four (50%) mentors reported helping students with their resume, application, personal statement, and/or interview preparations.

Table 98. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=4)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	100.0%	0.0%	
	4	0	**4**
Recommending extracurricular programs that align with students' goals	75.0%	25.0%	
	3	1	**4**
Recommending Army Educational Outreach Programs that align with students' goals	100.0%	0.0%	
	4	0	**4**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	100.0%	0.0%	
	4	0	**4**
Discussing STEM career opportunities within the DoD or other government agencies	75.0%	25.0%	
	3	1	**4**
Discussing STEM career opportunities in private industry or academia	100.0%	0.0%	
	4	0	**4**
Discussing the economic, political, ethical, and/or social context of a STEM career	75.0%	25.0%	
	3	1	**4**
Recommending student and professional organizations in STEM to my student(s)	100.0%	0.0%	
	4	0	**4**
Helping students build a professional network in a STEM field	100.0%	0.0%	
	4	0	**4**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	50.0%	50.0%	
	2	2	**4**

URAP

Large proportions of URAP mentors reported using several strategies to help make learning activities relevant to students (Table 99). For example, nearly all reported becoming familiar with their students' backgrounds and interests (96%) and encouraging students to suggest new readings, activities, or projects (93%). Strategies used somewhat less frequently were helping students understand how STEM can help them improve their own community (44%) as well as helping students become aware of the role STEM plays in their everyday lives (67%).

Table 99. Mentors Using Strategies to Establish Relevance of Learning Activities (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the URAP experience	96.3%	3.7%	
	26	1	**27**
Giving students real-life problems to investigate or solve	85.2%	14.8%	
	23	4	**27**
Selecting readings or activities that relate to students' backgrounds	88.9%	11.1%	
	24	3	**27**
Encouraging students to suggest new readings, activities, or projects	92.6%	7.4%	
	25	2	**27**
Helping students become aware of the role(s) that STEM plays in their everyday lives	66.7%	33.3%	
	18	9	**27**
Helping students understand how STEM can help them improve their own community	44.4%	55.6%	
	12	15	**27**
Asking students to relate real-life events or activities to topics covered in URAP	77.8%	22.2%	
	21	6	**27**

Likewise, mentors reported using a variety of strategies to support the diverse needs of students as learners (Table 100). Nearly 90% of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (90%); directing students to other individuals or programs for additional support as needed (85%); and interacting with students and other personnel the same way regardless of their background (85%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (41%).

Table 100. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the URAP experience	77.8%	22.2%	
	21	6	**27**

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Interact with students and other personnel the same way regardless of their background	85.2%	14.8%	
	23	4	**27**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	88.9%	11.1%	
	24	3	**27**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	59.3%	40.7%	
	16	11	**27**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	81.5%	18.5%	
	22	5	**27**
Directing students to other individuals or programs for additional support as needed	85.2%	14.8%	
	23	4	**27**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	40.7%	59.3%	
	11	16	**27**

Most mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 101). Over three-quarters of mentors (85%-93%) reported using all strategies except allowing students to resolve conflicts and reach agreements within their team (70%).

Table 101. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	85.2%	14.8%	
	23	4	**27**
Having my student(s) explain difficult ideas to others	92.6%	7.4%	
	25	2	**27**
Having my student(s) listen to the ideas of others with an open mind	92.6%	7.4%	
	25	2	**27**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	85.2%	14.8%	
	23	4	**27**
	85.2%	14.8%	

Having my student(s) give and receive constructive feedback with others	23	4	**27**
Having students work on collaborative activities or projects as a member of a team	92.6%	7.4%	
	25	2	**27**
Allowing my student(s) to resolve conflicts and reach agreement within their team	70.4%	29.6%	
	19	8	**27**

When asked about strategies to support students' engagement in authentic STEM activities (Table 102), more than three-quarters (90%-100%) of URAP mentors reported using all strategies.

Table 102. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=27)

	Yes - I used this strategy	**No - I did not use this strategy**	**Response Total**
Teaching (or assigning readings) about specific STEM subject matter	88.9%	11.1%	
	24	3	**27**
Having my student(s) search for and review technical research to support their work	88.9%	11.1%	
	24	3	**27**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	92.6%	7.4%	
	25	2	**27**
Supervising my student(s) while they practice STEM research skills	96.3%	3.7%	
	26	1	**27**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	27	0	**27**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	27	0	**27**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	27	0	**27**
Encouraging students to seek support from other team members	100.0%	0.0%	
	27	0	**27**

The final group of items about mentoring strategies focused on supporting students' STEM educational and career pathways (Table 103). All (100%) responding URAP mentors reported asking students about their educational and career goals. Most also provided guidance about educational pathways that will prepare students for a STEM career (90%); discussed STEM career opportunities in private industry or academia (74%); and helped students build a professional network in a STEM field (74%). Less than half of mentors reported discussing the economic, political, ethical, and/or social context of a STEM career (44%).

Table 103. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	100.0%	0.0%	
	27	0	**27**
Recommending extracurricular programs that align with students' goals	66.7%	33.3%	
	18	9	**27**
Recommending Army Educational Outreach Programs that align with students' goals	70.4%	29.6%	
	19	8	**27**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	88.9%	11.1%	
	24	3	**27**
Discussing STEM career opportunities within the DoD or other government agencies	63.0%	37.0%	
	17	10	**27**
Discussing STEM career opportunities in private industry or academia	74.1%	25.9%	
	20	7	**27**
Discussing the economic, political, ethical, and/or social context of a STEM career	44.4%	55.6%	
	12	15	**27**
Recommending student and professional organizations in STEM to my student(s)	55.6%	44.4%	
	15	12	**27**
Helping students build a professional network in a STEM field	74.1%	25.9%	
	20	7	**27**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	66.7%	33.3%	
	18	9	**27**

Program Features and Satisfaction – Overall

Participant satisfaction with program features and experiences can influence the number and quality of future apprentices and mentors, factors central to the success of the AEOP's apprenticeship programs. To gain insight into participant satisfaction, both apprentices and mentors were asked to respond to questionnaire items about their satisfaction with various components of the program.

Program Features and Satisfaction - Army Laboratory-Based Programs

CQL

Apprentices were asked how satisfied they were with a number of features of the CQL program (Table 105). Approximately half or more of responding apprentices were somewhat or very much satisfied with all of the listed program features. Features apprentices reported being most satisfied with included: the physical location of program activities (95%); amount of the stipend (95%); and timeliness of receiving stipend (95%). Few apprentices expressed dissatisfaction with CQL program features, although 22% of students were not satisfied with administrative tasks such as security clearances and issuing CAC cards.

Table 105. Student Satisfaction with CQL Program Features (n=58)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	3.4%	20.7%	27.6%	48.3%	
	0	2	12	16	28	**58**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	0.0%	22.4%	31.0%	20.7%	25.9%	
	0	13	18	12	15	**58**
Communicating with your host site organizers	3.4%	0.0%	6.9%	37.9%	51.7%	
	2	0	4	22	30	**58**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	5.2%	32.8%	62.1%	
	0	0	3	19	36	**58**
The variety of STEM topics available to you in the Apprenticeship Program	1.7%	1.7%	5.2%	25.9%	65.5%	
	1	1	3	15	38	**58**
Teaching or mentoring provided during Apprenticeship Program activities	1.7%	1.7%	3.4%	13.8%	79.3%	
	1	1	2	8	46	**58**
Amount of stipend (payment)	0.0%	0.0%	5.2%	31.0%	63.8%	
	0	0	3	18	37	**58**
Timeliness of receiving stipend (payment)	0.0%	1.7%	3.4%	20.7%	74.1%	
	0	1	2	12	43	**58**
Research abstract preparation requirements	5.2%	0.0%	10.3%	27.6%	56.9%	
	3	0	6	16	33	**58**

Apprentices were also asked about the availability of their mentors during CQL (Table 106). Nearly all apprentices reported that their mentor was available at least half of the time (95%), and more than half (57%) indicated their mentor was always available.

Table 106. Apprentice Reports of Availability of Mentors (n=58)

	Response Percent	Response Total
I did not have a mentor	1.72 %	1
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	3.45 %	2
The mentor was available about half of the time of my project	6.90 %	4

The mentor was available more than half of the time	31.03 %	18
The mentor was always available	56.90 %	33

CQL apprentices were asked about their satisfaction with various elements of their research experience (Table 107). Approximately two-thirds or more indicated being "very much" satisfied with all elements of their experience (ranging from 62%-85%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 88%-95%).

Table 107. Apprentice Satisfaction with Their Experience (n=58)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	3.4%	1.7%	10.3%	84.5%	
	0	2	1	6	49	**58**
My working relationship with the group or team	3.4%	3.4%	1.7%	8.6%	82.8%	
	2	2	1	5	48	**58**
The amount of time I spent doing meaningful research	3.4%	5.2%	3.4%	25.9%	62.1%	
	2	3	2	15	36	**58**
The amount of time I spent with my research mentor	1.7%	1.7%	8.6%	15.5%	72.4%	
	1	1	5	9	42	**58**
The research experience overall	1.7%	3.4%	0.0%	19.0%	75.9%	
	1	2	0	11	44	**58**

An open-ended item on the questionnaire asked apprentices about their overall satisfaction with their CQL experience. All but 1 of the 58 apprentices who responded to the question had something positive to say about their experience. Many apprentice comments were simple affirmations of the program such as "very satisfied" and "I am definitely considering returning to this program." Other apprentices who provided more detailed comments about their experience cited their satisfaction with the skills and experience they gained, their mentors, the opportunities to network with peers and Army S&Es, the career information they gained, and the opportunities to learn about other AEOPs. For example,

> *"Overall, my experience as a research apprentice at [Army lab] under CQL was amazing. I am continuing to collaborate with my team during the academic year on a volunteer basis as I am now a SMART Scholarship recipient and will be working full time with ARL upon completion of my degree. The research experiences I have had and continue to have at [this lab] have equipped me*

with the skills and experience necessary to pursue a PhD…Overall, this program has greatly improved my life and allowed me to pursue my dreams." (CQL Apprentice)

"The work was impactful, interesting, and pushed me to be a better engineer. And almost all of my satisfaction was a result of my mentors and the work environment they created for me. They made sure I was progressing, understanding what I was doing, and overall having an enjoyable experience. Because of them, I will definitely consider working for the DoD and hope to apply for a SMART Scholarship." (CQL Apprentice)

My experience overall was a good one. The transition from college to the workplace was smooth and my mentor was a large part of that. He was always available for contact and made sure I had all the tools to succeed. The work was challenging, but rewarding. I learned new skills… and was able to apply them in a work setting." (CQL Apprentice)

Ten apprentice respondents (17%) provided positive comments about their CQL experiences but also offered some caveats. The caveats mentioned included dissatisfaction with the mentor-apprentice pairings and level of site preparation, program organization, limited opportunities for apprentices to interact with one another, limited representation of women in the workplace, and various logistical concerns including requests for higher pay, more information about stipends, timeliness of acceptance into the program, and assistance with housing. For example,

"I had a very good experience overall at CQL, translating my skills to a real world problem and teaching myself things along the way to help in the projects. The part that could be improved was mainly in the organization of the place I went to, as they didn't seem very prepared to take on an intern, and at times it seemed like I was underutilized because of a lack of preparation." (CQL Apprentice)

"I really appreciate the opportunity that AEOP has given me. Although, I do wish that AEOP would pair mentor and mentee better, as I have been paired with a mentor that has a job that I personally consider uninteresting. The task/project that I have been assigned is not in the STEM field and more administrative work rather than lab work." (CQL Apprentice)

"I'm overall pretty satisfied with my apprenticeship program experience. Once my internship actually started, the work I did was pretty enjoyable, and everyone on my team was nice. However, I don't know if this was just something that happened in my particular experience, but I felt like there weren't any women working where I worked at all. I know that in general, there are not a lot of women working in STEM fields, but I feel like there still definitely could have been more women in this program. There are certainly more girls in my CS and engineering classes than I ever saw in this program." (CQL Apprentice)

"Overall I am satisfied with the program. It is a great opportunity to be paired with government researchers and gain insight on STEM research. The connections made through CQL will be useful moving forward. Unfortunately the timeline with which students are selected for this program needs to be pushed forward. I was only notified of my acceptance into the program at the end of April. At this point many other internship opportunities had sent out offers and began processing students. It's difficult waiting to hear back from CQL offers so late into the game, especially if other offers are on the table." (CQL Apprentice)

Only 1 apprentices had no positive comments about his CQL experience. This apprentice did not elaborate upon his reasons for dissatisfaction, simply characterizing his satisfaction as "low."

An open-ended questionnaire item asked apprentices to list three benefits of CQL. The 59 apprentices who responded cited a variety of benefits. The most frequently mentioned (39 apprentices or 66%) were the research skills and lab experiences they gained followed by the networking opportunities and mentoring (mentioned by 21 apprentices or 36%). Eighteen apprentices (31%) cited career information as a benefit, 13 (22%) mentioned the workplace experience they gained, and 11 (19%) mentioned increased confidence as a benefit of CQL. Other benefits, mentioned by 11 or fewer apprentices (less than 17%) included exposure to DoD research, STEM knowledge gains, the presentation opportunities and/or gains in communication skills, teamwork, problem-solving skills, independent work opportunities, and graduate school information as benefits.

Focus group participants were also asked to comment upon the benefits of CQL. These apprentices cited as benefits the opportunities to explore and fine-tune career interests and options, the value of gaining experience working in a professional setting, networking, gaining real-world problem solving skills, the value of the symposia to which they were exposed, and the ease of the application process. Apprentices said, for example,

"[A benefit of CQL is] getting more experience with STEM related work in general because I don't know what I want to do as a career. Having this opportunity to explore the STEM world a little bit and find out about some of the opportunities that are available to me, that was really valuable." (CQL Apprentice)

"[A benefit of CQL is] dealing with pitfalls in terms of experiments not quite turning out how we had expected them to, and figuring out workarounds, instruments breaking down, and fixing the instruments. That was very useful." (CQL Apprentice)

[Before CQL], I was split between medicine and research…Within the first couple of weeks [of CQL], I was like, 'I remember why I love research. I want to do this…I'll do everything I need to to end up back here because I love my work." (CQL Apprentice)

Apprentices were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The most frequently suggested improvements among the 57 apprentices who provided at least one suggestion were to provide more opportunities for apprentices to connect with one another (14 apprentices or 25%) and earlier computer access (9 or 16%). Seven mentors (12%) suggested more hours or a longer program and 7 suggested better mentor preparation and/or more mentor involvement. Apprentices mentioned by 6 or fewer apprentices (less than 11%) included streamlining intake procedures, providing a symposium or more presentation opportunities, matching student interests with mentors' more closely, providing exposure to other areas of research, and providing better communication about symposium requirements and requirements and due dates for deliverables.

Apprentices participating in focus groups were also asked for their opinions about how the CQL program could be improved. Their responses include suggestions for providing more guidance about expectations for apprentices' work and deliverables, posting lists of mentors and their projects so that students can request to work with specific mentors, improving program organization, and expanding into "more non-scientific areas."

CQL mentors also generally reported being somewhat or very much satisfied with the program components they experienced (Table 108). More than half of mentors reported being somewhat or very much satisfied with all program features except for two items for that large proportions of mentors had not experienced: communicating with AAS (71% had not experienced) and timeliness of stipend payment to apprentices (35% had not experienced). Areas of greatest satisfaction (somewhat or very much) were: support for instruction or mentorship during program activities (88%) and application or registration process (71%). Few mentors expressed dissatisfaction with program features although 12% reported being "not at all" satisfied with administrative tasks such as in-processing and network access and timeliness of stipend payment to apprentices.

Table 108. Mentor Satisfaction with CQL Program Features (n=17)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	17.6%	0.0%	11.8%	29.4%	41.2%	
	3	0	2	5	7	**17**
Other administrative tasks (in-processing, network access, etc.)	23.5%	11.8%	5.9%	23.5%	35.3%	
	4	2	1	4	6	**17**
Communicating with Academy of Applied Science (AAS)	70.6%	0.0%	5.9%	5.9%	17.6%	
	12	0	1	1	3	**17**
	29.4%	0.0%	11.8%	29.4%	29.4%	

Communicating with CQL organizers	5	0	2	5	5	**17**
Support for instruction or mentorship during program activities	11.8%	0.0%	0.0%	41.2%	47.1%	
	2	0	0	7	8	**17**
Amount of stipends for apprentices (payment)	29.4%	5.9%	5.9%	17.6%	41.2%	
	5	1	1	3	7	**17**
Timeliness of stipend payment to apprentices	35.3%	11.8%	11.8%	0.0%	41.2%	
	6	2	2	0	7	**17**
Research abstract preparation requirements	41.2%	0.0%	0.0%	11.8%	47.1%	
	7	0	0	2	8	**17**
Research presentation process	35.3%	0.0%	5.9%	17.6%	41.2%	
	6	0	1	3	7	**17**

Mentors were also asked to respond to open-ended items asking for their opinions about the program. When asked about their satisfaction with CQL, 5 of the 6 respondents had something positive to say. These mentors made general comments such as "Great experience! Glad to be part of the program." Another mentor was generally positive about the program and noted that after several years of participation she has seen administrative improvement but added "I still have to hunt for paperwork and instructions. For example, I saw that I needed to do this survey, but I really had to hunt for the link!" One other mentor did not make any positive comments but noted that the in-processing procedures are "tedious" and requested "a standard form that is automatically compiled by AEOP for each student and sent to the organization's security office."

Another open-ended item asked mentors to identify the three most important strengths of CQL. Sixteen mentors identified at least one benefit of the program. The most frequently mentioned strength, mentioned by 10 respondents, was the research and hands-on experience apprentices received. Mentors also mentioned fairly frequently (3-7 respondents) the STEM learning apprentices experience, the career information they receive, the networking opportunities for apprentices, and the opportunity to experience working as a part of a team.

Mentors participating in focus groups echoed these themes. These mentors emphasized the insight students gain about real-world scientific research, the respect for DoD research they gain, and the opportunities for career exploration. For example, mentors said, *"[CQL] gives them a lot of experience in the real world with real world equipment, real world problems, real world presentations. They attend meetings of the branch, teams and so forth. It gives them a lot of good practical experience."* (CQL Mentor)

"It allows the students certainly in my field to experience working in an environment where they can potentially see themselves having a career. For a lot of the students that we have, they have paid experiences which are working in bars and doing all these different things. What they want to do is work and work more seriously under scientific guidance. Those students that we've had in the past go on to either do masters or PhDs or go into lab technical positions. It's been really positive for them." (CQL Mentor)

"[Apprentices] actually see that the DoD does a lot of really, really good world class science that impacts people's lives all over the world, not just the soldiers and so they develop a respect. As they go on, whether they become involved with DoD or not, when they're out there working in science in another area, they have a respect. They may come back and collaborate and do projects with the DoD because they have that experience. That's all very, very positive and it gets things out." (CQL Mentor)

Mentors were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The 11 mentors who identified at least one area for improvement made a variety of suggestions. The most frequently mentioned suggestion (mentioned by 5 mentors) was to provide a larger budget in order to fund more apprentices and lab supplies. Three mentors suggested providing more mentor and/or site manager training. Other suggestions, mentioned by 1 or 2 mentors, included providing apprentices with more exposure to various areas, beginning the CAC process earlier, providing more career information, providing more clear guidelines for presentations and reports, a clearer application process, improvements in the survey, and providing more information on other STEM programs.

Mentors participating in focus groups also offered a variety of suggestion for program improvement. Several comments focused on budgetary issues, suggesting funding for apprentice professional development activities and providing "floating funds" for labs. Other suggestions included improving network access for apprentices, providing more opportunities for mentors and apprentices to socialize, , inviting the AEOP to site symposia, eliminating the lab coats students are given, and improving the 21st Century Skills survey. For example, mentors said,

"I can't put a CQL student on this particular assay because it will cost me a lot to get the substrate and the enzyme. I move them to other like the pre-screen, or whatever assays that I can cover. These kinds of funds that I'm talking about…If we can work together, write something, do something to get funds for such particular expensive assay, [it] will give them more experience." (CQL Mentor)

"I think the [21st Century Skills] survey doesn't ask good questions...They give a whole list of categories and they want to know, the student, are they improving? Have they reached mastery or something? My argument is I could go through myself after a 30 year career and a PhD to say I have not mastered those things. Why are you asking in the beginning of the summer and the end of the summer whether my student has? I can say she's improved in some things, but she's not going to master it by the time I'm even finished with it." (CQL Mentor)

Apprentices participating in focus groups also reported learning about CQL primarily through family members. Apprentices also noted learning about CQL through past participation in AEOPs, citing past participation in GEMS, SEAP, and URAP.

CQL apprentices were asked to report on their input into the design of their project (Table 109). One apprentice (2%) reported independently designing their entire project, however 43% indicated they had some input or choice in project design. Approximately 41% of apprentices reported being assigned a project by their mentors.

Table 109. Apprentice Input on Design of Their Project (n=58)

	Response Percent	Response Total
I did not have a project	5.17 %	3
I was assigned a project by my mentor	41.38 %	24
I worked with my mentor to design a project	17.24 %	10
I had a choice among various projects suggested by my mentor	15.52 %	9
I worked with my mentor and members of a research team to design a project	8.62 %	5
I designed the entire project on my own	1.72 %	1

Apprentices were also asked about their participation in research groups (Table 110). Although most apprentices reported working in close proximity with others during CQL, they tended to work independently on their projects (69%). Few (16%) worked in isolation with their research mentor, and approximately 16% of apprentices worked collaboratively in a group on the same project.

Table 110. Apprentice Participation in a Research Group (n=58)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	15.52 %	9
I worked with others in a shared laboratory or other space, but we worked on different projects	24.14 %	14
I worked alone on my project and I met with others regularly for general reporting or discussion	12.07 %	7

I worked alone on a project that was closely connected with projects of others in my group	32.76 %	19
I worked with a group who all worked on the same project	15.52 %	9

SEAP

Apprentices were asked how satisfied they were with a number of features of the SEAP program (Table 111). More than half of responding apprentices were somewhat or very much satisfied with all of the listed program features. Features apprentices reported being most satisfied with included: the physical location of program activities (97%); teaching/mentoring provided during SEAP (95%); and applying/registering for the program (94%). Few apprentices expressed dissatisfaction with most SEAP program features, although 20% of students were not satisfied with administrative tasks such as security clearances and issuing CAC cards.

Table 111. Student Satisfaction with SEAP Program Features (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	5.7%	54.3%	40.0%	**35**
	0	0	2	19	14	**35**
Other administrative tasks (security clearances, issuing CAC cards, etc.)	0.0%	20.0%	25.7%	40.0%	14.3%	
	0	7	9	14	5	**35**
Communicating with your host site organizers	17.1%	2.9%	14.3%	25.7%	40.0%	
	6	1	5	9	14	**35**
The physical location(s) of Apprenticeship Program activities	2.9%	0.0%	0.0%	31.4%	65.7%	
	1	0	0	11	23	**35**
The variety of STEM topics available to you in the Apprenticeship Program	0.0%	0.0%	11.4%	28.6%	60.0%	
	0	0	4	10	21	**35**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	2.9%	22.9%	74.3%	
	0	0	1	8	26	**35**
Amount of stipends (payment)	0.0%	2.9%	11.4%	22.9%	62.9%	
	0	1	4	8	22	**35**
	2.9%	2.9%	11.4%	14.3%	68.6%	

Timeliness of payment of stipends (payment)	1	1	4	5	24	**35**
Research abstract preparation requirements	2.9%	2.9%	20.0%	34.3%	40.0%	
	1	1	7	12	14	**35**

Apprentices were also asked about the availability of their mentors during SEAP (Table 112). Nearly all apprentices reported that their mentor was available at least half of the time (97%), and 43% indicated their mentor was always available.

Table 112. Apprentice Reports of Availability of Mentors (n=35)

	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	2.86 %	1
The mentor was available about half of the time of my project	14.29 %	5
The mentor was available more than half of the time	40.00 %	14
The mentor was always available	42.86 %	15

SEAP apprentices were asked about their satisfaction with various elements of their research experience (Table 113). Approximately half or more apprentices indicated being "very much" satisfied with all elements of their experience (ranging from 49%-86%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 83%-97%).

Table 113. Apprentice Satisfaction with Their Experience (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	2.9%	0.0%	11.4%	85.7%	
	0	1	0	4	30	**35**
My working relationship with the group or team	11.4%	0.0%	5.7%	11.4%	71.4%	
	4	0	2	4	25	**35**
The amount of time I spent doing meaningful research	0.0%	2.9%	11.4%	37.1%	48.6%	
	0	1	4	13	17	**35**
	0.0%	0.0%	8.6%	31.4%	60.0%	

The amount of time I spent with my research mentor	0	0	3	11	21	**35**
The research experience overall	0.0%	0.0%	5.7%	25.7%	68.6%	
	0	0	2	9	24	**35**

SEAP apprentices were asked to comment on their overall satisfaction with their SEAP experiences in an open-ended questionnaire item. All of the 29 apprentices who provided a response made positive comments, focusing on their opportunities to experience real-life hands-on research, the career information they received, their increased confidence in their abilities, and their mentors. For example:

> *"My experience as a student apprentice of the Department of Defense gave me an experience in the STEM fields that my high school education never could. I had the opportunity to work alongside researchers solving real-world problems. I'm very grateful for SEAP. My mentor was dedicated to exposing me to the variety of job opportunities available in STEM fields as well as STEM fields within the Department of Defense."* (SEAP Apprentice)

> *"This program, overall, far exceeded my expectations. To be able to work in a real engineering laboratory on important and viable projects helped me to more fully realize what exactly being an engineer or scientist means. This program made sure that I had all of the assistance needed to enable my success, and much equipment and resources were made available to me for my project. The benefits of this program will continue to help me in my coming years, and I now eagerly await the opportunity to perform future STEM research."* (SEAP Apprentice)

> *"I have had an amazing experience in the SEAP program! I have always been interested in pursuing a degree in the STEM field, specifically engineering, and I feel like the program gave me the confidence to follow through with it. When I first began the program, I was extremely worried that I didn't have the skills or intelligence to work on a real world project. However, the more I learned, asked questions, and designed, the more self assured I became. Now, I feel as though I have the conviction and knowledge to seek more STEM opportunities with confidence and eagerness!"* (SEAP Apprentice)

Eleven of the responded with positive comments, but offered some caveats as well. These caveats focused primarily on issues with computer access and security clearance (5 comments), and issues such as (1 or 2 comments each) insufficient work, their mentor's lack of availability, a request for more thorough information and orientation to the research tasks they are charged with, opportunities to connect with other apprentices, and dissatisfaction with mentors and the type of work assigned to them. For example:

> *"Overall [I am] very happy, however needing an escort extremely limited my projects. Without computer access and having to go to meetings I was slowed down in my research."* (SEAP Apprentice)

"I loved this program a lot because of how much hands on research I was able to do. I actually felt I was contributing to the world in some small way. I learned many new skills that will definitely help me in my future, and make me stand out among college applications in the fall. I was very satisfied for the most part, except for a few things. There were many times where I would just sit at my desk sometimes doing nothing. I got bored while waiting for example, for my bacteria to grow. I wasn't given anything else to do." (SEAP Apprentice)

"It was a great program, but the fact that I didn't know any other intern until the last couple of weeks of the program is the main dilemma. Knowing other interns the same age as you really helps you enjoy the time at the underground labs a lot better. So the first week that the interns come, provide a lunch or gathering where everyone can meet each other and grow closer over the months." (SEAP Apprentice)

"My main issue with SEAP was that my mentor did not work in a lab or even in a hands-on STEM field…After talking to other apprentices at the same site, I learned that many of them had a similar issue. My mentor also did not seem to be prepared for what I would be working on. The program provides an amazing opportunity, but it did not turn out how I expected it to. To say that the AEOP needs to be more selective about who is allowed to mentor would be an understatement." (SEAP Apprentice)

In another open-ended questionnaire item, SEAP apprentices were asked to name three benefits of SEAP. The 35 apprentices who responded cited a variety of benefits. The most frequently cited benefits were gaining STEM skills and/or research experience (mentioned by 25 apprentices), the career information and exposure (mentioned by 16 apprentices), the networking opportunities (mentioned by 13 apprentices), and the opportunity to develop general workplace skills (mentioned by 11 apprentices). Other, less frequently mentioned, benefits included writing and communications skills (7 apprentices), and (mentioned by 4 or 5 apprentices each) teamwork, problem solving, confidence, patience, and developing independent work skills.

Apprentices participating in focus groups also cited a number of benefits of participating in SEAP. These apprentices focused on the exposure to real-world research, the the STEM skills, career information, and problem solving skills they gained in SEAP. For example,

"[SEAP] exposed us to the military side of the research. We always thought that only private [entities do] do research, private companies, universities...I didn't really know the military does them." (SEAP Apprentice)

"I feel I've gotten a lot of experience in the lab and trying to figure out if this is what to do in the future." (SEAP Apprentice)

"My mentor is very into throwing you in and getting you to figure it out on your own…which has been really helpful because you just have to figure out what to do. It's creative problem solving." (SEAP Apprentice)

Apprentices were also asked in an open-ended questionnaire item to list three ways in which the SEAP program could be improved. The 34 apprentices who provided at least one suggestion offered a variety of suggestions. The most frequently mentioned improvement (mentioned by 14 apprentices) was improving computer access and the security clearance process. Nine apprentices suggested providing opportunities for apprentices to interact with each other while 6 apprentices suggested improved communication between the program, mentors, and apprentices. Other suggested improvements (mentioned by 5 or fewer apprentices) included:

- Providing tours at the start of the program and/or orientation
- Clearer instructions and goals or outcomes from mentors
- More seminars or webinars and/or more speakers or more variety in speakers
- More frequent or more timely stipend payments
- More one on one time with mentors or better explanation of mentors' roles
- Larger stipend
- Better matching of students to mentors
- Providing more AEOP information
- Ensuring that students have enough work
- Connecting mentors with apprentices before the program begins.

SEAP apprentices participating in focus groups echoed these suggestions for improvements. Focus group participants focused on access to labs, computer access, streamlining orientation, and providing opportunities for collaboration with other apprentices as potential program improvements.

SEAP mentors also generally reported being somewhat or very much satisfied with the program components they experienced (Table 114). Approximately half or more mentors reported being somewhat or very much satisfied with all program features except for two items that more than a third had not experienced: amount of stipends (40% not experienced) and timeliness of stipend payment to apprentices (45% not experienced). Areas of greatest satisfaction (somewhat or very much) were: application or registration process (65%); communication with SEAP organizers (65%); research presenation process (65%); and research abstract preparation requirements (65%). Few mentors expressed dissatisfaction with program features although 10% reported being "not at all" satisfied with the research presentation process and research abstract preparation requirements.

Table 114. Mentor Satisfaction with SEAP Program Features (n=20)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	25.0%	0.0%	10.0%	40.0%	25.0%	
	5	0	2	8	5	**20**
Other administrative tasks (in-processing, network access, etc.)	15.0%	0.0%	25.0%	45.0%	15.0%	
	3	0	5	9	3	**20**
Communicating with SEAP organizers	10.0%	0.0%	25.0%	40.0%	25.0%	
	2	0	5	8	5	**20**
Support for instruction or mentorship during program activities	15.0%	0.0%	25.0%	50.0%	10.0%	
	3	0	5	10	2	**20**
Amount of stipends (payment)	40.0%	0.0%	5.0%	25.0%	30.0%	
	8	0	1	5	6	**20**
Timeliness of payment (stipends)	45.0%	5.0%	5.0%	10.0%	35.0%	
	9	1	1	2	7	**20**
Research presentation process	0.0%	10.0%	25.0%	15.0%	50.0%	
	0	2	5	3	10	**20**
Research abstract preparation requirements	5.0%	10.0%	20.0%	25.0%	40.0%	
	1	2	4	5	8	**20**

Mentors were also asked to respond to an open-ended questionnaire item asking them to comment on their overall satisfaction with SEAP. Of the 13 mentors who responded to this question, 10 made positive comments. These comments focused on the quality of the students in the program and the value of the program in exposing students to real-life, hands-on research. For example,

> *"I was very satisfied with the SEAP experience. The student I worked with was intelligent, well-mannered, dependable, and eager to learn. It was beneficial to me, as I could rely on the student to assist in the lab. I believe the student had a good experience being exposed to numerous projects and researchers to get a sense of the types of problems we are faced with. He was able to do to hands-on research with a purpose, without excessive pressure or responsibility."* (SEAP Mentor)

Two mentors responded with positive comments, but offered some caveats. These caveats focused on the inclusiveness of the student selection process and computer access issues. For example, *"Overall, SEAP is a good way to get young people into the lab to introduce them to science and humanize the process to them…SEAP is how we introduce young adults to science. When this concept is core to a SEAP program, my satisfaction is high. This year saw an initial attempt to inflict more elitist attitudes on 'scientific quality' and aim to bring in students who were already more scientifically involved or inclined. I strongly disagree with this practice. SEAP is the opportunity to cultivate attitudes and mindsets that grow and expand our field, and when we stick to that, it makes SEAP a great experience. When we try to use it as a training for lab-specific tasks, I think it fails to live up to its potential."* (SEAP Mentor)

"Good experience other than the perennial issues with taking weeks to get computer accounts. A third of the summer can be over before they are up and running, so this really precludes having a computer oriented project." (SEAP Mentor)

The 3 mentors who had no positive comments about SEAP, focused their comments on a perceived lack of program information, a need for more information for mentors, and issues with students requiring escorts. For example,

"The biggest headache was dealing with program coordination issues, such as bad information for in-processing, no follow-through on laptop provisioning, and crazy poster printing deadlines." (SEAP Mentor)

"My overall experience as a SEAP mentor was not very good. The escorting requirements were significant to the extent that it led to a tremendous amount more work for me during the SEAP timeframe. The inability to obtain 'no escort' status became a focal point of our everyday operations such that it was by far the topic that was discussed the most with the student. I will likely not participate in SEAP mentorship in the future as I can not justify the time, money, and effort expended." (SEAP Mentor)

In another open-ended questionnaire item, mentors were asked to identify the three most important strengths of SEAP. Among the 20 mentors who responded, the most frequently mentioned SEAP strength was the hands-on, real world research experiences apprentices gain (mentioned by 19 mentors) Other strengths mentioned included the career and/or DoD research information students gain (mentioned by 6 mentors), the opportunity for apprentices to network with professionals (mentioned by 5 mentors), and the fact that the program engages students at a young age (mentioned by 4 mentors). Other strengths, mentioned by 3 or fewer mentors included the opportunity to develop the STEM workforce, students' increased interest in STEM, the speakers and/or AEOP activities, the flexibility to match students with mentor interests, the program organization, and the quality of students enrolled in the program.

Mentors participating in focus groups echoed these themes, focusing on apprentices' opportunities to experience real-world research and receive career information. As one mentor said, *"[SEAP] gives them a sense of definitely what goes on in a research lab environment. That's something that they don't get exposed to, especially in high school… They get to see the real world. The application of what they've learned in school."* (SEAP Mentor)

Mentors in focus groups also cited their own sense of fulfillment and the opportunity to teach as a benefit of the program.

"[SEAP is] a chance to inspire them or to help them find their way. In that way, it's helping me maybe reshape how I think about teaching science or teaching anything in general. It's not something that we really get as much of an opportunity as researchers." (SEAP Mentor)

Mentors were also asked in a questionnaire item to suggest three ways in which SEAP could be improved for future participants. The 16 mentors who responded provided a wide range of improvements, none mentioned by more than 4 mentors. Improvements mentioned included:

- Improvements in student selection, including more flexibility, more time, or more information about students (4 mentors)
- Better communication between mentors and program administrators (3 mentors)
- More interaction between apprentices (3 mentors)
- Better onboarding processes and communication (2 mentors)
- More information about the abstract and poster requirements (2 mentors)
- Earlier outreach in order to increase the candidate pool (2 mentors)
- More AEOP information (2 mentors)
- More events (2 mentors)
- Faster computer access/addressing escort requirements (2 mentors)

SEAP mentors participating in focus groups also offered suggestions for program improvements. These suggestions included the following:

- Providing better information about DoD careers and research
- Providing more program information for mentors
- Recruiting more mentors by using incentives
- Ensuring that financial support for students does not need to come from the labs
- Providing a longer program or extending the program throughout the school year
- Holding a poster session or meet and greet with other SEAP apprentices in the area
- Providing more AEOP information
- Using Army outreach capabilities to publicize SEAP
- Providing housing support for students who are not from the local area

Mentors said, for example,

"I didn't even know the student that I have this summer that she was in this program. I feel like I haven't really gotten any information about what SEAP is, what's involved." (SEAP Mentor)

"One of the challenges that the program has faced, I've seen over time, it's getting scientists or people here to get engaged...[In] my group, I tried to convince those scientists we need to bring more students." (SEAP Mentor)

"if you wanted to utilize the Army gears that are already there, there are huge outreach efforts within the Army itself, and it seems like a waste if AEOP isn't able to utilize this, because I know even here at the institute, we have a pretty robust community outreach program just as a single institute, not to mention what the base does and what "big Army" does. It seems a little odd that AEOP hasn't been able to tap into that for reaching out to underserved communities." (SEAP Mentor)

Mentors in focus groups were also asked to comment on ways that the SEAP might best reach underserved populations. While most mentors had little knowledge of current programmatic efforts to reach these populations, mentor responses focused on marketing and outreach efforts and ensuring that the message conveyed is accessible to the target audience. In particular, one mentor emphasized the importance of letting students know that the program offers a stipend and another suggested supporting students as they move through the application process (e.g., how to ask for a letter or recommendation). Several mentors proposed providing outreach to a greater diversity of high schools. Another mentor suggested using the "right mentor" to deliver the message about SEAP in order to ensure that the message is accessible to diverse audiences.

SEAP apprentices were asked to report on their input into the design of their project (Table 115). No apprentices reported independently designing their entire project, however 40% indicated they had some input or choice in project design. Approximately 54% of apprentices reported being assigned a project by their mentors.

Table 115. Apprentice Input on Design of Their Project (n=35)

	Response Percent	Response Total
I did not have a project	5.71 %	2
I was assigned a project by my mentor	54.29 %	19
I worked with my mentor to design a project	11.43 %	4
I had a choice among various projects suggested by my mentor	14.29 %	5
I worked with my mentor and members of a research team to design a project	14.29 %	5
I designed the entire project on my own	0.00 %	0

Apprentices were also asked about their participation in research groups (Table 116). Although most apprentices reported working in close proximity with others during SEAP, they tended to work independently on their projects (63%). Few (17%) worked in isolation with their research mentor, and 20% of apprentices worked collaboratively in a group on the same project.

Table 116. Apprentice Participation in a Research Group (n=35)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	17.14 %	6
I worked with others in a shared laboratory or other space, but we worked on different projects	25.71 %	9
I worked alone on my project and I met with others regularly for general reporting or discussion	31.43 %	11
I worked alone on a project that was closely connected with projects of others in my group	5.71 %	2
I worked with a group who all worked on the same project	20.00 %	7

Program Features and Satisfaction – University-Based Programs

REAP

Apprentices were asked how satisfied they were with a number of features of the REAP program (Table 117). Half or more of responding apprentices were somewhat or very much satisfied with all of the listed program features. Features apprentices reported being most satisfied with included: applying/registering for the program (95%); amount of the stipend (89%); and communicating with the host site organizers (89%). Few apprentices expressed dissatisfaction with REAP program features, although 12% of students were not satisfied with timeliness of stipend payments.

Table 117. Apprentice Satisfaction with REAP Program Features (n=83)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	2.4%	2.4%	22.9%	72.3%	
	0	2	2	19	60	**83**
Other administrative tasks (in-processing, network access, etc.)	4.8%	1.2%	9.6%	28.9%	55.4%	
	4	1	8	24	46	**83**
Communicating with your host site organizers	4.8%	2.4%	3.6%	18.1%	71.1%	
	4	2	3	15	59	**83**

The physical location(s) of Apprenticeship Program activities	1.2%	3.6%	6.0%	12.0%	77.1%	
	1	3	5	10	64	**83**
The variety of STEM topics available to you in the Apprenticeship Program	3.6%	4.8%	14.5%	20.5%	56.6%	
	3	4	12	17	47	**83**
Teaching or mentoring provided during Apprenticeship Program activities	1.2%	2.4%	7.2%	9.6%	79.5%	
	1	2	6	8	66	**83**
Amount of stipends (payment)	2.4%	3.6%	4.8%	24.1%	65.1%	
	2	3	4	20	54	**83**
Timeliness of payment of stipends	8.4%	12.0%	6.0%	16.9%	56.6%	
	7	10	5	14	47	**83**
Research abstract preparation requirements	3.6%	2.4%	13.3%	31.3%	49.4%	
	3	2	11	26	41	**83**

Apprentices were also asked about the availability of their mentors during REAP (Table 118). Nearly all apprentices reported that their mentor was available at least half of the time (94%), and more than two-thirds (70%) indicated their mentor was always available.

Table 118. Apprentice Reports of Availability of Mentors (n=83)

Choice	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	6.02 %	5
The mentor was available about half of the time of my project	8.43 %	7
The mentor was available more than half of the time	15.66 %	13
The mentor was always available	69.88 %	58

REAP apprentices were asked about their satisfaction with various elements of their research experience (Table 119). Approximately two-thirds or more indicated being “very much” satisfied with all elements of their experience (ranging from 63%-84%). The vast majority of apprentices reported being at least “somewhat” satisfied with each experience (ranging from 87%-96%).

Table 119. Apprentice Satisfaction with Their Experience (n=83)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	2.4%	6.0%	7.2%	84.3%	
	0	2	5	6	70	**83**
My working relationship with the group or team	6.0%	0.0%	3.6%	19.3%	71.1%	
	5	0	3	16	59	**83**
The amount of time I spent doing meaningful research	0.0%	3.6%	9.6%	24.1%	62.7%	
	0	3	8	20	52	**83**
The amount of time I spent with my research mentor	0.0%	3.6%	8.4%	18.1%	69.9%	
	0	3	7	15	58	**83**
The research experience overall	0.0%	0.0%	3.6%	22.9%	73.5%	
	0	0	3	19	61	**83**

Apprentices were provided an opportunity to provide additional feedback on their overall satisfaction with their REAP experience in an open-ended item on the questionnaire. Of the 70 apprentices who responded to this question, all made positive comments. These responses were often simple affirmations such as, "This was a great program" and This program helped me with a lot and I'm very thankful for the opportunity." The apprentices who elaborated upon their experiences emphasized their satisfaction with their learning, the opportunity for hands-on research experience, the career information they gained, the value of the program for resume building and college applications, their relationships with their mentors, the stipend, and their interactions with peers and college students. For example,

> *"Overall, the program not only improved my resume for the future career, but also encouraged me to involve on STEM program…[My mentor] taught us the way to think effectively and successfully. He made us not to satisfy with simplified solution by instilling the inquisitive eyes to our minds. He encouraged and supported the students with the mind of a mentor, who truly wants their students be successful."* (REAP Apprentice)

> *"[REAP] was very good and helped me learn more about research and careers in STEM. The mentors were very helpful and easy to work with and the other participants were also fun to be around. Overall the experience was great and I learned a lot from my research and interacting with other people and made me learn more about careers."* (REAP Apprentice)

> *"The mentors were great and were far from intimidating. They were so helpful and interested in my work at school and my plans for the future."* (REAP Apprentice)

"It was a good experience and allowed me to enhance my lab skills, and work with equipment that I might have to use in college or the future. I got to meet other interns with different backgrounds, and hear about many different experiences yet relate to them while going through this new experience." (REAP Apprentice)

"I enjoyed participating in this program because it gave me a good idea on how research occurs in the real world.I didn't have any background on what we were researching. So I had to learn a bit of programming, new software, and a lot about epilepsy but that just made all the more fun. I had a lot of fun with my research partner as well as with students that attend the university." (REAP Apprentice)

Eleven apprentices (16%) apprentices made positive comments, but included some caveats. These caveats included suggestions for more flexibility in content, more mentor availability, providing more content area background information or guidelines for projects, making sure the stipend is paid in a timely fashion, and comments about program organization. For example,

"It was a good experience, but I wish I was given a bit more freedom with the project I wanted to do." (REAP Apprentice)

"Overall, I think I got a lot of hands on experience…I wish that our project could have been more research based; I really would have liked to have a question and conclusion along with a research paper. I also feel that the mentors were often too busy with their own research or teaching. I hope that in the future, there can be more mentor involvement…There were multiple points during the program when I was stuck and didn't receive timely advice. I think that the program can improve if it were scaffolded; I understand that this is a university setting but it would be better if we started off with more of the basics and progressed to the heavy research side." (REAP Apprentice)

"I was pretty satisfied with my program experience...Many things were very unorganized. Often times, things wouldn't go as planned and we would find out very last minute , which is a HUGE inconvenience. We were told we would get our stipends…between June 29- July 6. It is July 20th and none of the program participants have received their stipends... The mentor was very helpful and patient. She was very concerned about our projects. She also made sure we understood fully." (REAP Apprentice)

Apprentices were also asked to list three benefits of participating in REAP. The 83 apprentices who provided at least one suggestion cited a variety of benefits. The most frequently mentioned benefits were the STEM skills and research skills they gained (mentioned by 43% of students), their STEM learning (mentioned by 41% of students), the career information they gained (mentioned by 36% of students), and the opportunity for real world, hands-on experience (mentioned by 35% of students). Other benefits relatively frequently mentioned included the value of the mentors and networking (mentioned by 31% of students), the teamwork skills students gained (mentioned by 20% of students), and the understanding they gained of workplace skills and/or how university labs operate (mentioned by 18% of students).

Twenty-one students (26%) cited specific 21st Century skills they had gained, including the ability to work independently and the problem solving and time management skills they gained.

REAP apprentices were also asked in an open-ended questionnaire item to list three ways that the REAP program could be improved. The 76 apprentices who provided at least one suggestion mentioned a wide variety of areas of potential program improvement. The most frequently mentioned improvements were suggestions that apprentices have more input into the choice of topic or project (mentioned by 30% of apprentices), more specific guidelines or clearer instructions for projects (mentioned by 22% of apprentices) and expanding the program to include more participants and/or more locations (mentioned by 22% of apprentices). Other improvements mentioned included suggestions about the stipend (either increasing the stipend or improving the timeliness of stipend payment) (18%), program organization and/or scheduling (13%), providing more mentor interaction (16%), providing more career information (11%), and providing opportunities for students to continue research past the summer (9%).

REAP mentors also generally reported being somewhat or very much satisfied with the program components they experienced (Table 120). More than three-quarters of mentors reported being somewhat or very much satisfied with all program features. Areas of greatest satisfaction (somewhat or very much) were: support for instruction or mentorship during program activities (87%) and communication with REAP organizers (85%). Very few mentors expressed dissatisfaction with any program feature (0%-2% not at all satisfied).

Table 120. Mentor Satisfaction with REAP Program Features (n=67)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	16.4%	0.0%	3.0%	9.0%	71.6%	
	11	0	2	6	48	**67**
Other administrative tasks (in-processing, network access, etc.)	17.9%	0.0%	1.5%	14.9%	65.7%	
	12	0	1	10	44	**67**
Communicating with REAP organizers	11.9%	0.0%	3.0%	4.5%	80.6%	
	8	0	2	3	54	**67**
Support for instruction or mentorship during program activities	7.5%	1.5%	4.5%	14.9%	71.6%	
	5	1	3	10	48	**67**
Research abstract preparation requirements	14.9%	1.5%	3.0%	25.4%	55.2%	
	10	1	2	17	37	**67**

Mentors were also asked to respond to open-ended items asking for their opinions about the program. All of the 37 mentors who responded to an item asking them about their overall satisfaction with REAP made positive comments. Mentors' comments focused on student learning opportunities, the college and career information apprentices gained, the research skills and experiences REAP offers, and the satisfaction they gained from mentoring students. For example,

> *"The REAP experience has been very productive…I believe the students gained deeper knowledge and understanding about how to engage in research. They also seemed to gain real knowledge and appreciation for working in a university laboratory. It was enjoyable to watch the mentors and mentees interact with each other. Great experience! I hope to have more students in future summer offerings."* (REAP Mentor)

> *"I was particularly pleased with the group this summer. Each was able to define a project within the objectives of the laboratory. This provided them with autonomy when they wanted it, but also the ability to ask others in the lab for help when they needed it. The projects were 'real' both in the sense that we had not performed the experiments before and in the sense that we benefit from achieving the objectives. There were plenty of problems to be solved, but that also means the students can feel real achievement when they do surmount the obstacles."* (REAP Mentor)

> *"The REAP program has been of great benefit to the 3 students that we had on campus this summer and to our campus overall… It was personally rewarding to watch our students grow other the summer. They became confident in their skills and knowledge and reinforced their interests in STEM careers."* (REAP Mentor)

Two mentors made positive comments about REAP but also offered caveats. These caveats focused on the funding provided to apprentices and mentors, and logistics associated with the proposal process and the way funding flows to the university. These mentors said,

> *"I am satisfied with REAP and intend to continue supporting it. The administrative staff are great. The funding provided to mentors/groups to support the high school apprentice[s] are too low. Faculty have tremendous demands on their time and research funding, so unless the program offsets these, it is not sustainable. The proposal process is too lengthy. It should be streamlined with fewer questions, and permit a renewal process that leverages past, approved proposals."* (REAP Mentor)

> *"REAP is a great program. However, faculty needs to comply with University rule that all programs should pay the indirect rate to the University. I even [suggested to the] REAP program office that I can give up my PI's stipend in replace of indirect cost. I cannot apply for the program if this is not accommodated."* (REAP Mentor)

Mentors were asked to identify the three most important strengths of REAP. The 50 mentors who responded with at least one strength, cited program strengths similar to the benefits cited by apprentices.

The most frequently cited strength was the exposure to STEM research and technology and opportunity for hands-on laboratory experiences (mentioned by 50% of mentors). Other strengths mentioned by mentors included the stipend (26%), the STEM skills apprentices gain (16%), the career information students receive (14%), the value of the mentor-mentee relationship (14%), the exposure to college and information about college the program provides (12%), and that REAP serves students under-represented in STEM fields (10%).

The 40 mentors who provided at least one response when asked to list three ways in which REAP should be improved for future participants provided a wide range of suggestions. The most frequently mentioned suggestions (38%) focused on funding for mentors and students, including providing a larger stipend, providing additional financial support for mentors, and general comments about increasing the budget or lengthening the time of awards. Another 9 mentors (23%) suggested creating more apprentice positions. Other suggestions, mentioned by 13% of mentors, included connecting REAP students in different locations and providing better program communication. Suggestions made by 5% of mentors included providing more program outreach, providing opportunities to continue apprentices' work past the summer, providing more field trips, providing travel grants for apprentices to present their research, extending the length of the program, and providing more fun activities for apprentices.

REAP apprentices were asked to report on their input into the design of their project (Table 121). Two apprentices (2%) reported independently designing their entire project, while 42% indicated they had some input or choice in project design. Approximately 52% of apprentices reported being assigned a project by their mentors.

Table 121. Apprentice Input on Design of Their Project (n=83)

Choice	Response Percent	Response Total
I did not have a project	6.02 %	5
I was assigned a project by my mentor	51.81 %	43
I worked with my mentor to design a project	15.66 %	13
I had a choice among various projects suggested by my mentor	13.25 %	11
I worked with my mentor and members of a research team to design a project	10.84 %	9
I designed the entire project on my own	2.41 %	2

Apprentices were also asked about their participation in research groups (Table 122). Although most apprentices reported working in close proximity with others during REAP, they tended to work independently on their projects (55%). Few (10%) worked in isolation with their research mentor, and approximately 35% of apprentices worked collaboratively in a group on the same project.

Table 122. Apprentice Participation in a Research Group (n=83)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	9.64 %	8
I worked with others in a shared laboratory or other space, but we worked on different projects	32.53 %	27
I worked alone on my project and I met with others regularly for general reporting or discussion	9.64 %	8
I worked alone on a project that was closely connected with projects of others in my group	13.25 %	11
I worked with a group who all worked on the same project	34.94 %	29

HSAP

Apprentices were asked how satisfied they were with a number of features of the HSAP program (Table 123). Approximately two-thirds or more of responding apprentices were somewhat or very much satisfied with all of the listed program features. Features apprentices reported being most satisfied with included: teaching/mentoring provided during HSAP (100%); amount of the stipend (100%); and applying/registering for the program (95%). Few apprentices expressed dissatisfaction with HSAP program features, although 16% of students were not satisfied with timeliness of stipend payment.

Table 123. Apprentice Satisfaction with HSAP Program Features (n=19)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	5.3%	36.8%	57.9%	
	0	0	1	7	11	**19**
Other administrative tasks (in-processing, network access, etc.)	0.0%	0.0%	10.5%	47.4%	42.1%	
	0	0	2	9	8	**19**
Communicating with your host site organizers	5.3%	0.0%	5.3%	31.6%	57.9%	
	1	0	1	6	11	**19**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	10.5%	10.5%	78.9%	
	0	0	2	2	15	**19**
The variety of STEM topics available to you in the Apprenticeship Program	0.0%	0.0%	26.3%	31.6%	42.1%	
	0	0	5	6	8	**19**
	0.0%	0.0%	0.0%	10.5%	89.5%	

Teaching or mentoring provided during Apprenticeship Program activities	0	0	0	2	17	**19**
Amount of stipends (payment)	0.0%	0.0%	0.0%	15.8%	84.2%	
	0	0	0	3	16	**19**
Timeliness of payment of stipend	0.0%	15.8%	21.1%	26.3%	36.8%	
	0	3	4	5	7	**19**
Research abstract preparation requirements	0.0%	0.0%	26.3%	31.6%	42.1%	
	0	0	5	6	8	**19**

Apprentices were also asked about the availability of their mentors during HSAP (Table 124). All apprentices reported that their mentor was available at least half of the time (100%), and almost half (47%) indicated their mentor was always available.

Table 124. Apprentice Reports of Availability of Mentors (n=19)

Choice	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	0.00 %	0
The mentor was available about half of the time of my project	5.26 %	1
The mentor was available more than half of the time	47.37 %	9
The mentor was always available	47.37 %	9

HSAP apprentices were asked about their satisfaction with various elements of their research experience (Table 125). More than half indicated being "very much" satisfied with all elements of their experience (ranging from 58%-90%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 79%-100%).

Table 125. Apprentice Satisfaction with Their Experience (n=19)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	5.3%	36.8%	57.9%	
	0	0	1	7	11	**19**

My working relationship with the group or team	10.5%	10.5%	0.0%	0.0%	78.9%	
	2	2	0	0	15	**19**
The amount of time I spent doing meaningful research	0.0%	0.0%	0.0%	42.1%	57.9%	
	0	0	0	8	11	**19**
The amount of time I spent with my research mentor	0.0%	0.0%	15.8%	26.3%	57.9%	
	0	0	3	5	11	**19**
The research experience overall	0.0%	0.0%	0.0%	10.5%	89.5%	
	0	0	0	2	17	**19**

When asked about their overall satisfaction with HSAP in an open-ended questionnaire item, all 27 apprentices who provided a response had something positive to say. Comments focused on the value of the learning apprentices experienced, their research exposure and experience, the college and career information they received, and the networking opportunities associated with participating in HSAP. For example,

> *"The connections I had made with my mentor, the other interns, and the other people in the lab group made the summer a fulfilling experience. I learned to be more persistent, creative, and inquisitive because research does not come easily. At the end of the program, I learned more about what researchers do, made great friendships, gained a lot of respect for researchers and was able to reflect on my growth. I am glad that I applied and am highly satisfied with my HSAP experience!"* (HSAP Apprentice)

> *"Overall, I am very glad I participated in the Apprenticeship Program. I gained valuable knowledge about working with other people on research projects related to STEM, knowledge about research, and tidbits about how working in the future will be like. Exposure to new experiences this summer helped promote my individual growth in becoming more independent and aware of my world and future."* (HSAP Apprentice)

> *"This program was so valuable to me in learning that I would like to further pursue research in college and potentially beyond. I got a lot of totally new exposure to fields I never knew about, and learned so much about what it's like to work on university research like this."* (HSAP Apprentice)

Two of the apprentices had positive comments but also offered some caveats. These students mentioned the pressures of undertaking an independent project, the perception that their mentor was unprepared to work with them, and a comment about the stipend being taxed. These students said:

"Overall I was pretty happy with the experience. I got to experience some research which felt a lot more 'real' than the experiments in chemistry class...However, I feel like it might have been better if my supervisor had not tried to give me my own, separate project…In order to discuss it with me, he had to leave his own research for a little while, and I felt that I may actually have been hindering his research instead of helping it. If I had assisted him on his project it may have put less pressure on the supervisor, and given them more opportunities to engage with their intern. It also would have provided a little more satisfaction for me to know that I was working on a real project which could potentially help others." (HSAP Apprentice)

"I was satisfied with my experience in the Apprenticeship Program. I enjoyed the research performed, the knowledge gained, and the experience gained performing research…However, I did have a few issues with the program. I felt that my mentor was unprepared to have me work in her lab this summer. She didn't seem aware of the guidelines and project requirements that I needed to complete. She knew who I was and that I would be conducting research under her, but nothing specific to the program. Almost none of my research was relative to the military or DoD. My biggest complaint was the stipend. I was paid under the University's worker system as a lab assistant. I was taxed on my paycheck every pay period. I was not paid under a stipend like the program suggests." (HSAP Apprentice)

In another open-ended item, apprentices were asked to list three benefits of HSAP. The 28 apprentices who responded cited a variety of benefits, however the most recently mentioned was, by far, the research exposure and experience and the STEM skills they gained during HSAP (mentioned by 23 apprentices). Eleven apprentices cited networking as a benefit while 9 cited career information, 8 college information, and 7 teamwork and presentation or public speaking skills as benefits of HSAP, and another 4 apprentices cited the STEM learning they experienced as benefits. Other responses, mentioned by 3 or fewer apprentices included time management skills, interactions with mentors, confidence, problem solving, access to technology and equipment, and the stipend.

Apprentices participating in interviews echoed these themes and commented on several other benefits including the availability of their mentors and the information they gained about scholarships and other opportunities. For example,

"It's nice having that mentor right there and being able to ask questions. It's very individually-based. She looked at what your strong at and what you need help in. It's been very beneficial." (HSAP Apprentice)

"I'm interested in the research field, but I'm not quite certain of what I wanted to do in research field. I thought that this program would give me outlook on different career choices that I may have in the future." (HSAP Apprentice)

"One thing that I've gotten from that is just the public speaking aspect of it and how to present myself, and my data, and my results....Never in a million years would I've thought that I'd be able to stand up in front of a group of people and present my research. Now, after being in this program for 10 weeks, I'm more than confident presenting." (HSAP Apprentice)

HSAP apprentices were also asked in an open-ended questionnaire item to indicate three ways that the program could be improved. The 26 apprentices who responded provided a wide variety of suggestions, however the most frequently mentioned suggestions had to do with communication (mentioned by 17 apprentices), including communicating about stipend payments, sending more frequent (weekly) newsletters, communication about program requirements, dates, and resources required for the apprenticeship (e.g., laptops). No other single improvement was mentioned by more than 4 students. These included providing more host sites, ensuring that the site is prepared and/or providing information to mentors, providing more research options, and various improvements to the application (e.g., being able to save progress, providing a way to see the student's application status, and providing easier access to the location list).

Students participating in interviews were also asked to suggest program improvements. These students also focused on improvements to various program logistics, including providing the schedule and site location earlier in the application process, altering the work hours, and improving communication between the program and apprentices and mentors.

The 4 HSAP mentors who responded to the questionnaire also generally reported being somewhat or very much satisfied with the program components they experienced (Table 126). Half or more of mentors reported being somewhat or very much satisfied with all program features except for one item communicating with AAS, which 75% reported not having experienced. Areas of greatest satisfaction (somewhat or very much) were: communicating with HSAP organizers (100%); other administrative tasks (100%); and application or registration process (100%). Few mentors expressed dissatisfaction with program features although one mentor (25%) reported being "not at all" satisfied with support for instruction/mentorship during program activities.

Table 126. Mentor Satisfaction with HSAP Program Features (n=4)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	4	**4**
Other administrative tasks (in-processing, network access, etc.)	0.0%	0.0%	0.0%	50.0%	50.0%	
	0	0	0	2	2	**4**

Communicating with Army Research Office (ARO)	25.0%	0.0%	0.0%	0.0%	75.0%	
	1	0	0	0	3	**4**
Communicating with HSAP organizers	0.0%	0.0%	0.0%	25.0%	75.0%	
	0	0	0	1	3	**4**
Support for instruction or mentorship during program activities	0.0%	25.0%	0.0%	0.0%	75.0%	
	0	1	0	0	3	**4**
Stipends (payment)	25.0%	0.0%	0.0%	0.0%	75.0%	
	1	0	0	0	3	**4**
Research abstract preparation requirements	0.0%	0.0%	25.0%	25.0%	50.0%	
	0	0	1	1	2	**4**
Communicating with Academy of Applied Science (AAS)	75.0%	0.0%	0.0%	0.0%	25.0%	
	3	0	0	0	1	**4**

The 2 mentors who responded to an open-ended questionnaire item asking about their overall satisfaction with the program both responded positively, although one mentioned that he would like for the program to communicate more clear expectations for students. They said:

> *"As a university professional, HSAP gives me an opportunity to interact on a daily basis with high school students to better understand their experiences before they become undergraduates. I am most excited about the opportunity to provide mentoring and guidance to these students as they formulate potential career pathways, and to encourage them to succeed. As one of my previous students said, 'The program and your mentoring changed my life! I had been told by many high school teachers that certain areas and subjects were beyond my capability',but you showed my that I can do it. You really gave me confidence to succeed.'"* (HSAP Mentor)

Mentors were asked to list three program strengths in another open-ended questionnaire item. While only 3 mentors responded to this item, they offered a variety of strengths included the research exposure and experience, the college and career information apprentices gain, the DoD career information apprentices receive, the fact that the program allows time for apprentices to experience growth and learning, and the stipend.

Mentors participating in interviews echoed the above themes and also noted that students gain valuable workplace skills, the opportunity to interact with college students in a university setting, independent learning opportunities, opportunities to network, and that HSAP prepares them for a smooth high school to college transition. For example, *"My students, in their lab, actually learn how to…share their equipment, how to arrange the schedules, how to collaborate…The lab management training enable them to know how to deal with other colleagues in the future [in] the research environment or academic environment."* (HSAP Mentor)

"The students have developed their networking with students from other high schools and also undergraduate students…[and] other faculty members in this department. This will be much more beneficial when they apply for the start of their college life." (HSAP Mentor)

"I have learned that, when I couple a high school student to an undergraduate student, the output of the undergraduate students goes significantly up….He or she feels he is responsible for a person and that he or she needs to give the right example." (HSAP Mentor)

When mentors were asked about their suggestions for program improvement, their comments focused on program logistics. Mentors suggested providing clearer expectations to apprentices in terms of deadlines and requirements, more opportunities for apprentices to present their research, providing supports for mentors regarding working with high school students, providing additional support to sites in their local outreach efforts, encouraging younger students to apply so that mentors can assist them with choosing their high school classes, and increasing funding so that more apprentices can participate. One mentor pointed toward a need to focus less on national publicity for the program in favor of local level outreach. He said,

"There are nationally advertised web pages where people can apply. The applicants that we don't specifically encouraged to apply, they're typically not relevant. They're either too far away or they don't quite fit the categories that we want them to fit. There could be greater emphasis on helping the mentors and the hosting institutions on finding good applicants." (HSAP Mentor)

HSAP apprentices were asked to report on their input into the design of their project (Table 127). No apprentices reported independently designing their entire project, however 32% indicated they had some input or choice in project design. Approximately 63% of apprentices reported being assigned a project by their mentors.

Table 127. Apprentice Input on Design of Their Project (n=19)

Choice	Response Percent	Response Total
I did not have a project	5.26 %	1
I was assigned a project by my mentor	63.16 %	12
I worked with my mentor to design a project	10.53 %	2

I had a choice among various projects suggested by my mentor	5.26 %	1
I worked with my mentor and members of a research team to design a project	15.79 %	3
I designed the entire project on my own	0.00 %	0

Apprentices were also asked about their participation in research groups (Table 128). Although most apprentices reported working in close proximity with others during HSAP, they tended to work independently on their projects (63%). Few (11%) worked in isolation with their research mentor, and approximately 26% of apprentices worked collaboratively in a group on the same project.

Table 128. Apprentice Participation in a Research Group (n=19)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	10.53 %	2
I worked with others in a shared laboratory or other space, but we work on different projects	36.84 %	7
I worked alone on my project and I met with others regularly for general reporting or discussion	5.26 %	1
I worked alone on a project that was closely connected with projects of others in my group	21.05 %	4
I work with a group who all worked on the same project	26.32 %	5

URAP

Apprentices were asked how satisfied they were with a number of features of the URAP program (Table 129). More than three-quarters of responding apprentices were somewhat or very much satisfied with all of the listed program features. Features apprentices reported being most satisfied with included: applying/registering for the program (91%) and the physical location of URAP (91%). Few apprentices expressed dissatisfaction with URAP program features, although 12% of students were not satisfied with timeliness of stipend payment.

Table 129. Apprentice Satisfaction with URAP Program Features (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	8.8%	29.4%	61.8%	
	0	0	3	10	21	**34**

Other administrative tasks (in-processing, network access, etc.)	5.9%	5.9%	5.9%	52.9%	29.4%	
	2	2	2	18	10	**34**
Communicating with your host site organizers	0.0%	2.9%	8.8%	29.4%	58.8%	
	0	1	3	10	20	**34**
The physical location(s) of Apprenticeship Program activities	5.9%	0.0%	2.9%	8.8%	82.4%	
	2	0	1	3	28	**34**
The variety of STEM topics available to you in the Apprenticeship Program	5.9%	0.0%	11.8%	17.6%	64.7%	
	2	0	4	6	22	**34**
Teaching or mentoring provided during Apprenticeship Program activities	2.9%	5.9%	8.8%	11.8%	70.6%	
	1	2	3	4	24	**34**
Amount of stipend (payment)	0.0%	2.9%	11.8%	8.8%	76.5%	
	0	1	4	3	26	**34**
Timeliness of payment (stipend)	2.9%	11.8%	5.9%	8.8%	70.6%	
	1	4	2	3	24	**34**
Research abstract preparation requirements	5.9%	2.9%	14.7%	29.4%	47.1%	
	2	1	5	10	16	**34**

Apprentices were also asked about the availability of their mentors during URAP (Table 130). Nearly all apprentices reported that their mentor was available at least half of the time (88%), and more than half (65%) indicated their mentor was always available.

Table 130. Apprentice Reports of Availability of Mentors (n=34)

Choice	Response Percent	Response Total
I did not have a mentor	2.94 %	1
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	8.82 %	3
The mentor was available about half of the time of my project	5.88 %	2
The mentor was available more than half of the time	17.65 %	6
The mentor was always available	64.71 %	22

URAP apprentices were asked about their satisfaction with various elements of their research experience (Table 131). More than half indicated being "very much" satisfied with all elements of their experience (ranging from 56%-82%). The vast majority of apprentices reported being at least "somewhat" satisfied with each experience (ranging from 85%-88%).

Table 131. Apprentice Satisfaction with Their Experience (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	2.9%	2.9%	5.9%	5.9%	82.4%	
	1	1	2	2	28	**34**
My working relationship with the group or team	8.8%	0.0%	2.9%	14.7%	73.5%	
	3	0	1	5	25	**34**
The amount of time I spent doing meaningful research	0.0%	8.8%	2.9%	32.4%	55.9%	
	0	3	1	11	19	**34**
The amount of time I spent with my research mentor	2.9%	5.9%	2.9%	23.5%	64.7%	
	1	2	1	8	22	**34**
The research experience overall	0.0%	2.9%	11.8%	8.8%	76.5%	
	0	1	4	3	26	**34**

When apprentices were asked about their overall satisfaction with URAP in an open-ended questionnaire item, 25 of the 27 who provided responses to this question made positive comments about their URAP experiences. Some were simple affirmations such as "I learned so much from this program! It was an incredible experience." Those who provided more details about their experiences mentioned the value of the research experience, their mentors, and the graduate school and career information they received. For example:

> *"I was extremely satisfied with my apprenticeship program to say the very least. What I believe made it most worth while was my mentor... From the very beginning of the program all the way to the end, [my mentor] made sure that I not only felt comfortable with what it was I was doing, but also constantly reminded me of the significance of the work and why we were doing the things we did. [He] took the time to explain every aspect of the research to me, and made sure I knew the importance of everything I was doing, which made the experience extremely rewarding. By the end of the program I felt a great sense of accomplishment, and I would not trade the experience for anything. I thank and appreciate everyone involved in the program and am very grateful to have had this opportunity."* (URAP Apprentice)

“This program has been invaluable for me in professional development and basic research techniques. [My mentor] spent a lot of time investing in not only the education, but giving us advice that translates to many facets of life. He also exposed me to areas of science that I did not know existed. Meeting Mrs. Jennifer Ardouin was a great experience as well. As a black women in science, it is not so common to see women like me in higher places. It was very refreshing to speak with her. It gave me a feeling of comfort. I would highly recommend this experience to anyone.” (URAP Apprentice)

“I truly enjoyed the experience of conducting research. I had no idea these types of things, research, were being done in my field, Computer Science. I was amazed and inspired to continue to do my own research in the field of robotics and/or work with a professor at my University to do research. Thank you so much for the opportunity, it was truly a great summer.” (URAP Apprentice)

Three apprentices made positive comments about the program but also offered some caveats. These caveats were focused on the amount of work available for apprentices, mentor availability and preparation, the stipend, and communication. These apprentices said,

“The research I was doing was interesting and immediately relevant to the real world, which I liked. The main problem was that I spent a lot of time doing nothing productive because there wasn't anything for me to do. Several other students in the same lab seemed to be experiencing the same issue. The labor efficiency within this particular lab could definitely be improved.” (URAP Apprentice)

“I was very satisfied with the experience. My mentor (grad student) was great and available at all times. I am a physics major, and the program was geared towards chemists, and my mentor did an amazing job getting me up to speed. The professor in charge was considerably less available though, both in person and via email. Getting my information into the system took a very long time, and there was a lot of paperwork required that should've been done before my first day. I would have rather showed up to the business office a week before my start date and done the paperwork so that I could get started right away.” (URAP Apprentice)

“I was very satisfied with my Apprenticeship Program…There was room for improvement in the distribution of the stipend and communication. The stipend was dispersed starting after I had concluded my research, which could have made the program impossible for someone in a more desperate financial situation who had been promised some financial support throughout the program. The paperwork was also not provided in a timely fashion, and the initial paperwork provided was incorrect. This could have been due to unclear communication between the program and the laboratory or something internal at the host institution. It also would have been helpful to be allowed to reach out to the mentors earlier. My mentor did not realize he was supposed to reach out to me, and I was not supposed to request information until a certain date.” (URAP Apprentice)

Two apprentices made no positive comments about their URAP experiences and instead focused on mentors' limited availability and the irrelevancy of program resources to physics work. These apprentices said,

> *"Overall, I am disappointed with my experience over the course of the program. The professor rarely shows up claiming he isn't getting paid for the summer so it is still his vacation time…The equipment that was provided by the Army to be used during the program is still sitting in his lab in the shipping plastic so it wasn't and will not be used anytime soon…I personally had to set it up to get trained to use the SEM…In the end, I learned absolutely nothing from my mentor and while the URAP program may be a fantastic opportunity for students to get experience in STEM I myself cannot say that it was the case for me. Everything that I learned over the course of this program was self-taught which I'm sure is not the intention of the URAP program."* (URAP Apprentice)

> *" The Apprenticeship Program should try to work with the PI's or others in their field to tailor the resources provided. My program is in theoretical physics, and as such I feel like a lot of the resources weren't very relevant to what I was doing. I mentioned during the site visit that the lab-coat felt like a novelty because (given the nature of my research) I never stepped foot in a lab. It might be more generally useful to instead provide a professional portfolio (or something along those lines). Furthermore I didn't really watch any of the webinars because, again, due to the type of research I work on they didn't feel relevant to what I'm doing. That said, this seems to be common among STEM programs that aren't specifically physics focused due to how niche physics (and physics research) can be."* (URAP Apprentice)

Apprentices were asked in an open-ended questionnaire item to list three benefits of URAP. The 34 apprentices who provided at least one response mentioned a variety of benefits. The most frequently cited benefit, mentioned by 18 (53%) apprentices was the research experience and skills they gained. Another 9 (26%) apprentices mentioned specific STEM skills, including skills such as 3D printing and learning new computer programs. Teamwork, career information, and networking were mentioned as benefits by 7 apprentices (21%) each and 6 (18%) mentioned the problem-solving skills they gained as a benefit. Benefits mentioned by 5 apprentices (15%) included the value of mentors, communication and/or presentation skills, independent work skills, confidence, and the perspective they gained about research. Benefits cited by fewer than 5 apprentices included time management, the stipend, and general gains in STEM knowledge.

Apprentices participating in interviews were also asked to reflect on the benefits of participation in URAP. Participants' comments echoed the themes mentioned above, focusing on the value of the laboratory experience, networking, mentors, and independent research, and the education and career information they gained. For example,

> *"The opportunity to develop my own questions and to be able to pursue those [was a benefit of URAP]... I've been able to manipulate my experimental design, which is really fun and exciting. It*

connected me with other researchers and allowed me to meet some really great people in the field." (URAP Apprentice)

"Once the internship is over, [my mentor] is still a person that I can go back and talk to about things, and use as a reference in a professional relationship later. (URAP Apprentice)

"[Benefits of URAP are] learning how to problem solve, learning how to read manuals, learning how to work equipment. I feel that I've gotten less dependent on having to work asking for help and using my own knowledge in trying to solve problems." (URAP Apprentice)

Apprentices were also asked in an open-ended question to list three ways in which the URAP program could be improved. Thirty apprentices suggested at least one improvements, and suggestions were widely varied. The most frequently mentioned improvements related to communication with the program (mentioned by 8 apprentices, or 27%), including suggestions for better communication about stipends, abstract and poster requirements, and general suggestions for better communication. Seven apprentices (23%) suggested providing more project or topic choices, 6 apprentices (20%) suggested providing more opportunities for connections between AEOP participants, and 6 (20%) suggested providing more or more varied webinars or DoD speakers. Five apprentices (17%) suggested ensuring that mentors are prepared to work with apprentices, and 4 or fewer apprentices mentioned improvements such as providing more sites and/or more participants, more DoD information, more opportunities for teamwork, a longer program or an option to continue the program through the school year, and more funding for the program.

Apprentices participating in interviews were also asked for their ideas about how URAP could be improved. These apprentices' comments echoed the questionnaire responses, focusing on more clear communication about abstract and poster requirements and goals and expectations of apprentices, providing more hours in the program, accepting applicants earlier, providing verification that applications have been received and/or status updates on applications, and providing more thorough descriptions of labs on the website.

URAP mentors also generally reported being somewhat or very much satisfied with the program components they experienced (Table 132). Two-thirds or more of mentors reported being somewhat or very much satisfied with all program features except for communicating with AAS, which 59% of mentors had not experienced. Areas of greatest satisfaction (somewhat or very much) were: communicating with URAP organizers (93%) and application or registration process (89%). Few mentors expressed dissatisfaction with program features although 7% reported being "not at all" satisfied with administrative tasks such as in-processing and network access as well as stipends.

Table 132. Mentor Satisfaction with URAP Program Features (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	3.7%	3.7%	3.7%	37.0%	51.9%	
	1	1	1	10	14	**27**
Other administrative tasks (in-processing, network access, etc.)	14.8%	7.4%	3.7%	22.2%	51.9%	
	4	2	1	6	14	**27**
Communicating with Army Research Office (ARO)	11.1%	0.0%	3.7%	11.1%	74.1%	
	3	0	1	3	20	**27**
Communicating with URAP organizers	3.7%	0.0%	3.7%	25.9%	66.7%	
	1	0	1	7	18	**27**
Support for instruction or mentorship during program activities	11.1%	3.7%	7.4%	22.2%	55.6%	
	3	1	2	6	15	**27**
Stipends (payment)	11.1%	7.4%	11.1%	3.7%	66.7%	
	3	2	3	1	18	**27**
Research abstract preparation requirements	14.8%	0.0%	7.4%	33.3%	44.4%	
	4	0	2	9	12	**27**
Communicating with Academy of Applied Science (AAS)	59.3%	3.7%	0.0%	3.7%	33.3%	
	16	1	0	1	9	**27**

Like apprentices, mentors were asked to reflect on their overall satisfaction with URAP in an open-ended questionnaire item. Of the 19 responses received, 17 respondents offered positive comments about URAP. Mentors expressed satisfaction with the research and DoD exposure apprentices gain and the program management For example,

> *"I am extremely satisfied with the experience. It is a great opportunity to mentor undergraduates, expose them to research, and motivate them STEM careers and graduate school. As a prior military officer, the best part is exposing students to non-uniform DoD service which 99% have never even known about, let alone considered."* (URAP Mentor)

> *"Outstanding! I will definitely apply to participate in this program again, and regularly. The program is run efficiently and passionate by the program director, and with substantial support from the academy. That collaborative strength shows."* (URAP Mentor)

Three mentors made positive comments about the program but also offered offered caveats to their overall satisfaction. These caveats included comments about providing better communication about deadlines and abstract requirements, better mentor guidelines, and providing mentors with more flexibility in using funding. For example,

> *"The program attempts to accomplish something important, but it is too restrictive. PIs generally know how to engage students in research. Give us the latitude to use the available funding to support one, two, etc. students rather than locking down on a prescribed number. Allow the funds to move into the academic year so students making progress can use up any additional funds. The application process is also too restrictive. We are locked into the applicants. What if another student comes along at the start of summer and we would like to support that person? With NSF REU supplements, we receive funds and use them at our discretion for supporting undergraduate students. Please move to a more flexible model."* (URAP Mentor)

Two mentors made no positive comments. These mentors cited the timing of applications, funding, and apprentice notification as sources of dissatisfaction. For example,

> *"The application process was very slow and frustrating. The student who was due to start under URAP got delayed because DOD took a very long time to confirm funding. Confirmation came very late and the student had to wait till the last minute to know when they can start. This reflected in their commitment toward the URAP experience as they also had committed to other projects outside of the program."* (URAP Mentor)

Mentors were asked to identify the three most important strengths of URAP in another open-ended questionnaire item. The most frequently cited strength among the 24 mentors who responded was apprentices' access to hands-on, cutting edge research in URAP (mentioned by 16 mentors, or 67%). Mentors also mentioned various other strengths, although no more than 4 mentors mentioned any one strength. For example, 4 mentors (17%) cited exposure to DoD research and the stipend as strengths of URAP while 3 (13%) mentioned the program administration and communication, the focus on diversity, and the career information apprentices receive as strengths. Other strengths, mentioned by 1 or 2 mentors included teamwork, communication skills, the quality of the students the program attracts, and the networking opportunities in URAP.

Mentors participating in interviews were asked about the value of URAP for apprentices and for themselves. Mentors cited the value of exposure to real world research, learning professional habits, career information, publication opportunities, and networking as benefits to students. For example, mentors said:

> *"Students will participate in front-line research, get exposed to different ideas and fields that may not necessarily be represented as much in their home institution and see actually how life as a professional scientist works, which is very different to taking classes and doing homework."* (URAP Mentor)

"The biggest benefit, of course, is getting hands-on experience in research, which includes not just the techniques and skills of carrying out research, but also certain experience in how research is conducted, the ups and downs of it, and the qualities that it takes in one's self to succeed in research." (URAP Mentor)

"There's a very strong effort from the HSAP and URAP program leaders to let the students know what the opportunities are in the Army and other DoD agencies." (URAP Mentor)

Mentors also noted that URAP had benefits for them also. They expressed appreciation for the teaching and mentoring experience, the opportunity to select and get to know students from other institutions, the value of URAP in recruiting graduate students, and that participating in URAP provides evidence of effective outreach for their programs. For example,

"[URAP is] helping actually my graduate students because I have them co-advise or mentor these undergraduate researchers. It gives them exposure in doing that, which I think will be really valuable in their professional activity later and look good in their CV when they apply for jobs." (URAP Mentor)

" [URAP is] symbiotic in that way that the students are getting exposed to these good programs but were also able to show that we're doing a good job in these areas." (URAP Mentor)

The questionnaire also asked mentors to note three ways in which URAP could be improved for future participants. Among the 15 mentors who responded, the most frequently mentioned suggestion was to provide an earlier application and acceptance process and an earlier funding stream (mentioned by 6 mentors, or 40%). Three mentors (20%) suggested better communication about deadlines, abstract requirements and goals, and other programs. No other single improvement was mentioned by more than two mentors. These included suggestions such as recruiting more students, providing sites with resources to assist with recruiting, providing a cohort of URAP students at sites and/or providing more connections between apprentices, providing a conference for students to present their work, and providing clearer expectations for mentors.

Mentors participating in interviews were also asked to share their ideas about ways that URAP could be improved. These mentors mentioned providing AEOP information to mentors in a form that can easily be shared by email, providing more apprenticeship spots, providing cohorts of URAP students at sites, more supports for mentors about how to work with apprentices, and providing a system to evaluate mentors and send more apprentices to the best mentors. For example,

"[An improvement would be to] have a system of evaluating mentors and allow more apprenticeships to mentors who do a good job at it...In other words, measure mentors for their performances and allow more opportunities and more apprentices to higher performing mentors." (URAP Mentor)

URAP apprentices were asked to report on their input into the design of their project (Table 133). Three apprentices (9%) reported independently designing their entire project, however 47% indicated they had some input or choice in project design. Half (50%) of apprentices reported being assigned a project by their mentors.

Table 133. Apprentice Input on Design of Their Project (n=34)

Choice	Response Percent	Response Total
I did not have a project	2.94 %	1
I was assigned a project by my mentor	50.00 %	17
I worked with my mentor to design a project	8.82 %	3
I had a choice among various projects suggested by my mentor	17.65 %	6
I worked with my mentor and members of a research team to design a project	11.76 %	4
I designed the entire project on my own	8.82 %	3

Apprentices were also asked about their participation in research groups (Table 134). Although most apprentices reported working in close proximity with others during URAP, they tended to work independently on their projects (59%). Few (9%) worked in isolation with their research mentor, and approximately 32% of apprentices worked collaboratively in a group on the same project.

Table 134. Apprentice Participation in a Research Group (n=34)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	8.82 %	3
I worked with others in a shared laboratory or other space, but we work on different projects	17.65 %	6
I worked alone on my project and I met with others regularly for general reporting or discussion	26.47 %	9
I worked alone on a project that was closely connected with projects of others in my group	14.71 %	5
I work with a group who all worked on the same project	32.35 %	11

7 | Priority #3 Findings

Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army.

How Participants Found out About AEOP – Overall

In order to understand what apprentice recruitment strategies are most effective, apprentices were asked to report how they learned about AEOP. Findings for each apprenticeship program are presented in this section.

How Participants Found out About AEOP – Army Laboratory-Based Programs

CQL

CQL apprentices reported a variety of sources of information about AEOP (Table 135). The most frequently selected sources of information, selected by a third or more of apprentices, included past participant of the program (30%); family member (30%); someone who works with the program (32%); and someone who works with the DoD (43%).

Table 135. How Apprentices Learned About AEOP (n=53)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	28%	15
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	15%	8
Past participant of program	30%	16
Friend	25%	13
Family Member	30%	16
Someone who works at the school or university I attend	15%	8
Someone who works with the program	32%	17

Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	43%	23
Community group or program	2%	1
Choose Not to Report	2%	1

Apprentices participating in focus groups also reported learning about CQL primarily through family members. In addition, apprentices noted learning about CQL through past participation in AEOPs, citing past participation in GEMS, SEAP, and URAP.

CQL mentors were also asked how they learned about AEOP (Table 136). More than a third (35%) of mentors reported learning about AEOP through someone who works with the DoD. Other sources of information (cited by 29% of participants) included workplace communications and past participants of the program.

Table 136. How Mentors Learned About AEOP (n=17)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	24%	4
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	0%	0
An email or newsletter from school, university, or a professional organization	6%	1
Past CQL participant	29%	5
A student	6%	1
A colleague	24%	4
My supervisor or superior	24%	4
A CQL site host or director	6%	1
Workplace communications	29%	5
Someone who works with the Department of Defense (Army, Navy, Air Force)	35%	6
Other, (specify):	0%	0

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in CQL. (Table 137). The most frequently selected motivators for participating in CQL related to apprentices' educational interests and learning. More than 85% of apprentices indicated that they were motivated to participate in CQL by their interest in STEM (94%); desire to learn something new or interesting (89%); desire to expand laboratory or research skills (87%); and learning in ways that are not possible in school (87%).

Table 137. Factors Motivating Apprentices to Participate in CQL (n=53)

	Response Percent	Response Total
Teacher or professor encouragement	25%	13
An academic requirement or school grade	11%	6
Desire to learn something new or interesting	89%	47
The mentor(s)	70%	37
Building college application or résumé	58%	31
Networking opportunities	74%	39
Interest in science, technology, engineering, or mathematics (STEM)	94%	50
Interest in STEM careers with the Army	83%	44
Having fun	55%	29
Earning stipends or awards for doing STEM	47%	25
Opportunity to do something with friends	4%	2
Opportunity to use advanced laboratory technology	74%	39
Desire to expand laboratory or research skills	87%	46
Learning in ways that are not possible in school	87%	46
Serving the community or country	66%	35
Exploring a unique work environment	64%	34
Figuring out education or career goals	64%	34
Seeing how school learning applies to real life	68%	36
Recommendations of past participants	21%	11
Choose Not to Report	0%	0

CQL apprentices participating in focus groups were also asked why they chose to participate in CQL. These apprentices cited the opportunity to gain hands-on research experience, career information, and the opportunity for in-depth learning as motivators for participating.

Mentors were asked how apprentices were recruited for CQL (Table 138). Mentors most frequently reported that apprentices were recruited through AEOP Applications (47%), followed by colleague(s) in their workplace (41%), and personal acquaintances (24%). Nearly half (47%) of participating mentors reported not knowing how their apprentices had been recruited for CQL.

Table 138. Mentor Reports of Recruitment Strategies (n=17)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	47%	8
Personal acquaintance(s) (friend, family, neighbor, etc.)	24%	4
Colleague(s) in my workplace	41%	7
K-12 school teacher(s) outside of my workplace	12%	2
University faculty outside of my workplace	12%	2
Informational materials sent to K-12 schools or Universities outside of my workplace	12%	2
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	12%	2
Communication(s) generated by a university or faculty (newsletter, email blast, website)	18%	3
STEM or STEM Education conference(s) or event(s)	12%	2
Organization(s) that serve underserved or underrepresented populations	0%	0
The student contacted me (the mentor) about the program	18%	3
I do not know how student(s) were recruited for CQL	47%	8
Other	0%	0

SEAP

SEAP apprentices reported a variety of sources of information about AEOP (Table 139). The most frequently selected sources of information, selected by a half or more of apprentices, included a famiy member (54%) and someone who works for the DoD (51%).

Table 139. How Participants Learned About AEOP (n=35)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	23%	8
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	23%	8
Past participant of program	31%	11
Friend	20%	7
Family Member	54%	19

Someone who works at the school or university I attend	11%	4
Someone who works with the program	6%	2
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	51%	18
Community group or program	3%	1
Choose Not to Report	0%	0

Apprentices participating in focus groups were asked about how they learned about SEAP. Most of the apprentices who answered had heard about SEAP through a family member or personal connection, although one apprentice had learned about SEAP through her school internship coordinator.

SEAP mentors were also asked how they learned about AEOP (Table 140). Almost a third (29%) of mentors reported learning about AEOP through someone who works with the DoD. Other sources of information (cited by 14% of participants) included a friend, someone who works with the program, and past participant of the program.

Table 140. How Mentors Learned About AEOP (n=7)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0%	0
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	0%	0
Past participant of program	14%	1
Friend	14%	1
Family Member	0%	0
Someone who works at the school or university I attend	0%	0
Someone who works with the program	14%	1
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	29%	2
Community group or program	0%	0
Choose Not to Report	14%	1

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in SEAP. (Table 141). The most frequently selected motivators for participating in SEAP related to apprentices' educational interests and learning. More than 85% of apprentices indicated that they were motivated to participate in SEAP by their interest in STEM (91%); desire to learn something new or interesting (89%); and learning in ways that are not possible in school (86%).

Table 141. Factors Motivating Apprentices to Participate in SEAP (n=35)

	Response Percent	Response Total
Teacher or professor encouragement	17%	6
An academic requirement or school grade	3%	1
Desire to learn something new or interesting	89%	31
The mentor(s)	49%	17
Building college application or résumé	69%	24
Networking opportunities	46%	16
Interest in science, technology, engineering, or mathematics (STEM)	91%	32
Interest in STEM careers with the Army	54%	19
Having fun	71%	25
Earning stipends or awards for doing STEM	46%	16
Opportunity to do something with friends	11%	4
Opportunity to use advanced laboratory technology	80%	28
Desire to expand laboratory or research skills	74%	26
Learning in ways that are not possible in school	86%	30
Serving the community or country	57%	20
Exploring a unique work environment	69%	24
Figuring out education or career goals	80%	28
Seeing how school learning applies to real life	63%	22
Recommendations of past participants	26%	9
Choose Not to Report	0%	0

Apprentices participating in focus groups cited the hands-on research experience, the resume-building value of the experience, and the stipend as reasons for participating in SEAP. For example,

> *"I'm visiting colleges and a lot of universities say they focus heavily on research. I wanted to try that before I go into college, have some experience."* (SEAP Apprentice)

SEAP mentors were asked how apprentices were recruited for SEAP (Table 142). Mentors most frequently reported that apprentices were recruited through AEOP Applications (50%), followed by colleague(s) in their workplace (40%), and personal acquaintances (35%). A quarter (25%) of participating mentors reported not knowing how their apprentices had been recruited for SEAP.

Table 142. Mentor Reports of Strategies Used to Recruit Apprentices (n = 20)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	50%	10
Personal acquaintance(s) (friend, family, neighbor, etc.)	35%	7
Colleague(s) in my workplace	40%	8
K-12 school teacher(s) outside of my workplace	20%	4
University faculty outside of my workplace	5%	1
Informational materials sent to K-12 schools or Universities outside of my workplace	5%	1
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	5%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	0%	0
STEM or STEM Education conference(s) or event(s)	5%	1
Organization(s) that serve underserved or underrepresented populations	5%	1
The student contacted me (the mentor) about the program	5%	1
I do not know how student(s) were recruited for SEAP	25%	5
Other	0%	0

How Participants Found out About AEOP – University-Based Programs

REAP

REAP apprentices reported a variety of sources of information about AEOP (Table 143). The most frequently selected sources of information, selected by almost a quarter or more of apprentices, included school/university newsletter, email or website (38%) or someone who works at the school/university they attend (24%).

Table 143. How Apprentices Learned about AEOP (n=66)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	18%	12
AEOP on Facebook, Twitter, Instagram, or other social media	3%	2
School or university newsletter, email, or website	38%	25
Past participant of program	15%	10
Friend	18%	12
Family Member	18%	12
Someone who works at the school or university I attend	24%	16
Someone who works with the program	18%	12
Someone who works with the Department of Defense	3%	2
Community group or program	3%	2
Choose Not to Report	3%	2

REAP apprentices participating in interviews cited similar sources of information when asked how they had learned about REAP. These apprentices had learned about REAP from emails from their schools; personal connections, including friends and contacts at host institutions; high school teachers and advisors; through previous participation in AEOP.

Mentors were also asked how they learned about AEOP (Table 144). Approximately a third or more of mentors reported learning about AEOP through a STEM conference or STEM education course (39%); AAS (36%); or a colleague (32%).

Table 144. How Mentors Learned about AEOP (n=28)

Choice	Response Percent	Response Total
Academy of Applied Science (AAS)	36%	10
Army Educational Outreach Program (AEOP) website	4%	1
AEOP on Facebook, Twitter, Pinterest, or other social media	21%	6
A STEM conference or STEM education conference	39%	11
An email or newsletter from school, university, or a professional organization	7%	2
Past REAP participant	0%	0
A student	25%	7
A colleague	32%	9
My supervisor or superior	4%	1

A REAP site host or director	7%	2
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	36%	10
Other	4%	1

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in REAP. (Table 145). The most frequently selected motivators for participating in REAP related to apprentices' educational interests and learning. More than three-quarters of apprentices indicated that they were motivated to participate in REAP by their interest in STEM (98%); desire to learn something new or interesting (91%); opportunity to use advanced laboratory technology (82%); and learning in ways that are not possible in school (80%).

Table 145. Factors Motivating Apprentices to Participate in REAP (n=66)

Choice	Response Percent	Response Total
Teacher or professor encouragement	36%	24
An academic requirement or school grade	6%	4
Desire to learn something new or interesting	91%	60
The mentor(s)	45%	30
Building college application or résumé	53%	35
Networking opportunities	42%	28
Interest in science, technology, engineering, or mathematics (STEM)	98%	65
Interest in STEM careers with the Army	44%	29
Having fun	64%	42
Earning stipends or awards for doing STEM	36%	24
Opportunity to do something with friends	17%	11
Opportunity to use advanced laboratory technology	82%	54
Desire to expand laboratory or research skills	76%	50
Learning in ways that are not possible in school	80%	53
Serving the community or country	42%	28
Exploring a unique work environment	68%	45
Figuring out education or career goals	79%	52
Seeing how school learning applies to real life	56%	37
Recommendations of past participants	14%	9

Choose Not to Report	0%	0

The REAP apprentices who participated in interviews cited their desire for research experience and career information as primary motivators for their participation. Interview participants also cited STEM learning, the value of participating for their college applications and resumes, and the networking opportunities REAP provides as motivators.

Mentors were asked how apprentices were recruited for REAP (Table 146). Mentors most frequently reported that apprentices were recruited through AEOP Applications (75%), followed by K-12 school teacher(s) outside of their workplace (37%) and colleague(s) in their workplace (28%). Only 15% of participating mentors reported not knowing how their apprentices had been recruited for REAP.

Table 146. Mentor Reports of Recruitment Strategies (n=67)

Choice	Response Percent	Response Total
Applications from AEOP (REAP)	75%	50
Personal acquaintance(s) (friend, family, neighbor, etc.)	18%	12
Colleague(s) in my workplace	28%	19
K-12 school teacher(s) outside of my workplace	37%	25
University faculty outside of my workplace	12%	8
Informational materials sent to K-12 schools or Universities outside of my workplace	24%	16
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	13%	9
Communication(s) generated by a university or faculty (newsletter, email blast, website)	13%	9
STEM or STEM Education conference(s) or event(s)	12%	8
Organization(s) that serve underserved or underrepresented populations	22%	15
The student contacted me (the mentor) about the program	9%	6
I do not know how student(s) were recruited for REAP	15%	10
Other	4%	3

HSAP

HSAP apprentices reported a variety of sources of information about AEOP (Table 147). The most frequently selected sources of information, selected by a third or more of apprentices, included someone who works at their school/university (59%); the AEOP website (41%); and past program participant (35%).

Table 147. How Apprentices Learned About AEOP (n=17)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	41%	7
AEOP on Facebook, Twitter, Instagram, or other social media	6%	1
School or university newsletter, email, or website	24%	4
Past participant of program	35%	6
Friend	12%	2
Family Member	24%	4
Someone who works at the school or university I attend	59%	10
Someone who works with the program	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	6%	1
Community group or program	6%	1
Choose Not to Report	0%	0

Apprentices participating in interviews reported learning about HSAP from various sources, including teachers or counselors, friends, or online.

Mentors were also asked how they learned about AEOP (Table 148). The one mentor who responded to this question indicated they learned about AEOP because they were a past participant.

Table 148. How Mentors Learned About AEOP (n=1)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0.00 %	0
AEOP on Facebook, Twitter, Instagram, or other social media	0.00 %	0
School or university newsletter, email, or website	0.00 %	0
Past participant of program	100.00 %	1
Friend	0.00 %	0
Family Member	0.00 %	0
Someone who works at the school or university I attend	0.00 %	0

Someone who works with the program	0.00 %	0
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.00 %	0
Community group or program	0.00 %	0
Choose Not to Report	0.00 %	0

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in HSAP. (Table 149). The most frequently selected motivators for participating in HSAP related to apprentices' educational interests and learning. More than 90% of apprentices indicated that they were motivated to participate in HSAP by their interest in STEM (100%); desire to learn something new or interesting (94%); and desire to expand laboratory or research skills (94%).

Table 149. Factors Motivating Apprentice Participation in HSAP (n=17)

Choice	Response Percent	Response Total
Teacher or professor encouragement	41%	7
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	94%	16
The mentor(s)	35%	6
Building college application or résumé	71%	12
Networking opportunities	35%	6
Interest in science, technology, engineering, or mathematics (STEM)	100%	17
Interest in STEM careers with the Army	41%	7
Having fun	65%	11
Earning stipends or awards for doing STEM	41%	7
Opportunity to do something with friends	12%	2
Opportunity to use advanced laboratory technology	76%	13
Desire to expand laboratory or research skills	94%	16
Learning in ways that are not possible in school	82%	14
Serving the community or country	53%	9
Exploring a unique work environment	65%	11
Figuring out education or career goals	71%	12
Seeing how school learning applies to real life	65%	11

Recommendations of past participants	18%	3
Choose Not to Report	0%	0

Apprentices participating in interviews cited the learning and hands-on research opportunities and career information as motivators for participating in HSAP. For example,

> *"I'm interested in the research field, but I'm not quite certain of what I wanted to do in research field. I thought that this program would give me outlook on different career choices that I may have in the future."* (HSAP Apprentice)

> *"I really wanted to find an opportunity to immerse myself in STEM. I was looking online for summer programs to try out and many of them were out of state and would be very, very costly. I wanted to see if I could even get the opportunity to work at a local university and in a program that's free that I just go commute and where I could really test my limits.... I wanted to see if I could learn about different machines and different materials that are used in engineering, and really see what an engineer does."* (HSAP Apprentice)

Mentors were asked how apprentices were recruited for HSAP (Table 150). Mentors most frequently reported that apprentices were recruited through AEOP Applications (100%), followed by colleague(s) in their workplace (50%), and informational materials sent to K-12 schools or universities outside of their workplace (50%). None of the 4 participating mentors reported not knowing how their apprentices had been recruited for HSAP.

Table 150. Mentor Reports of Recruitment Strategies (n=4)

Choice	Response Percent	Response Total
Applications from the Academy of Applied Science (AAS) or the AEOP	100%	4
Personal acquaintance(s) (friend, family, neighbor, etc.)	25%	1
Colleague(s) in my workplace	50%	2
K-12 school teacher(s) outside of my workplace	75%	3
University faculty outside of my workplace	25%	1
Informational materials sent to K-12 schools or Universities outside of my workplace	50%	2
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	25%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	0%	0
STEM or STEM Education conference(s) or event(s)	25%	1
Organization(s) that serve underserved or underrepresented populations	25%	1

The student contacted me (the mentor) about the program	25%	1
I do not know how student(s) were recruited for REAP	0%	0
Other	0%	0

URAP

URAP apprentices reported a variety of sources of information about AEOP (Table 151). The most frequently selected sources of information, selected by nearly a half more of apprentices, included someone who works at the university they attend (59%), and a school/university newsletter, email, or website (47%).

Table 151. How Apprentices Learned About AEOP (n=27)*

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0%	0
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	47%	16
Past participant of program	3%	1
Friend	6%	2
Family Member	3%	1
Someone who works at the school or university I attend	59%	20
Someone who works with the program	15%	5
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	3%	1
Community group or program	3%	1
Choose Not to Report	0%	0

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

URAP apprentices participating in interviews also cited contacts at their college or university as primary sources of information about the program. Apprentices cited advisors, a flyer posted in a public forum, honors program coordinators, and mentors from previous research experiences as sources of information about URAP.

Mentors were also asked how they learned about AEOP (Table 152). More than half (59%) of mentors reported learning about AEOP through the ARO website. Other sources of information cited by nearly a quarter or more of mentors included their supervisor (30%) and the AEOP website (22%).

Table 152. How Mentors Learned About AEOP (n=27)

Choice	Response Percent	Response Total
Army Research Office (ARO) website	59%	16
Academy of Applied Science (AAS)	4%	1
Army Educational Outreach Program (AEOP) website	22%	6
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	0%	0
An email or newsletter from school, university, or a professional organization	0%	0
Past HSAP participant	11%	3
A student	4%	1
A colleague	4%	1
My supervisor or superior	30%	8
A URAP site host or director	4%	1
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	19%	5
Other, (specify):	15%	4

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in URAP (Table 153). The most frequently selected motivators for participating in URAP related to apprentices' educational interests and learning. Approximately three-quarters or more of apprentices indicated that they were motivated to participate in URAP by their interest in STEM (100%); desire to learn something new or interesting (85%); and learning in ways that are not possible in school (74%).

Table 153. Factors Motivating Apprentice Participation in URAP (n=34)

Choice	Response Percent	Response Total
Teacher or professor encouragement	44%	15
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	85%	29
The mentor(s)	35%	12

Building college application or résumé	71%	24
Networking opportunities	62%	21
Interest in science, technology, engineering, or mathematics (STEM)	100%	34
Interest in STEM careers with the Army	32%	11
Having fun	56%	19
Earning stipends or awards for doing STEM	44%	15
Opportunity to do something with friends	6%	2
Opportunity to use advanced laboratory technology	62%	21
Desire to expand laboratory or research skills	82%	28
Learning in ways that are not possible in school	74%	25
Serving the community or country	38%	13
Exploring a unique work environment	50%	17
Figuring out education or career goals	62%	21
Seeing how school learning applies to real life	53%	18
Recommendations of past participants	3%	1
Choose Not to Report	0%	0

Apprentices participating in interviews were also asked about why they chose to participate in URAP. These apprentices' responses also focused primarily on the value of the research experience. Apprentices also noted the value of being able to work with mentors, the stipend, and a pre-existing interest in the military. As one apprentice said,

> *"It seemed like a great opportunity to do some independent research in a lab that's very well respected, and to learn to design my own experiments and research questions."* (URAP Apprentice)

Mentors were asked how apprentices were recruited for URAP (Table 154). Mentors most frequently reported that apprentices were recruited through AAS or AEOP Applications (89%), followed by colleague(s) in their workplace (33%), communications from a university (26%), and student contacted the mentor about URAP (26%). All but one mentor (4%) indicated having some knowledge of how their apprentices had been recruited.

Table 154. Mentor Reports of Recruitment Strategies (n=27)

Choice	Response Percent	Response Total
Applications from the Academy of Applied Science (AAS) or the AEOP	89%	24
Personal acquaintance(s) (friend, family, neighbor, etc.)	15%	4

Colleague(s) in my workplace	33%	9
K-12 school teacher(s) outside of my workplace	19%	5
University faculty outside of my workplace	15%	4
Informational materials sent to K-12 schools or Universities outside of my workplace	19%	5
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	15%	4
Communication(s) generated by a university or faculty (newsletter, email blast, website)	26%	7
STEM or STEM Education conference(s) or event(s)	4%	1
Organization(s) that serve underserved or underrepresented populations	15%	4
The student contacted me (the mentor) about the program	26%	7
I do not know how student(s) were recruited for REAP	4%	1
Other	4%	1

Previous Program Participation & Future Interest – Overall

An objective of the AEOP is to create a robust pipeline of programs. In order to understand how apprenticeship programs are supporting this goal, students were asked about what AEOPs they had participated in in the past and what AEOPs they are interested in participating in in the future. Likewise, mentors were asked to report on what AEOPs they had discussed with their apprentices.

Previous Program Participation & Future Interest – Army Laboratory-Based Programs

CQL

Apprentices were asked to report on their previous participation in AEOPs (Table 155). While 38% indicated they had never participated in any AEOP programs, smaller proportions reported having participated in the following AEOPs: CQL (26%), SEAP (19%), GEMS (15%), Camp Invention (8%), UNITE (2%), and JSHS (2%). A quarter of responding CQL participants reported participating in other STEM programs (25%) that were not part of AEOP.

Table 155. Previous Participation in AEOP Programs (n=53)*

Choice	Response Percent	Response Total
Camp Invention	8%	4
eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	15%	8
UNITE	2%	1
Junior Science & Humanities Symposium (JSHS)	2%	1
Science & Engineering Apprenticeship Program (SEAP)	19%	10
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	26%	14
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	38%	20
Other STEM Program	25%	13

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

CQL apprentices were also asked how interested they were in participating in AEOPs in the future (Table 156). Almost all apprentices were at least somewhat interested in participating in CQL again (91%), and more than half of apprentices (54%-72%) reported being at least somewhat interested in all programs except GEMS-NPM (33%). Nearly a third or more of apprentices had never heard of the NDSEG fellowship (35%), GEMS-NPM (33%), and URAP (31%).

Table 156. Student Interest in Future AEOP Programs (n=58)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	0.0%	3.4%	5.2%	22.4%	69.0%	
	0	2	3	13	40	**58**

Undergraduate Research Apprenticeship Program (URAP)	31.0%	8.6%	6.9%	25.9%	27.6%	
	18	5	4	15	16	**58**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	17.2%	8.6%	1.7%	8.6%	63.8%	
	10	5	1	5	37	**58**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	34.5%	10.3%	1.7%	12.1%	41.4%	
	20	6	1	7	24	**58**
GEMS Near Peer Mentor Program	32.8%	22.4%	12.1%	19.0%	13.8%	
	19	13	7	11	8	**58**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during CQL. Table 157 displays results and shows the most frequently discussed program was GEMS-NPM (71%). More than 40% of mentors reported discussing CQL (47%) and SMART (41%) with their apprentices. Almost 65% of mentors reported discussing AEOPs in general but without reference to any specific program.

Table 157. Mentors Explicitly Discussing AEOPs with Apprentices (n=17)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
College Qualified Leaders (CQL)	47.1%	52.9%	
	8	9	**17**
GEMS Near Peer Mentor Program	70.6%	29.4%	
	12	5	**17**
Undergraduate Research Apprenticeship Program (URAP)	11.8%	88.2%	
	2	15	**17**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	41.2%	58.8%	
	7	10	**17**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	17.6%	82.4%	
	3	14	**17**
I discussed AEOP with my student(s) but did not discuss any specific program	64.7%	35.3%	
	11	6	**17**

SEAP

Apprentices were asked to report on their previous participation in AEOPs (Table 158). While 37% indicated they had participated in GEMS or never participated in any AEOP programs, smaller proportions reported having participated in the following AEOPs: SEAP (20%), eCM (9%), Camp Invention (3%), and JSHS (3%). Almost half of responding SEAP participants reported participating in other STEM programs (46%) that were not part of AEOP.

Table 158. Previous Participation in AEOP Programs (n=54)*

Choice	Response Percent	Response Total
Camp Invention	3%	1
eCYBERMISSION	9%	3
Junior Solar Sprint (JSS)	3%	1
Gains in the Education of Mathematics and Science (GEMS)	37%	13
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	20%	7
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	37%	13
Other STEM Program	46%	16

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

SEAP apprentices were also asked how interested they were in participating in AEOPs in the future (Table 159). More than half of apprentices were at least somewhat interested in participating in CQL (54%), and SMART (63%). Nearly a quarter or more of apprentices had never heard of any AEOP listed (23%-51%).

Table 159. Student Interest in Future AEOP Programs (n=35)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	25.7%	5.7%	14.3%	14.3%	40.0%	
	9	2	5	5	14	**35**
College - Undergraduate Research Apprenticeship Program (URAP)	40.0%	5.7%	11.4%	17.1%	25.7%	
	14	2	4	6	9	**35**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	22.9%	5.7%	8.6%	20.0%	42.9%	
	8	2	3	7	15	**35**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	51.4%	5.7%	11.4%	8.6%	22.9%	
	18	2	4	3	8	**35**
High School and College - GEMS Near Peer Mentor Program	28.6%	17.1%	17.1%	17.1%	20.0%	
	10	6	6	6	7	**35**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during SEAP. Table 160 displays results and shows the most frequently discussed program was SEAP (75%). Aside from SEAP, the overwhelming majority of SEAP mentors did not discuss specific AEOPs (55%-100%) or AEOP in general (85%) with their participants.

Table 160. Mentors Explicitly Discussing AEOPs with Apprentices (n=20)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
GEMS	20.0%	80.0%	
	4	16	**20**
UNITE	0.0%	100.0%	
	0	20	**20**
Junior Science & Humanities Symposium (JSHS)	5.0%	95.0%	
	1	19	**20**
Science & Engineering Apprenticeship Program (SEAP)	75.0%	25.0%	
	15	5	**20**

Research & Engineering Apprenticeship Program (REAP)	0.0%	100.0%	
	0	20	**20**
High School Apprenticeship Program (HSAP)	5.0%	95.0%	
	1	19	**20**
College Qualified Leaders (CQL)	45.0%	55.0%	
	9	11	**20**
GEMS Near Peer Mentor Program	10.0%	90.0%	
	2	18	**20**
Undergraduate Research Apprenticeship Program (URAP)	5.0%	95.0%	
	1	19	**20**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	20.0%	80.0%	
	4	16	**20**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	20	**20**
I discussed AEOP with my student(s) but did not discuss any specific program	15.0%	85.0%	
	3	17	**20**

Previous Program Participation & Future Interest – University-Based Programs

REAP

Apprentices were asked to report on their previous participation in AEOPs (Table 161). While 62% indicated they had never participated in any AEOP programs, smaller proportions reported having participated in the following AEOPs: UNITE (21%), GEMS (5%), and REAP (5%). Twenty percent of responding REAP participants reported participating in other STEM programs that were not part of AEOP.

Table 161. Apprentice Participation in AEOP Programs (n=66)*

Choice	Response Percent	Response Total
Camp Invention	0%	0

eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	5%	3
UNITE	21%	14
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	5%	3
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	62%	41
Other STEM Program	20%	13

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

REAP apprentices were also asked how interested they were in participating in AEOPs in the future (Table 162). Less than half of apprentices reported being at least somewhat interested in participating in AEOPs listed (22%-49%), and at least a third of apprentices indicated that they had never heard of the programs (35%-59%).

Table 162. Apprentice Interest in Future AEOP Programs (n=83)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	59.0%	0.0%	9.6%	13.3%	18.1%	
	49	0	8	11	15	**83**
College - Undergraduate Research Apprenticeship Program (URAP)	34.9%	2.4%	13.3%	14.5%	34.9%	
	29	2	11	12	29	**83**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	37.3%	1.2%	15.7%	10.8%	34.9%	
	31	1	13	9	29	**83**

College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	44.6%	7.2%	9.6%	14.5%	24.1%	
	37	6	8	12	20	**83**
High School and College - GEMS Near Peer Mentor Program	38.6%	2.4%	15.7%	22.9%	20.5%	
	32	2	13	19	17	**83**
High School - Junior Science and Humanities Symposium (JSHS)	43.4%	6.0%	15.7%	14.5%	20.5%	
	36	5	13	12	17	**83**
High School - eCYBERMISSION	55.4%	10.8%	12.0%	10.8%	10.8%	
	46	9	10	9	9	**83**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during REAP. Table 163 displays results and shows the most frequently discussed program was REAP (79%). A large majority of mentors reported not discussing any other specific AEOPs with their REAP apprentices (61%-87%). Further, less than half of mentors (45%) reported discussing AEOPs in general but without reference to any specific program.

Table 163. Mentors Explicitly Discussing AEOPs with Students (n=67)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
UNITE	35.8%	64.2%	
	24	43	**67**
Junior Science & Humanities Symposium (JSHS)	25.4%	74.6%	
	17	50	**67**
Science & Engineering Apprenticeship Program (SEAP)	31.3%	68.7%	
	21	46	**67**
Research & Engineering Apprenticeship Program (REAP)	79.1%	20.9%	
	53	14	**67**
High School Apprenticeship Program (HSAP)	31.3%	68.7%	
	21	46	**67**
College Qualified Leaders (CQL)	17.9%	82.1%	
	12	55	**67**

GEMS Near Peer Mentor Program	13.4%	86.6%	
	9	58	**67**
Undergraduate Research Apprenticeship Program (URAP)	38.8%	61.2%	
	26	41	**67**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	37.3%	62.7%	
	25	42	**67**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	16.4%	83.6%	
	11	56	**67**
I discussed AEOP with my student(s) but did not discuss any specific program	44.8%	55.2%	
	30	37	**67**

HSAP

Apprentices were asked to report on their previous participation in AEOPs (Table 164). While 76% indicated they had never participated in any AEOP programs, only one apprentice reported having participated in Camp Invention (6%) and GEMS (6%). Over a quarter of responding HSAP participants reported participating in other STEM programs (29%) that were not part of AEOP.

Table 164. Previous Participation in AEOP Programs (n=20)*

Choice	Response Percent	Response Total
Camp Invention	6%	1
eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	6%	1
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0

Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	76%	13
Other STEM Program	29%	5

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

HSAP apprentices were also asked how interested they were in participating in AEOPs in the future (Table 165). Approximately two-thirds or more reported being interested in URAP (74%) and SMART (63%). While more than half of HSAP apprentices indicated they had never heard of CQL (74%), GEMS-NPM (58%), and NDSEG (53%).

Table 165. Apprentice Interest in Future AEOP Programs (n=19)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	73.7%	0.0%	10.5%	5.3%	10.5%	
	14	0	2	1	2	**19**
College - Undergraduate Research Apprenticeship Program (URAP)	21.1%	0.0%	5.3%	26.3%	47.4%	
	4	0	1	5	9	**19**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	26.3%	0.0%	10.5%	21.1%	42.1%	
	5	0	2	4	8	**19**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	52.6%	5.3%	21.1%	10.5%	10.5%	
	10	1	4	2	2	**19**
High School and College - GEMS Near Peer Mentor Program	57.9%	0.0%	21.1%	0.0%	21.1%	
	11	0	4	0	4	**19**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during HSAP (Table 166). Only four mentors responded to this item; 75%-100% of these mentors indicated they did not discuss any specific AEOP with their participants. Three of the four mentors (75%) reported discussing AEOP with their apprentices, but not any specific programs.

Table 166. Mentors Explicitly Discussing AEOPs with Apprentices (n=4)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
UNITE	25.0%	75.0%	
	1	3	**4**
Junior Science & Humanities Symposium (JSHS)	25.0%	75.0%	
	1	3	**4**
Science & Engineering Apprenticeship Program (SEAP)	25.0%	75.0%	
	1	3	**4**
Research & Engineering Apprenticeship Program (REAP)	25.0%	75.0%	
	1	3	**4**
High School Apprenticeship Program (HSAP)	0.0%	100.0%	
	0	4	**4**
College Qualified Leaders (CQL)	25.0%	75.0%	
	1	3	**4**
GEMS Near Peer Mentor Program	25.0%	75.0%	
	1	3	**4**
Undergraduate Research Apprenticeship Program (URAP)	25.0%	75.0%	
	1	3	**4**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	0.0%	100.0%	
	0	4	**4**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	25.0%	75.0%	
	1	3	**4**
I discussed AEOP with my student(s) but did not discuss any specific program	75.0%	25.0%	
	3	1	**4**

URAP

Apprentices were asked to report on their previous participation in AEOPs (Table 167). No URAP apprentices reported participating in any other AEOP. Only 15% of URAP participants indicated they had previously participated in a STEM program not associated with AEOP.

Table 167. Previous Participation in AEOP Programs (n=35)*

Choice	Response Percent	Response Total
Camp Invention	0%	0
eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	0%	0
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	88%	30
Other STEM Program	15%	5

*Note - this item was asked at registration – therefore the number of respondents will differ from the actual evaluation survey

URAP apprentices were also asked how interested they were in participating in AEOPs in the future (Table 168). Over 40% of apprentices reported being interested in URAP again (56%) and SMART (44%). Large proportions of apprentices indicated they had not heard of CQL (56%), GEMS-NPM (56%), and NDSEG (41%).

Table 168. Apprentice Interest in Future AEOP Programs (n=34)

	I've never heard of	Not at all	A little	Somewhat	Very much	Response Total

	this program					
College - College Qualified Leaders (CQL)	55.9%	11.8%	17.6%	8.8%	5.9%	
	19	4	6	3	2	**34**
College - Undergraduate Research Apprenticeship Program (URAP)	2.9%	17.6%	23.5%	17.6%	38.2%	
	1	6	8	6	13	**34**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	23.5%	8.8%	23.5%	17.6%	26.5%	
	8	3	8	6	9	**34**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	41.2%	2.9%	26.5%	8.8%	20.6%	
	14	1	9	3	7	**34**
High School and College - GEMS Near Peer Mentor Program	55.9%	20.6%	8.8%	8.8%	5.9%	
	19	7	3	3	2	**34**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during URAP (Table 169). A majority of mentors (76%) reported discussing AEOP in general but not specific programs. Large proportions of mentors reported not discussing any specific AEOPs with their apprentices (70%-96%).

Table 169. Mentors Explicitly Discussing AEOPs with Apprentices (n=27)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
College Qualified Leaders (CQL)	7.4%	92.6%	
	2	25	**27**
GEMS Near Peer Mentor Program	3.7%	96.3%	
	1	26	**27**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	18.5%	81.5%	
	5	22	**27**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	29.6%	70.4%	
	8	19	**27**
I discussed AEOP with my student(s) but did not discuss any specific program	74.1%	25.9%	
	20	7	**27**

Awareness of STEM Careers & DoD STEM Careers & Research – Overall

A goal of AEOPs is to increase the number of students who pursue STEM careers. As such, apprentices were asked how many jobs/careers in STEM in general, and STEM jobs/careers in the DoD more specifically, they learned about during their AEOP apprenticeship experiences. Additionally, AEOP apprentices' attitudes about the importance of DoD research are considered an important prerequisite to their continued interest in the field and their potential involvement in DoD or STEM careers in the future. Apprentices were therefore asked to respond to questionnaire items gauging their opinions about DoD researchers and research. This section presents results for these areas.

Awareness of STEM Careers & DoD STEM Careers & Research – Army Laboratory-Based Programs

CQL

Tables 170 and 171 show that a large majority of CQL apprentices (93%) reported learning about at least one STEM job/career and that most (74%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (93%) reported learning about at least one DoD STEM job/career, although somewhat fewer (67%) reported learning about 3 or more Army or DoD STEM jobs during CQL.

Table 170. Number of STEM Jobs/Careers Apprentices Learned About During CQL (n=58)

	Response Percent	Response Total
None	6.90 %	4
1	8.62 %	5
2	10.34 %	6
3	25.86 %	15
4	3.45 %	2
5 or more	44.83 %	26

Table 171. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During CQL (n=58)

	Response Percent	Response Total
None	6.90 %	4
1	8.62 %	5
2	17.24 %	10
3	24.14 %	14
4	0.00 %	0

5 or more	43.10 %	25

Apprentices participating in focus groups were also asked about whether and how they learned about Army or DoD STEM careers during CQL. All participants reported learning about these careers, citing their mentors, informal conversations, invited speakers, and networking events as sources of information.

CQL apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements (Table 172). For example, 97% agreed or strongly agreed that DoD researchers advance science and engineering fields, and 97% agreed or strongly agreed that DoD researchers solve real-world problems.

Table 172. Student Opinions about DoD Researchers and Research (n=58)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.7%	0.0%	1.7%	34.5%	62.1%	
	1	0	1	20	36	**58**
DoD researchers develop new, cutting edge technologies	1.7%	0.0%	5.2%	37.9%	55.2%	
	1	0	3	22	32	**58**
DoD researchers solve real-world problems	1.7%	0.0%	1.7%	32.8%	63.8%	
	1	0	1	19	37	**58**
DoD research is valuable to society	1.7%	0.0%	3.4%	22.4%	72.4%	
	1	0	2	13	42	**58**

SEAP

Tables 173 and 174 show that a large majority of SEAP apprentices (91%) reported learning about at least one STEM job/career, and that most (83%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (97%) reported learning about at least one DoD STEM job/career, and again most (86%) reported learning about 3 or more Army or DoD STEM jobs during SEAP.

Table 173. Number of STEM Jobs/Careers Apprentices Learned About During SEAP (n=35)

	Response Percent	Response Total
None	8.57 %	3
1	0.00 %	0

2	8.57 %	3
3	17.14 %	6
4	5.71 %	2
5 or more	60.00 %	21

Table 174. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During SEAP (n=35)

	Response Percent	Response Total
None	2.86 %	1
1	2.86 %	1
2	8.57 %	3
3	22.86 %	8
4	11.43 %	4
5 or more	51.43 %	18

Apprentices participating in focus groups were also asked about whether and how they learned about Army or DoD STEM careers during SEAP. Apprentices reported learning about these careers from their mentors, informal conversations, and networking events. For example,

> *"We did a networking session in which we went and talked to all of the people who work here and other people on SEAP. That was helpful for me, because I got to meet a bunch of people who are actually working here, and what they do and talking to them."* (SEAP Apprentice)

SEAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than nearly 90% agreeing to all statements (Table 175). For example, 97% agreed or strongly agreed that DoD researchers advance science and engineering fields, and 97% agreed or strongly agreed that DoD researchers solve real-world problems.

Table 175. Student Opinions about DoD Researchers and Research (n=35)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	2.9%	37.1%	60.0%	
	0	0	1	13	21	**35**
DoD researchers develop new, cutting edge technologies	0.0%	2.9%	8.6%	28.6%	60.0%	
	0	1	3	10	21	**35**
	0.0%	0.0%	2.9%	17.1%	80.0%	

DoD researchers solve real-world problems	0	0	1	6	28	**35**
DoD research is valuable to society	0.0%	0.0%	5.7%	28.6%	65.7%	
	0	0	2	10	23	**35**

Awareness of STEM Careers & DoD STEM Careers & Research – University-Based Programs

REAP

Tables 176 and 177 show that all REAP apprentices (100%) reported learning about at least one STEM job/career, and that most (76%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (77%) reported learning about at least one DoD STEM job/career, although somewhat fewer (43%) reported learning about 3 or more Army or DoD STEM jobs during REAP.

Table 176. Number of STEM Jobs/Careers Apprentices Learned About During REAP (n=83)

Choice	Response Percent	Response Total
None	0.00 %	0
1	7.23 %	6
2	16.87 %	14
3	27.71 %	23
4	13.25 %	11
5 or more	34.94 %	29

Table 177. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During REAP (n=83)

Choice	Response Percent	Response Total
None	22.89 %	19
1	14.46 %	12
2	19.28 %	16
3	19.28 %	16
4	6.02 %	5
5 or more	18.07 %	15

Apprentices participating in interviews were also asked about whether and how they learned about Army or DoD STEM careers during REAP. Apprentices reported various levels of exposure to DoD careers during their apprenticeships, citing their mentors, invited speakers, program emails, webinars, and previous participation in other AEOPs as sources of information.

REAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 80% agreeing to all statements (Table 178). For example, 87% agreed or strongly agreed that DoD researchers advance science and engineering fields, and 88% agreed or strongly agreed that DoD researchers develop new, cutting edge technologies.

Table 178. Apprentice Opinions about DoD Researchers and Research (n=83)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	13.3%	38.6%	48.2%	
	0	0	11	32	40	**83**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	12.0%	44.6%	43.4%	
	0	0	10	37	36	**83**
DoD researchers solve real-world problems	0.0%	0.0%	13.3%	36.1%	50.6%	
	0	0	11	30	42	**83**
DoD research is valuable to society	0.0%	0.0%	16.9%	25.3%	57.8%	
	0	0	14	21	48	**83**

HSAP

Tables 179 and 180 show that all HSAP apprentices (100%) reported learning about at least one STEM job/career, and that most (58%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (84%) reported learning about at least one DoD STEM job/career, although somewhat fewer (26%) reported learning about 3 or more Army or DoD STEM jobs during HSAP.

Table 179. Number of STEM Jobs/Careers Apprentices Learned About During HSAP (n=19)

Choice	Response Percent	Response Total
None	0.00 %	0
1	5.26 %	1
2	36.84 %	7

3	26.32 %	5
4	21.05 %	4
5 or more	10.53 %	2

Table 180. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During HSAP (n=19)

Choice	Response Percent	Response Total
None	15.79 %	3
1	31.58 %	6
2	26.32 %	5
3	26.32 %	5
4	0.00 %	0
5 or more	0.00 %	0

Apprentices participating in interviews were also asked about whether and how they learned about Army or DoD STEM careers during HSAP. While two of the apprentices had not learned about these careers during HSAP, others reported learning about them from their mentors and webinars.

HSAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with 90% or more agreeing to all statements (Table 181). For example, 95% agreed or strongly agreed that DoD researchers solve real-world problems, and 90% agreed or strongly agreed that DoD research is valuable to society.

Table 181. Apprentice Opinions about DoD Researchers and Research (n=19)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	10.5%	42.1%	47.4%	
	0	0	2	8	9	**19**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	10.5%	31.6	57.9%	
	0	0	2	6	11	**19**
DoD researchers solve real-world problems	0.0%	0.0%	13.3%	36.1%	50.6%	
	0	0	1	6	12	**19**
DoD research is valuable to society	0.0%	0.0%	16.9%	25.3%	57.8%	
	0	0	2	5	12	**19**

URAP

Tables 182 and 183 show that a large majority of URAP apprentices (82%) reported learning about at least one STEM job/career, and that half (50%) reported learning about 3 or more general STEM careers. Similarly, a majority of apprentices (53%) reported learning about at least one DoD STEM job/career, although somewhat fewer (24%) reported learning about 3 or more Army or DoD STEM jobs during URAP.

Table 182. Number of STEM Jobs/Careers Learned About During URAP (n=34)

Choice	Response Percent	Response Total
None	17.65 %	6
1	14.71 %	5
2	17.65 %	6
3	26.47 %	9
4	5.88 %	2
5 or more	17.65 %	6

Table 183. Number of DoD STEM Jobs/Careers Learned About During URAP (n=34)

Choice	Response Percent	Response Total
None	47.06 %	16
1	11.76 %	4
2	17.65 %	6
3	14.71 %	5
4	0.00 %	0
5 or more	8.82 %	3

Apprentices participating in interviews were also asked about whether and how they learned about Army or DoD STEM careers during URAP. While one apprentice had not learned about these careers, others reported learning about them from webinars and from the program administrator who visited the site.

URAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 85% agreeing to all statements (Table 184). For example, 91% agreed or strongly agreed that DoD researchers advance science and engineering fields, and 91% agreed or strongly agreed that DoD researchers solve real-world problems.

Table 184. Apprentice Opinions about DoD Researchers and Research (n=34)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	8.8%	44.1%	47.1%	
	0	0	3	15	16	34
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	11.8%	41.2%	47.1%	
	0	0	4	14	16	34
DoD researchers solve real-world problems	0.0%	0.0%	8.8%	44.1%	47.1%	
	0	0	3	15	16	34
DoD research is valuable to society	0.0%	0.0%	8.8%	44.1%	47.1%	
	0	0	3	15	16	34

Interest & Future Engagement in STEM – Overall

Another key goal of the AEOP is to develop a STEM-literate citizenry. It is important, therefore, that participants be engaged in and out of school with high quality STEM activities. In order to examine the impact of programs on apprentices' interest in future engagement in STEM, participants were asked to reflect on their intentions to engage in STEM activities outside of regular school classes. Apprentices reports of the change in the likelihood that they would engage in activities varied across activities.

Interest & Future Engagement in STEM – Level and Setting Comparisons

Apprentices were asked to indicate their likelihood in engaging with STEM activities outside of school as a result of participating in their AEOP. A composite score was calculated[26] by converting responses to a scale of 1 = "Much less likely" to 5 = "Much more likely", and the average across all items was calculated. Composite scores were used to test whether there were differences in apprentice future STEM engagement by program level (high school vs. undergraduate) and setting (army lab vs. university-based). No statistically significant differences in any scale were found by setting. However, there was a significant difference in reported by program level with high school apprentices reporting greater likelihood compared to university level apprentices (effect size is small with d = 0.325).[27]

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[26] Cronbach's alpha reliability for Future STEM engagement was 0.884.

[27] Independent Samples t-test for Future STEM engagement by program level: t(236)=2.50, p=0.013.

CQL

Approximately half or more (43%) of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL except working on solving mathematical or scientific puzzles (Table 185). For example, about three-quarter of apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (81%) and mentor or teach other students about STEM (72%). Composite scores were used to compare apprentice future STEM engagement by U2 classification and specific variables that make up U2. No differences were found in future STEM engagement by overall U2 classification or specific variables except for first generation status. Apprentices who reported that they were first generation college attenders indicated they were significantly more likely to engage in future STEM activities compared to apprentices who had a parent that attended college (effect size is medium with d = 0.577).[28]

Table 185. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=58)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	3.4%	1.7%	37.9%	34.5%	22.4%	
	2	1	22	20	13	**58**
Tinker (play) with a mechanical or electrical device	1.7%	3.4%	43.1%	32.8%	19.0%	
	1	2	25	19	11	**58**
Work on solving mathematical or scientific puzzles	0.0%	3.4%	53.4%	24.1%	19.0%	
	0	2	31	14	11	**58**
Use a computer to design or program something	1.7%	1.7%	32.8%	34.5%	29.3%	
	1	1	19	20	17	**58**
Talk with friends or family about STEM	0.0%	3.4%	27.6%	32.8%	36.2%	
	0	2	16	19	21	**58**
Mentor or teach other students about STEM	0.0%	1.7%	25.9%	37.9%	34.5%	
	0	1	15	22	20	**58**
Help with a community service project related to STEM	1.7%	1.7%	29.3%	37.9%	29.3%	
	1	1	17	22	17	**58**

[28] Independent Samples t-test for Future STEM engagement by first generation status: t(55)=2.14, p=0.037.

Participate in a STEM camp, club, or competition	1.7%	1.7%	46.6%	27.6%	22.4%	
	1	1	27	16	13	**58**
Take an elective (not required) STEM class	0.0%	1.7%	36.2%	32.8%	29.3%	
	0	1	21	19	17	**58**
Work on a STEM project or experiment in a university or professional setting	0.0%	1.7%	17.2%	39.7%	41.4%	
	0	1	10	23	24	**58**

The questionnaire also included and item to gauge apprentices' educational aspirations (Table 186). When asked about how far CQL apprentices wanted to go in formal education after participating in the program, all responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (21%) or terminal degree (48%) in their field.

Table 186. Apprentice Education Aspirations After CQL (n=58)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	24.14 %	14
Get more education after college	6.90 %	4
Get a master's degree	20.69 %	12
Get a Ph.D.	34.48 %	20
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	5.17 %	3
Get a combined M.D. / Ph.D.	6.90 %	4
Get another professional degree (law, business, etc.)	1.72 %	1

SEAP

Approximately half or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after their SEAP experience (Table 187). For example, 70 or more of apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (71%); talk with family or friends about STEM (74%); and mentor or teach other students about STEM (83%). Composite scores were used to compare apprentice future STEM engagement by U2 classification and specific variables that make up U2. No differences were found in future STEM engagement by overall U2 classification or specific variables.

Table 187. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=35)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	0.0%	45.7%	40.0%	14.3%	
	0	0	16	14	5	**35**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	51.4%	31.4%	17.1%	
	0	0	18	11	6	**35**
Work on solving mathematical or scientific puzzles	0.0%	2.9%	40.0%	40.0%	17.1%	
	0	1	14	14	6	**35**
Use a computer to design or program something	0.0%	2.9%	37.1%	28.6%	31.4%	
	0	1	13	10	11	**35**
Talk with friends or family about STEM	0.0%	2.9%	22.9%	42.9%	31.4%	
	0	1	8	15	11	**35**
Mentor or teach other students about STEM	0.0%	0.0%	17.1%	48.6%	34.3%	
	0	0	6	17	12	**35**
Help with a community service project related to STEM	0.0%	0.0%	37.1%	34.3%	28.6%	
	0	0	13	12	10	**35**
Participate in a STEM camp, club, or competition	0.0%	0.0%	42.9%	28.6%	28.6%	
	0	0	15	10	10	**35**
Take an elective (not required) STEM class	0.0%	0.0%	37.1%	25.7%	37.1%	
	0	0	13	9	13	**35**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	28.6%	17.1%	54.3%	
	0	0	10	6	19	**35**

When asked about how far they wanted to go in formal education after participating in the program, all responding SEAP apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (31%) or terminal degree (46%) in their field (Table 188).

Table 188. Apprentice Education Aspirations After SEAP (n=35)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	14.29 %	5
Get more education after college	8.57 %	3
Get a master's degree	31.43 %	11
Get a Ph.D.	31.43 %	11
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	11.43 %	4
Get a combined M.D. / Ph.D.	2.86 %	1
Get another professional degree (law, business, etc.)	0.00 %	0

Interest & Future Engagement in STEM – University-Based Programs

REAP

More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after REAP (Table 189). For example, more than 80% apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (88%) and take an elective STEM class (81%). Composite scores were used to compare apprentice future STEM engagement by U2 classification and specific variables that make up U2. No differences were found in future STEM engagement by overall U2 classification or specific variables except for free and reduced lunch status. Apprentices with low-SES reported significantly more likelihood of engaging in future STEM activities compared to students who did not receive free or reduced lunch (effect size is medium with d = 0.594).[29]

Table 189. Change in Likelihood Apprentice Will Engage in STEM Activities Outside of School (n=83)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	1.2%	3.6%	41.0%	33.7%	20.5%	
	1	3	34	28	17	**83**

[29] Independent Samples t-test for Future STEM engagement by free and reduced lunch status: t(59)=2.28, p=0.027.

Tinker (play) with a mechanical or electrical device	2.4%	6.0%	30.1%	39.8%	21.7%	
	2	5	25	33	18	**83**
Work on solving mathematical or scientific puzzles	0.0%	4.8%	30.1%	45.8%	19.3%	
	0	4	25	38	16	**83**
Use a computer to design or program something	2.4%	4.8%	31.3%	28.9%	32.5%	
	2	4	26	24	27	**83**
Talk with friends or family about STEM	0.0%	1.2%	22.9%	31.3%	44.6%	
	0	1	19	26	37	**83**
Mentor or teach other students about STEM	0.0%	3.6%	20.5%	32.5%	43.4%	
	0	3	17	27	36	**83**
Help with a community service project related to STEM	0.0%	3.6%	20.5%	38.6%	37.3%	
	0	3	17	32	31	**83**
Participate in a STEM camp, club, or competition	0.0%	1.2%	25.3%	20.5%	53.0%	
	0	1	21	17	44	**83**
Take an elective (not required) STEM class	0.0%	3.6%	15.7%	28.9%	51.8%	
	0	3	13	24	43	**83**
Work on a STEM project or experiment in a university or professional setting	0.0%	3.6%	8.4%	22.9%	65.1%	
	0	3	7	19	54	**83**

When asked about how far they wanted to go in formal education after participating in the program, all responding REAP apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (28%) or terminal degree (55%) in their field (Table 190).

Table 190. Apprentice Education Aspirations After REAP (n=83)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	13.25 %	11
Get more education after college	3.61 %	3
Get a master's degree	27.71 %	23
Get a Ph.D.	16.87 %	14

Get a medical-related (M.D.), veterinary (D.V.M), or dental degree (D.D.S)	19.28 %	16
Get a combined M.D. / Ph.D.	15.66 %	13
Get another professional degree (law, business, etc.)	3.61 %	3

HSAP

More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after HSAP (Table 191). For example, 90% or more of apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (95%) and mentor or teach other students about STEM (90%). Composite scores were used to compare apprentice future STEM engagement by U2 classification and specific variables that make up U2. No differences were found in future STEM engagement by overall U2 classification or specific variables.

Table 191. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=19)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	5.3%	0.0%	42.1%	36.8%	15.8%	
	1	0	8	7	3	**19**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	36.8%	47.4%	15.8%	
	0	0	7	9	3	**19**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	36.8%	57.9%	5.3%	
	0	0	7	11	1	**19**
Use a computer to design or program something	0.0%	0.0%	42.1%	31.6%	26.3%	
	0	0	8	6	5	**19**
Talk with friends or family about STEM	0.0%	0.0%	21.1%	42.1%	36.8%	
	0	0	4	8	7	**19**
Mentor or teach other students about STEM	0.0%	0.0%	10.5%	47.4%	42.1%	
	0	0	2	9	8	**19**
Help with a community service project related to STEM	0.0%	0.0%	21.1%	42.1%	36.8%	
	0	0	4	8	7	**19**
	0.0%	0.0%	26.3%	31.6%	42.1%	

Participate in a STEM camp, club, or competition	0	0	5	6	8	**19**
Take an elective (not required) STEM class	0.0%	0.0%	21.1%	31.6%	47.4%	
	0	0	4	6	9	**19**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	5.3%	36.8%	57.9%	
	0	0	1	7	11	**19**

When asked about how far they wanted to go in formal education after participating in the program, all responding HSAP apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (21%) or terminal degree (66%) in their field (Table 192).

Table 192. Apprentice Education Aspirations After HSAP (n=19)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	10.53 %	2
Get more education after college	5.26 %	1
Get a master's degree	21.05 %	4
Get a Ph.D.	47.37 %	9
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	5.26 %	1
Get a combined M.D. / Ph.D.	10.53 %	2
Get another professional degree (law, business, etc.)	3.23 %	1

URAP

Approximately half or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after URAP except watching or reading non-fiction STEM (38%). For example, Table 193 shows that approximately 70% of apprentices indicated being more likely or much more likely to engage in working on STEM projects in a university setting (71%) and mentor or teach other students about STEM (68%). Composite scores were used to compare apprentice future STEM engagement by U2 classification and specific variables that make up U2. No differences were found in future STEM engagement by overall U2 classification or specific variables.

Table 193. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=34)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	5.9%	55.9%	26.5%	11.8%	
	0	2	19	9	4	**34**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	44.1%	32.4%	23.5%	
	0	0	15	11	8	**34**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	38.2%	41.2%	20.6%	
	0	0	13	14	7	**34**
Use a computer to design or program something	0.0%	0.0%	35.3%	41.2%	23.5%	
	0	0	12	14	8	**34**
Talk with friends or family about STEM	0.0%	0.0%	52.9%	32.4%	14.7%	
	0	0	18	11	5	**34**
Mentor or teach other students about STEM	0.0%	0.0%	32.4%	47.1%	20.6%	
	0	0	11	16	7	**34**
Help with a community service project related to STEM	0.0%	0.0%	50.0%	38.2%	11.8%	
	0	0	17	13	4	**34**
Participate in a STEM camp, club, or competition	0.0%	2.9%	44.1%	38.2%	14.7%	
	0	1	15	13	4	**34**
Take an elective (not required) STEM class	0.0%	0.0%	52.9%	29.4%	17.6%	
	0	0	18	10	6	**34**
Work on a STEM project or experiment in a university or professional setting	2.9%	0.0%	26.5%	32.4%	38.2%	
	1	0	9	11	13	**34**

When asked about how far they wanted to go in formal education after participating in the program, all responding URAP apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (32%) or terminal degree (44%) in their field (Table 194).

Table 194. Apprentice Education Aspirations After URAP (n=34)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	14.71 %	5
Get more education after college	8.82 %	3
Get a master's degree	32.35 %	11
Get a Ph.D.	32.35 %	11
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	5.88 %	2
Get a combined M.D. / Ph.D.	2.94 %	1
Get another professional degree (law, business, etc.)	2.94 %	1

Resources – Overall

The AEOP provides various resources to apprentices and mentors, including brochures, the AEOP website, and AEOP on social media. Apprentices and mentors were asked to comment on the usefulness of these resources, as well as on the usefulness of mentors and apprenticeship participation generally, for making apprentices aware of DoD STEM careers and other AEOPs.

Resources – Army Laboratory-Based Programs

CQL

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 195. Participation in the apprenticeship program (85%) and apprentices' mentors (81%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. A majority of apprentices reported that they either had not experienced AEOP resources such as the AEOP brochure, the ARO website, and AEOP on social media or found them not impactful on their awareness of DoD STEM careers.

Table 195. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=58)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	24.1%	8.6%	32.8%	19.0%	15.5%	
	14	5	19	11	9	**58**

AEOP on Facebook, Twitter or other social media	65.5%	15.5%	13.8%	5.2%	0.0%	
	38	9	8	3	0	**58**
Army Research Office (ARO) website	63.8%	10.3%	6.9%	15.5%	3.4%	
	37	6	4	9	2	**58**
AEOP brochure	46.6%	15.5%	15.5%	19.0%	3.4%	
	27	9	9	11	2	**58**
My Apprenticeship Program mentor	5.2%	5.2%	8.6%	17.2%	63.8%	
	3	3	5	10	37	**58**
Presentations or information shared in the Apprenticeship Program	12.1%	3.4%	24.1%	29.3%	31.0%	
	7	2	14	17	18	**58**
Participation in the Apprenticeship Program	3.4%	1.7%	10.3%	22.4%	62.1%	
	2	1	6	13	36	**58**

Mentors were also asked how useful these resources were for exposing students to DoD STEM careers (Table 196). Similar to apprentices, mentors were most likely to rate participation in CQL as useful, with 82% selecting this as a somewhat or very much useful resource. Invited speakers were perceived to be at least somewhat useful by 65% of responding mentors. Most mentors had not experienced AEOP materials such as the It Starts Here! Magazine (88%), AEOP on social media (82%), and the AEOP brochure (71%) as resources for exposing students to DoD STEM careers.

Table 196. Impact of Resources on Exposing Students to DoD STEM Careers (n=17)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	35.3%	0.0%	23.5%	17.6%	23.5%	
	6	0	4	3	4	**17**
AEOP on Facebook, Twitter or other social media	82.4%	5.9%	5.9%	0.0%	5.9%	
	14	1	1	0	1	**17**
AEOP brochure	70.6%	5.9%	11.8%	5.9%	5.9%	
	12	1	2	1	1	**17**
CQL Program Administrator or site coordinator	41.2%	0.0%	17.6%	5.9%	35.3%	
	7	0	3	1	6	**17**

My Apprenticeship Program mentor	41.2%	0.0%	17.6%	5.9%	35.3%	
	7	0	3	1	6	**17**
Invited speaker or "career" events	35.3%	0.0%	0.0%	17.6%	47.1%	
	6	0	0	3	8	**17**
Participation in CQL	17.6%	0.0%	0.0%	35.3%	47.1%	
	3	0	0	6	8	**17**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 197). Two sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in CQL (76%) and their program mentors (74%). More than half of responding apprentices had not experienced AEOP resources such as AEOP on social media (72%) and the AEOP brochure (57%).

Table 197. Impact of Resources on Student Awareness of AEOPs (n=58)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	31.0%	1.7%	20.7%	24.1%	22.4%	
	18	1	12	14	13	**58**
AEOP on Facebook, Twitter or other social media	72.4%	17.2%	6.9%	3.4%	0.0%	
	42	10	4	2	0	**58**
AEOP brochure	56.9%	8.6%	15.5%	17.2%	1.7%	
	33	5	9	10	1	**58**
My Apprenticeship Mentor	6.9%	6.9%	12.1%	19.0%	55.2%	
	4	4	7	11	32	**58**
Presentations or information shared through the Apprenticeship Program	15.5%	3.4%	22.4%	34.5%	24.1%	
	9	2	13	20	14	**58**
Participation in CQL	6.9%	1.7%	15.5%	19.0%	56.9%	
	4	1	9	11	33	**58**

Mentors were also asked how useful various resources were in their efforts to expose students to AEOPs (Table 198). Participation in CQL was most commonly reported (81%) as somewhat or very much useful for this purpose. Most mentors reported that they did not experience materials provided by AEOP such as social media (82%) and the AEOP brochure (65%) as resources for exposing students to AEOPs.

Table 198. Impact of Resources on Exposing Students to AEOPs (n=17)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	29.4%	0.0%	11.8%	23.5%	35.3%	
	5	0	2	4	6	**17**
AEOP on Facebook, Twitter or other social media	82.4%	5.9%	5.9%	0.0%	5.9%	
	14	1	1	0	1	**17**
AEOP brochure	64.7%	5.9%	5.9%	17.6%	5.9%	
	11	1	1	3	1	**17**
CQL Program Administrator or site coordinator	35.3%	5.9%	5.9%	17.6%	35.3%	
	6	1	1	3	6	**17**
Invited speakers or "career events	41.2%	0.0%	5.9%	11.8%	41.2%	
	7	0	1	2	7	**17**
Participation in CQL	18.8%	0.0%	0.0%	12.5%	68.8%	
	3	0	0	2	11	**17**

SEAP

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 199. Participation in the apprenticeship program (89%) and apprentices' mentors (74%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. A majority of apprentices reported that they had not experienced AEOP resources such as the ARO website (54%) and AEOP on social media (66%).

Table 199. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	31.4%	8.6%	31.4%	20.0%	8.6%	
	11	3	11	7	3	**35**
	65.7%	8.6%	22.9%	2.9%	0.0%	

AEOP on Facebook, Twitter or other social media	23	3	8	1	0	**35**
Army Research Office (ARO) website	54.3%	8.6%	25.7%	11.4%	0.0%	
	19	3	9	4	0	**35**
AEOP brochure	37.1%	8.6%	37.1%	11.4%	5.7%	
	13	3	13	4	2	**35**
My Apprenticeship Program mentor	2.9%	0.0%	22.9%	22.9%	51.4%	
	1	0	8	8	18	**35**
Presentations or information shared in the Apprenticeship Program	14.3%	5.7%	17.1%	28.6%	34.3%	
	5	2	6	10	12	**35**
Participation in the Apprenticeship Program	2.9%	0.0%	8.6%	20.0%	68.6%	
	1	0	3	7	24	**35**

Mentors were also asked how useful these resources were for exposing students to DoD STEM careers (Table 200). Similar to apprentices, mentors were most likely to rate participation in SEAP as useful, with 80% selecting this as a somewhat or very much useful resource. Invited speakers were perceived to be at least somewhat useful by 50% of responding mentors. Most mentors had not experienced AEOP materials such as AEOP on social media (70%) and the AEOP brochure (71%) as resources for exposing students to DoD STEM careers.

Table 200. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=20)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	45.0%	10.0%	25.0%	10.0%	10.0%	
	9	2	5	2	2	**20**
AEOP on Facebook, Twitter or other social media	70.0%	15.0%	10.0%	5.0%	0.0%	
	14	3	2	1	0	**20**
AEOP brochure	55.0%	15.0%	25.0%	5.0%	0.0%	
	11	3	5	1	0	**20**
SEAP Lab Coordinator	25.0%	15.0%	25.0%	20.0%	15.0%	
	5	3	5	4	3	**20**

Invited speakers or "career" events	25.0%	15.0%	10.0%	25.0%	25.0%	
	5	3	2	5	5	**20**
Participation in the Apprenticeship Program	5.0%	0.0%	15.0%	15.0%	65.0%	
	1	0	3	3	13	**20**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 201). Two sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in SEAP (86%) and their program mentors (77%). Approximately half or more of responding apprentices had not experienced AEOP resources such as AEOP on social media (80%) and the AEOP brochure (49%).

Table 201. Usefulness of Resources for Exposing Students to AEOPs (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	22.9%	2.9%	37.1%	20.0%	17.1%	
	8	1	13	7	6	**35**
AEOP on Facebook, Twitter or other social media	80.0%	0.0%	14.3%	5.7%	0.0%	
	28	0	5	2	0	**35**
AEOP brochure	48.6%	2.9%	28.6%	20.0%	0.0%	
	17	1	10	7	0	**35**
My Apprenticeship Mentor	8.6%	0.0%	14.3%	31.4%	45.7%	
	3	0	5	11	16	**35**
Presentations or information shared through the Apprenticeship Program	14.3%	0.0%	22.9%	37.1%	25.7%	
	5	0	8	13	9	**35**
Participation in the Apprenticeship Program	2.9%	0.0%	11.4%	28.6%	57.1%	
	1	0	4	10	20	**35**

Mentors were also asked how useful various resources were in their efforts to expose students to AEOPs (Table 202). Participation in SEAP was most commonly reported (90%) as somewhat or very much useful for this purpose followed by SEAP program administrator or site coordinator (60%). Most mentors reported that they did not experience materials provided by AEOP such as social media (70%) and the AEOP brochure (55%) as resources for exposing students to AEOPs.

Table 202. Impact of Resources on Student Awareness of AEOPs (n=20)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	35.0%	10.0%	25.0%	20.0%	10.0%	
	7	2	5	4	2	**20**
AEOP on Facebook, Twitter or other social media	70.0%	20.0%	0.0%	10.0%	0.0%	
	14	4	0	2	0	**20**
AEOP brochure	55.0%	20.0%	10.0%	15.0%	0.0%	
	11	4	2	3	0	**20**
SEAP Program Administrator or Site Coordinator	20.0%	5.0%	15.0%	20.0%	40.0%	
	4	1	3	4	8	**20**
Invited speakers or "career" events	45.0%	10.0%	0.0%	25.0%	20.0%	
	9	2	0	5	4	**20**
Participation in the Apprenticeship Program	5.0%	0.0%	5.0%	30.0%	60.0%	
	1	0	1	6	12	**20**

Resources – University-Based Programs

REAP

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 203. More than half of REAP participants reported all resources except one AEOP on social media – 54% had not experienced) as being somewhat or very much impactful on their awareness of DoD STEM careers. For example, approximately 60% or more of apprentices reported at least somewhat of an impact from: participating in REAP (76%); presentations or information shared in REAP (64%); their REAP mentor (63%); and the AEOP website (59%).

Table 203. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=83)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total

Army Educational Outreach Program (AEOP) website	14.5%	4.8%	21.7%	26.5%	32.5%	
	12	4	18	22	27	**83**
AEOP on Facebook, Twitter or other social media	54.2%	15.7%	10.8%	13.3%	6.0%	
	45	13	9	11	5	**83**
AEOP brochure	19.4%	9.6%	18.1%	24.1%	28.9%	
	16	8	15	20	24	**83**
My Apprenticeship Program mentor	6.0%	10.8%	20.5%	20.5%	42.2%	
	5	9	17	17	35	**83**
Presentations or information shared in the Apprenticeship Program	15.7%	7.2%	13.3%	25.3%	38.6%	
	13	6	11	21	32	**83**
Participation in the Apprenticeship Program	7.2%	4.8%	12.0%	16.9%	59.0%	
	6	4	10	14	49	**83**

Similar to REAP apprentices, half or more of their mentors reported all resources except for AEOP social media (54% did not experience) as useful for exposing students to DoD STEM careers (Table 204). Mentors were most likely to rate participation in REAP as useful, with 87% selecting this as a somewhat or very much useful resource. Other resources at least half of mentors reported as somewhat or very much useful for exposing apprentices to DoD STEM careers were: REAP program administratior or site coordinator (72%); STEM career information (61%); AEOP website (60%); and AEOP brochure (51%).

Table 204. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=67)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	25.4%	3.0%	11.9%	22.4%	37.3%	
	17	2	8	15	25	**67**
AEOP on Facebook, Twitter, Pinterest or other social media	53.7%	9.0%	13.4%	19.4%	4.5%	
	36	6	9	13	3	**67**
AEOP brochure	29.9%	3.0%	16.4%	23.9%	26.9%	
	20	2	11	16	18	**67**
REAP Program administrator or site coordinator	16.4%	0.0%	11.9%	23.9%	47.8%	
	11	0	8	16	32	**67**

STEM career information	25.4%	0.0%	13.4%	23.9%	37.3%	
	17	0	9	16	25	**67**
Participation in REAP	4.5%	0.0%	9.0%	20.9%	65.7%	
	3	0	6	14	44	**67**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 205). Three sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in REAP (87%); their program mentor (75%); and the AEOP website (74%). More than half of responding apprentices had not experienced AEOP on social media (53%).

Table 205. Impact of Resources on Apprentice Awareness of AEOPs (n=83)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	8.4%	1.2%	16.9%	21.7%	51.8%	
	7	1	14	18	43	**83**
AEOP on Facebook, Twitter, Pinterest or other social media	53.0%	16.9%	14.5%	10.8%	4.8%	
	44	14	12	9	4	**83**
AEOP brochure	16.9%	9.6%	21.7%	26.5%	25.3%	
	14	8	18	22	21	**83**
My Apprenticeship Mentor	6.0%	6.0%	13.3%	19.3%	55.4%	
	5	5	11	16	46	**83**
Presentations or information shared through the Apprenticeship Program	19.3%	3.6%	16.9%	26.5%	33.7%	
	16	3	14	22	28	**83**
Participation in the Apprenticeship Program	4.8%	1.2%	7.2%	12.0%	74.7%	
	4	1	6	10	62	**83**

Mentors were also asked how useful various resources were in their efforts to expose students to AEOPs (Table 206). Participation in REAP was most commonly reported (88%) as somewhat or very much useful for this purpose. Two-thirds or more of mentors also indicated the following resources were at least somewhat useful: REAP program administrator (78%); STEM career information (67%); and AEOP website (67%). Approxinately half of mentors reported not experiencing AEOP on social media (52%).

Table 206. Usefulness of Resources for Exposing Students to AEOPs (n=67)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	23.9%	0.0%	9.0%	23.9%	43.3%	
	16	0	6	16	29	**67**
AEOP on Facebook, Twitter, Pinterest or other social media	52.2%	10.4%	10.4%	19.4%	7.5%	
	35	7	7	13	5	**67**
AEOP brochure	26.9%	3.0%	13.4%	22.4%	34.3%	
	18	2	9	15	23	**67**
REAP Program administrator or site coordinator	11.9%	0.0%	10.4%	16.4%	61.2%	
	8	0	7	11	41	**67**
STEM career information	19.4%	1.5%	11.9%	22.4%	44.8%	
	13	1	8	15	30	**67**
Participation in REAP	6.0%	0.0%	6.0%	13.4%	74.6%	
	4	0	4	9	50	**67**

HSAP

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 207. Participation in the apprenticeship program (63%), apprentices' mentors (53%), and the AEOP website (53%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. A majority of apprentices reported that they had not experienced AEOP on social media (63%).

Table 207. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=19)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	21.1%	5.3%	21.1%	10.5%	42.1%	
	4	1	4	2	8	**19**
AEOP on Facebook, Twitter, Pinterest or other social media	63.2%	15.8%	15.8%	5.3%	0.0%	
	12	3	3	1	0	**19**

Army Research Office (ARO) website	47.4%	5.3%	21.1%	10.5%	15.8%	
	9	1	4	2	3	**19**
AEOP brochure	15.8%	10.5%	36.8%	21.1%	15.8%	
	3	2	7	4	3	**19**
My Apprenticeship Program mentor	5.3%	10.5%	31.6%	26.3%	26.3%	
	1	2	6	5	5	**19**
Presentations or information shared in the Apprenticeship Program	26.3%	15.8%	15.8%	21.1%	21.1%	
	5	3	3	4	4	**19**
Participation in the Apprenticeship Program	5.3%	5.3%	26.3%	26.3%	36.8%	
	1	1	5	5	7	**19**

Only four HSAP mentors responded when asked how useful these resources were for exposing students to DoD STEM careers (Table 208). All mentors rated the AEOP website as somewhat or very much useful. Three of four responding mentors also indicated the following resources were at least somewhat useful: ARO website (75%); HSAP program administrator or site coordinator (75%); and participation in HSAP (75%). Most mentors had not experienced AEOP materials such as AEOP on social media (100%) and invited speakers or career events (75%) as resources for exposing students to DoD STEM careers.

Table 208. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=4)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	0.0%	0.0%	25.0%	50.0%	25.0%	
	0	0	1	2	1	**4**
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	0.0%	50.0%	50.0%	
	0	0	0	2	2	**4**
AEOP on Facebook, Twitter, Pinterest or other social media	100.0%	0.0%	0.0%	0.0%	0.0%	
	4	0	0	0	0	**4**
AEOP brochure	50.0%	0.0%	0.0%	0.0%	50.0%	
	2	0	0	0	2	**4**
HSAP Program administrator or site coordinator	0.0%	0.0%	25.0%	25.0%	50.0%	
	0	0	1	1	2	**4**

Invited speakers or "career" events	75.0%	0.0%	0.0%	0.0%	25.0%	
	3	0	0	0	1	**4**
Participation in HSAP	25.0%	0.0%	0.0%	25.0%	50.0%	
	1	0	0	1	2	**4**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 209). Two sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in HSAP (74%) and the AEOP website (74%). More than half of responding apprentices had not experienced AEOP on social media (58%).

Table 209. Impact of Resources on Apprentice Awareness of AEOPs (n=19)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	15.8%	0.0%	10.5%	31.6%	42.1%	
	3	0	2	6	8	**19**
AEOP on Facebook, Twitter, Pinterest or other social media	57.9%	10.5%	15.8%	15.8%	0.0%	
	11	2	3	3	0	**19**
AEOP brochure	5.3%	10.5%	36.8%	15.8%	31.6%	
	1	2	7	3	6	**19**
My Apprenticeship Mentor	15.8%	21.1%	21.1%	5.3%	36.8%	
	3	4	4	1	7	**19**
Presentations or information shared through the Apprenticeship Program	36.8%	10.5%	15.8%	10.5%	26.3%	
	7	2	3	2	5	**19**
Participation in the Apprenticeship Program	5.3%	5.3%	15.8%	21.1%	52.6%	
	1	1	3	4	10	**19**

Mentors were also asked how useful various resources were in their efforts to expose students to AEOPs (Table 210). All four responding mentors indicated that the AEOP website and HSAP program administrator were at least somewhat useful for this purpose. Three-quarters (75%) of mentors reported participation in HSAP was somewhat or very much useful. Most mentors reported that they did not experience materials provided by AEOP such as social media (75%) and invited speakers or career events (75%) as resources for exposing students to AEOPs.

Table 210. Useful Resources for Exposing Apprentices to AEOPs (n=4)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	0.0%	0.0%	25.0%	75.0%	0.0%	
	0	0	1	3	0	**4**
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	0.0%	50.0%	50.0%	
	0	0	0	2	2	**4**
AEOP on Facebook, Twitter, Pinterest or other social media	75.0%	0.0%	25.0%	0.0%	0.0%	
	3	0	1	0	0	**4**
AEOP brochure	50.0%	0.0%	0.0%	0.0%	50.0%	
	2	0	0	0	2	**4**
HSAP Program administrator or site coordinator	0.0%	0.0%	0.0%	50.0%	50.0%	
	0	0	0	2	2	**4**
Invited speakers or "career" events	75.0%	0.0%	0.0%	0.0%	25.0%	
	3	0	0	0	1	**4**
Participation in HSAP	25.0%	0.0%	0.0%	25.0%	50.0%	
	1	0	0	1	2	**4**

URAP

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 211. Participation in the apprenticeship program (53%) was the only resource reported by more than half of URAP apprentices as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. A majority of apprentices reported that they had not experienced AEOP on social media (71%). All other resources had a broad spread of responses from URAP apprentices.

Table 211. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total

Army Educational Outreach Program (AEOP) website	35.3%	2.9%	29.4%	23.5%	8.8%	
	12	1	10	8	3	**34**
AEOP on Facebook, Twitter, Pinterest or other social media	70.6%	14.7%	11.8%	2.9%	0.0%	
	24	5	4	1	0	**34**
AEOP brochure	44.1%	8.8%	26.5%	14.7%	5.9%	
	15	3	9	5	2	**34**
My Apprenticeship Program mentor	17.6%	14.7%	23.5%	23.5%	20.6%	
	6	5	8	8	7	**34**
Presentations or information shared in the Apprenticeship Program	17.6%	11.8%	29.4%	8.8%	32.4%	
	6	4	10	3	11	**34**
Participation in the Apprenticeship Program	17.6%	14.7%	14.7%	26.5%	26.5%	
	6	5	5	9	9	**34**

Mentors were also asked how useful resources were for exposing students to DoD STEM careers (Table 212). As with the previous item, mentors were most likely to rate participation in URAP as useful, with 78% selecting this as a somewhat or very much useful resource. The HSAP program administrator or site coordinator (56%) and AEOP website (56%) were perceived to be at least somewhat useful by more than half of responding mentors. Most mentors had not experienced AEOP on social media (74%) as a resource for exposing students to DoD STEM careers.

Table 212. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	22.2%	7.4%	22.2%	22.2%	25.9%	
	6	2	6	6	7	**27**
Army Educational Outreach Program (AEOP) website	18.5%	3.7%	22.2%	33.3%	22.2%	
	5	1	6	9	6	**27**
AEOP on Facebook, Twitter, Pinterest or other social media	74.1%	7.4%	3.7%	11.1%	3.7%	
	20	2	1	3	1	**27**

AEOP brochure	48.1%	7.4%	11.1%	14.8%	18.5%	
	13	2	3	4	5	**27**
HSAP Program administrator or site coordinator	33.3%	7.4%	3.7%	18.5%	37.0%	
	9	2	1	5	10	**27**
Invited speakers or "career" events	44.4%	18.5%	11.1%	7.4%	18.5%	
	12	5	3	2	5	**27**
Participation in URAP	18.5%	0.0%	3.7%	14.8%	63.0%	
	5	0	1	4	17	**27**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 213). Two sources stood out as being particularly impactful (somewhat or very much) on apprentices: participation in URAP (65%) and their program mentors (68%). More than half of responding apprentices had not experienced AEOP on social media (72%).

Table 213. Impact of Resources on Apprentice Awareness of AEOPs (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	26.5%	5.9%	20.6%	26.5%	20.6%	
	9	2	7	9	7	**34**
AEOP on Facebook, Twitter, Pinterest or other social media	73.5%	17.6%	2.9%	2.9%	2.9%	
	25	6	1	1	1	**34**
AEOP brochure	38.2%	8.8%	20.6%	26.5%	5.9%	
	13	3	7	9	2	**34**
My Apprenticeship Mentor	8.8%	5.9%	17.6%	17.6%	50.0%	
	3	2	6	6	17	**34**
Presentations or information shared through the Apprenticeship Program	29.4%	8.8%	26.5%	11.8%	23.5%	
	10	3	9	4	8	**34**
Participation in the Apprenticeship Program	8.8%	5.9%	20.6%	14.7%	50.0%	
	3	2	7	5	17	**34**

Mentors were also asked how useful various resources were in their efforts to expose students to AEOPs (Table 214). Participation in URAP was most commonly reported (89%) as somewhat or very much useful for this purpose. Almost three-quarters of mentors also indicated that the URAP program administrator (70%) and AEOP website (74%) were at least somewhat useful for this purpose. Most mentors reported that they did not experience AEOP social media (67%) as a resource for exposing students to AEOPs.

Table 214. Usefulness of Resources for Exposing Apprentices to AEOPs (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	25.9%	3.7%	14.8%	33.3%	22.2%	
	7	1	4	9	6	**27**
Army Educational Outreach Program (AEOP) website	11.1%	3.7%	11.1%	37.0%	37.0%	
	3	1	3	10	10	**27**
AEOP on Facebook, Twitter, Pinterest or other social media	66.7%	11.1%	7.4%	11.1%	3.7%	
	18	3	2	3	1	**27**
AEOP brochure	40.7%	0.0%	18.5%	14.8%	25.9%	
	11	0	5	4	7	**27**
URAP Program administrator or site coordinator	25.9%	0.0%	3.7%	22.2%	48.1%	
	7	0	1	6	13	**27**
Invited speakers or “career” events	44.4%	3.7%	22.2%	3.7%	25.9%	
	12	1	6	1	7	**27**
Participation in URAP	7.4%	0.0%	3.7%	22.2%	66.7%	
	2	0	1	6	18	**27**

Overall Impact – Overall

Apprentices were asked to report the overall impacts of participating in the program on their confidence and interest in STEM, their awareness of and interest in participating in AEOPs in the future, and their awareness of and interest in STEM careers.

Overall Impact – Level and Setting Comparisons

Apprentices were asked to indicate their opinions about their program's overall impact. A composite score was calculated[30] by converting responses to a scale of 1 = "Disagree – this did not happen" to 4 = "Agree – program was primarily responsible", and the average across all items was calculated. Composite scores were used to test whether there were differences in apprentice program overall impact by program level (high school vs. undergraduate) and setting (army lab vs. university-based). No statistically significant differences in any scale were found by grade level or setting.

CQL

Approximately two-thirds or more agreed that CQL contributed in some way to each impact listed in this section (Table 215). For example, apprentices reported that CQL contributed to them having more awareness of Army or DoD research and careers (95%); increased confidence in their STEM knowledge, skills, and abilities (91%); and increased interest in pursuing a STEM career with the Army or DoD (85%). The overall impacts composite variable was used to test for differences in overall U2 classification and among subgroups of apprentices; no significant differences were found.

Table 215. Apprentice Opinions of CQL Impacts (n=58)

	Disagree - This did not happen	Disagree - This happened but not because of CQL	Agree - CQL contributed	Agree - CQL was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	3.4%	5.2%	63.8%	27.6%	
	2	3	37	16	**58**
I am more interested in participating in STEM activities outside of school requirements	3.4%	15.5%	55.2%	25.9%	
	2	9	32	15	**58**
I am more aware of other AEOPs	17.2%	5.2%	34.5%	43.1%	
	10	3	20	25	**58**
I am more interested in participating in other AEOPs	17.2%	3.4%	39.7%	39.7%	
	10	2	23	23	**58**
I am more interested in taking STEM classes in school	10.3%	25.9%	51.7%	12.1%	
	6	15	30	7	**58**
I am more interested in earning a STEM degree	6.9%	29.3%	50.0%	13.8%	
	4	17	29	8	**58**

[30] Cronbach's alpha reliability for overall program impact was 0.880.

I am more interested in pursuing a career in STEM	5.2%	19.0%	51.7%	24.1%	
	3	11	30	14	**58**
I am more aware of Army or DoD STEM research and careers	5.2%	0.0%	39.7%	55.2%	
	3	0	23	32	**58**
I have a greater appreciation of Army or DoD STEM research	10.3%	1.7%	37.9%	50.0%	
	6	1	22	29	**58**
I am more interested in pursuing a STEM career with the Army or DoD	12.1%	3.4%	37.9%	46.6%	
	7	2	22	27	**58**

SEAP

More than 70% of SEAP apprentices agreed that SEAP contributed in some way to each impact listed in this section (Table 216). For example, apprentices reported that SEAP contributed to them having a greater appreciation of Army or DoD STEM research (100%); increased confidence in their STEM knowledge, skills, and abilities (97%); and increased interest in pursuing a STEM career with the Army or DoD (86%). The overall impacts composite variable was used to test for differences in overall U2 classification and among subgroups of apprentices; no significant differences were found.

Table 216. Apprentice Opinions of SEAP Impacts (n=35)

	Disagree - This did not happen	**Disagree - This happened but not because of SEAP**	**Agree - SEAP contributed**	**Agree - SEAP was primary reason**	**Response Total**
I am more confident in my STEM knowledge, skills, and abilities	0.0%	2.9%	57.1%	40.0%	
	0	1	20	14	**35**
I am more interested in participating in STEM activities outside of school requirements	2.9%	11.4%	54.3%	31.4%	
	1	4	19	11	**35**
I am more aware of other AEOPs	8.6%	8.6%	37.1%	45.7%	
	3	3	13	16	**35**
I am more interested in participating in other AEOPs	8.6%	0.0%	40.0%	51.4%	
	3	0	14	18	**35**
	11.4%	17.1%	51.4%	20.0%	

I am more interested in taking STEM classes in school	4	6	18	7	**35**
I am more interested in earning a STEM degree	11.4%	8.6%	60.0%	20.0%	
	4	3	21	7	**35**
I am more interested in pursuing a career in STEM	8.6%	8.6%	60.0%	22.9%	
	3	3	21	8	**35**
I am more aware of Army or DoD STEM research and careers	5.7%	0.0%	37.1%	57.1%	
	2	0	13	20	**35**
I have a greater appreciation of Army or DoD STEM research	0.0%	0.0%	42.9%	57.1%	
	0	0	15	20	**35**
I am more interested in pursuing a STEM career with the Army or DoD	11.4%	2.9%	45.7%	40.0%	
	4	1	16	14	**35**

Overall Impact – University-Based Programs

REAP

Approximately two-thirds or more of REAP apprentices agreed that REAP contributed in some way to each impact listed in this section (Table 217). For example, apprentices reported that REAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (95%); increased interest in participating in STEM activities outside of school requirements (87%); and greater appreciation of Army and DoD STEM research (86%). The overall impacts composite variable was used to test for differences in overall U2 classification and among subgroups of apprentices; no significant differences were found.

Table 217. Apprentice Opinions of REAP Impacts (n=83)

	Disagree - This did not happen	Disagree - This happened but not because of REAP	Agree - REAP contributed	Agree - REAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	4.8%	57.8%	37.3%	
	0	4	48	31	**83**
I am more interested in participating in STEM	1.2%	12.0%	59.0%	27.7%	
	1	10	49	23	**83**

activities outside of school requirements					
I am more aware of other AEOPs	7.2%	12.0%	28.9%	51.8%	
	6	10	24	43	**83**
I am more interested in participating in other AEOPs	6.0%	9.6%	34.9%	49.4%	
	5	8	29	41	**83**
I am more interested in taking STEM classes in school	4.8%	25.3%	53.0%	16.9%	
	4	21	44	14	**83**
I am more interested in earning a STEM degree	1.2%	21.7%	56.6%	20.5%	
	1	18	47	17	**83**
I am more interested in pursuing a career in STEM	1.2%	16.9%	55.4%	26.5%	
	1	14	46	22	**83**
I am more aware of Army or DoD STEM research and careers	15.7%	6.0%	36.1%	42.2%	
	13	5	30	35	**83**
I have a greater appreciation of Army or DoD STEM research	8.4%	6.0%	42.2%	43.4%	
	7	5	35	36	**83**
I am more interested in pursuing a STEM career with the Army or DoD	22.9%	15.7%	39.8%	21.7%	
	19	13	33	18	**83**

HSAP

Approximately two-thirds or more of HSAP apprentices agreed that HSAP contributed in some way to each impact listed in this section (Table 218). For example, apprentices reported that HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%); greater appreciation of Army and DoD STEM research (95%); and increased interest in participating in STEM activities outside of school requirements (90%). The overall impacts composite variable was used to test for differences in overall U2 classification and among subgroups of apprentices; no significant differences were found overall or by specific subgroups except gender. Males reported significantly greater overall impact from HSAP than females (effect size is large with d = 0.898).[31]

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[31] Independent Samples t-test for CQL STEM Engagement by race/ethnicity: t(24)=2.20, p=.038.

Table 218. Apprentice Opinions of HSAP Impacts (n=19)

	Disagree - This did not happen	Disagree - This happened but not because of HSAP	Agree - HSAP contributed	Agree - HSAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	0.0%	89.5%	10.5%	
	0	0	17	2	**19**
I am more interested in participating in STEM activities outside of school requirements	0.0%	10.5%	68.4%	21.1%	
	0	2	13	4	**19**
I am more aware of other AEOPs	10.5%	15.8%	42.1%	31.6%	
	2	3	8	6	**19**
I am more interested in participating in other AEOPs	10.5%	5.3%	52.6%	31.6%	
	2	1	10	6	**19**
I am more interested in taking STEM classes in school	5.3%	21.1%	68.4%	5.3%	
	1	4	13	1	**19**
I am more interested in earning a STEM degree	5.3%	21.1%	63.2%	10.5%	
	1	4	12	2	**19**
I am more interested in pursuing a career in STEM	5.3%	15.8%	68.4%	10.5%	
	1	3	13	2	**19**
I am more aware of Army or DoD STEM research and careers	10.5%	5.3%	42.1%	42.1%	
	2	1	8	8	**19**
I have a greater appreciation of Army or DoD STEM research	5.3%	0.0%	52.6%	42.1%	
	1	0	10	8	**19**
I am more interested in pursuing a STEM career with the Army or DoD	26.3%	10.5%	31.6%	31.6%	
	5	2	6	6	**19**

URAP

Half or more of URAP apprentices agreed that URAP contributed in some way to each impact listed in this section (Table 219). For example, apprentices reported that URAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (94%); greater appreciation of Army and DoD

STEM research (85%); and increased awareness of Army or DoD STEM research and careers (82%). The overall impacts composite variable was used to test for differences in overall U2 classification and among subgroups of apprentices; no significant differences were found overall or by specific subgroups.

Table 219. Apprentice Opinions of URAP Impacts (n=34)

	Disagree - This did not happen	Disagree - This happened but not because of URAP	Agree - URAP contributed	Agree - URAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	5.9%	79.4%	14.7%	
	0	2	27	5	**34**
I am more interested in participating in STEM activities outside of school requirements	2.9%	26.5%	58.8%	11.8%	
	1	9	20	4	**34**
I am more aware of other AEOPs	17.6%	8.8%	44.1%	29.4%	
	6	3	15	10	**34**
I am more interested in participating in other AEOPs	17.6%	14.7%	50.0%	17.6%	
	6	5	17	6	**34**
I am more interested in taking STEM classes in school	2.9%	47.1%	38.2%	11.8%	
	1	16	13	4	**34**
I am more interested in earning a STEM degree	0.0%	35.3%	50.0%	14.7%	
	0	12	17	5	**34**
I am more interested in pursuing a career in STEM	0.0%	32.4%	55.9%	11.8%	
	0	11	19	4	**34**
I am more aware of Army or DoD STEM research and careers	17.6%	0.0%	50.0%	32.4%	
	6	0	17	11	**34**
I have a greater appreciation of Army or DoD STEM research	11.8%	2.9%	55.9%	29.4%	
	4	1	19	10	**34**
I am more interested in pursuing a STEM career with the Army or DoD	35.3%	8.8%	38.2%	17.6%	
	12	3	13	6	**34**

8

8 | Findings and Recommendations

Summary of Findings

The 2018 evaluation of apprenticeship program collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP's and program's objectives and intended outcomes. A summary of findings across apprenticeship programs is provided in Table 226. Findings for individual programs are provided in Tables 227-231.

CQL Findings

Table 226. 2018 CQL Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Slightly fewer students were placed in apprenticeships in 2018 than in 2017 although the number of applicants remained constant at 2017 levels.	A total of 574 students applied for CQL apprenticeships, compared to 575 in 2017.
	A total of 214 (37%) applicants were placed in CQL apprenticeships, a slight decrease from 2017 when 229 students (39%) were placed.
	Fifteen Army labs accepted applications for CQL apprentices in 2018. Apprentices were hosted at 13 of these sites (an increase over the 12 participating host sites in 2017).
One fifth of CQL apprentices met the AEOP definition of U2. Enrollment of apprentices from groups historically underserved and underrepresented in STEM showed variations from 2017 levels with the most substantial shifts being in lower participation by females and higher participation by	20% of CQL apprentices met the AEOP's definition of U2 in 2018.
	Participation by females decreased in 2018. Slightly less than half (45%) of participants were female, a decrease as compared to 2017 when 54% of CQL apprentices were female.
	Participation by White students (64%) and Asian students (14%) was similar to 2017 participation (67% and 14% respectively).
	The proportion of CQL participants identifying themselves as Black or African American increased somewhat as compared to 2017 (13% in 2018; 7% in 2017) while by students identifying as Hispanic or Latino remained relatively constant (6% in 2018; 5% in 2017).

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apprentices identifying as Black or African American.	Few students spoke English as a second language (3%) and relatively few were first generation college attenders (16%).
CQL mentors reported gains in 21st Century Skills for the few apprentices assessed; gains were statistically significant in only one area.	While only 3 apprentices were assessed for their growth in 21st Century Skills, mentors reported increases in these apprentices' 21st Century Skills from the beginning (pre-) to the end (post-) of their CQL experiences in all areas except Information, Media, & Technological Literacy. Apprentices demonstrated statistically significant growth in Communication, Collaboration, Social, & Cross-Cultural skills; growth in other skills was not significant.
Apprentices reported engaging in STEM practices more frequently in CQL than in their typical school experiences; non-minority apprentices reported more frequent engagement than minority apprentices.	Most apprentices (60% - 98%) reported engaging in each STEM practice about which they were asked at least once during their CQL experience. Apprentices were engaged particularly frequently (weekly or every day) in interacting with STEM researchers (98%), identifying questions or problems to investigate (93%), and working with a STEM researcher or company on a real-world STEM research project (91%).
	No significant differences were found in reported frequency of engaging in STEM Practices in CQL by U2 classification, although non-minority students reported significantly greater engagement on average compared to Minority students (medium effect size).
	Apprentices reported significantly higher frequency of engagement in STEM practices scores in CQL as compared to in school (extremely large effect size), suggesting that CQL offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in CQL; non-minority apprentices reported larger gains than minority apprentices.	A large majority of apprentices (86%-98%) reported experiencing some level of gains in their STEM knowledge as a result of participating in CQL. Apprentices were most likely to have experienced large gains in their knowledge of what everyday research work is like in STEM (69%) and knowledge of research conducted in a STEM topic or field (67%).
	There were no differences in gains in STEM knowledge by U2 classification although there were significant differences in STEM knowledge gains by race/ethnicity, with non-minority apprentices reporting higher gains than minority apprentices (medium effect size).
Apprentices reported gains in their STEM competencies as a result of participating in CQL; first generation college attenders reported larger gains than apprentices who had a parent who attended college.	A large majority of apprentices (93%-98%) reported experiencing some level of gains in their STEM competencies as a result of participating in CQL. Apprentices were most likely to have experienced large gains in communicating about their experiments and explanations in different ways (53%) and identifying the strengths and limitations of explanations in terms of how well they describe or predict observations (50%).
	There were no differences in gains in STEM competencies by U2 classification although there were significant differences in STEM

<table>
<tr><td></td><td>knowledge gains by first generation college status with students who reported being a first generation college student indicated greater gains in STEM competencies compared to students who had a parent who attended college (medium effect size).</td></tr>
<tr><td rowspan="2">Apprentices reported that CQL participation had positive impacts on their 21st Century Skills; first generation college attenders reported larger gains than apprentices who had a parent who attended college.</td><td>A large majority of apprentices (93%-98%) reported experiencing some level of gains in their 21st Century Skills as a result of participating in CQL. Apprentices were most likely to have experienced large gains in making changes when things do not go as planned (69%), sticking with a task until it is finished (60%), and communicating effectively with others (60%).</td></tr>
<tr><td>There were no differences in gains in 21st Century Skills by U2 classification although there were significant differences in these skill gains by first generation college status with students who reported being a first generation college student reporting greater gains in STEM competencies compared to students who had a parent who attended college (medium effect size).</td></tr>
<tr><td rowspan="2">Apprentices reported gains in their STEM identities as a result of participating in CQL; first generation college attenders reported larger gains than apprentices who had a parent who had attended college.</td><td>A large majority of apprentices (91%-98%) reported experiencing some level of gains in their STEM identities as a result of participating in CQL. Apprentices were most likely to have experienced large gains in feeling prepared for more challenging STEM activities (69%) and their desire to build relationships with mentors who work in STEM (69%).</td></tr>
<tr><td>There were no differences in gains in STEM identity by U2 classification although there were significant differences in gains by first generation college status with students who reported being a first generation college student reporting greater gains in STEM competencies compared to students who had a parent who attended college (medium effect size).</td></tr>
<tr><td colspan="2">Priority #2:
Support and empower educators with unique Army research and technology resources.</td></tr>
<tr><td>Mentors used a range of mentoring strategies with apprentices.</td><td>A majority of CQL mentors reported using most strategies associated with each of the five areas of effective mentoring about which they were asked:
1. Using strategies to establish relevance of learning activities (65%-100%)
2. Supporting the diverse needs of learners (47%-88%)
• 53% did not highlight under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM fields
3. Supporting student development of collaboration and interpersonal skills (82%-100%)
4. Supporting student engagement in “authentic” STEM activities (47%-88%)</td></tr>
</table>

	• 53% did not have their students search for and review technical research to support their work 5. Supporting student STEM educational and career pathways (41%-100%) • 59% did not help students with resumes, applications, personal statements, and/or interview preparations.
CQL apprentices were satisfied with program features that they had experienced and identified a number of benefits of CQL. Apprentices also offered various suggestions for program improvement.	Approximately half or more (46%-93%) of responding apprentices were somewhat or very much satisfied with all of the CQL program features about which they were asked. Features apprentices reported being most satisfied with included: the physical location of program activities (95%); amount of the stipend (95%); and timeliness of receiving stipend (95%).
	Few apprentices expressed dissatisfaction with CQL program features, although 22% of students were not satisfied with administrative tasks such as security clearances and issuing CAC cards.
	A large majority of apprentices (88%-95%) reported being at least "somewhat" satisfied with each element of their CQL experience. Apprentices were most likely to be "very much" satisfied with their working relationship with their mentors (85%) and their working relationship with the group or team (83%).
	Nearly all (98%) of apprentices made positive comments about their satisfaction with CQL in response to open-ended questions. The most frequently mentioned benefits were the research skills and lab experiences they gained followed by the networking opportunities and mentoring.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide more opportunities for apprentices to connect with one another and to provide earlier computer access
CQL mentors satisfied with program features that they had experienced and identified a number of strengths of the CQL program. Mentors also offered various suggestions for program improvements.	More than half (59%-88%) of mentors reported being somewhat or very much satisfied with all program features with the exception of two features that large proportions indicated having not experienced: communicating with AAS (71% did not experience) and timeliness of stipend payment to apprentices (35% did not experience). Mentors were most likely to be "very much" satisfied with support for instruction or mentorship during program activities (47%) and research abstract preparation requirements (47%).
	Nearly all mentors made positive comments about CQL in their responses to open-ended questions. The most frequently mentioned strength of CQL was the research and hands-on experience apprentices receive.
	In open-ended responses, the improvement most frequently suggested by mentors was to provide a larger budget in order to fund more apprentices and lab supplies.

<table>
<tr><th colspan="2">Priority #3:
Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army</th></tr>
<tr><td rowspan="2">Both CQL apprentices and mentors learned about AEOP primarily through DoD and personal contacts.</td><td>Apprentices most frequently learned about AEOP through past participants of the program (30%); family members (30%); someone who works with the program (32%); and someone who works with the DoD (43%).</td></tr>
<tr><td>More than a third (35%) of mentors reported learning about AEOP through someone who works with the DoD. Other sources of information (cited by 29% of participants) included workplace communications and past participants of the program.</td></tr>
<tr><td>Apprentices were motivated to participate in CQL primarily by the learning opportunities and their interest in STEM.</td><td>The most frequently cited motivators for participating in CQL were apprentices' interest in STEM (94%); desire to learn something new or interesting (89%); desire to expand laboratory or research skills (87%); and learning in ways that are not possible in school (87%).</td></tr>
<tr><td rowspan="3">CQL apprentices reported having participated in a variety of AEOPs in the past and are interested in participating in AEOPs in the future.</td><td>While 38% indicated they had never participated in any AEOP programs, apprentices reported having participated in the following AEOPs in the past: CQL (26%), SEAP (19%), GEMS (15%), Camp Invention (8%), UNITE (2%), and JSHS (2%). A quarter of responding CQL participants reported participating in other STEM programs (25%) that were not part of AEOP.</td></tr>
<tr><td>Almost all apprentices were at least somewhat interested in participating in CQL again (91%), and more than half of apprentices (54%-72%) reported being at least somewhat interested in all programs except GEMS-NPM (33%). Nearly a third or more of apprentices had never heard of the NDSEG fellowship (35%), GEMS-NPM (33%), and URAP (31%).</td></tr>
<tr><td>The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in CQL (76%) and their program mentors (74%). More than half of responding apprentices had not experienced AEOP resources such as AEOP on social media (72%) and the AEOP brochure (57%).</td></tr>
<tr><td rowspan="2">Mentors discussed AEOPs with apprentices, but with only limited reference to specific programs.</td><td>The program mentors most frequently discussed with apprentices was GEMS-NPM (71%). More than 40% of mentors reported discussing CQL (47%) and SMART (41%) with their apprentices. Almost 65% of mentors reported discussing AEOPs in general but without reference to any specific program.</td></tr>
<tr><td>The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs was participation in CQL (81%). Most mentors reported that they did not experience materials provided by AEOP such as social media (82%) and the AEOP brochure (65%) as resources for exposing students to AEOPs.</td></tr>
</table>

<table>
<tr><td rowspan="3">Apprentices learned about STEM careers during CQL, although they learned about more STEM careers generally than STEM careers specifically within the DoD.</td><td>A large majority of CQL apprentices (93%) reported learning about at least one STEM job/career, and most (74%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (93%) reported learning about at least one DoD STEM job/career, although somewhat fewer (67%) reported learning about 3 or more Army or DoD STEM jobs during CQL.</td></tr>
<tr><td>The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of DoD STEM careers were participation in CQL (85%) and their mentors (81%). A majority of apprentices reported that they either had not experienced AEOP resources such as the AEOP brochure, the ARO website, and AEOP on social media or found them not impactful on their awareness of DoD STEM careers.</td></tr>
<tr><td>The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were participation in CQL (82%) and invited speakers (65%). Most mentors had not experienced AEOP materials such as the It Starts Here! Magazine (88%), AEOP on social media (82%), and the AEOP brochure (71%) as resources for exposing students to DoD STEM careers.</td></tr>
<tr><td>Apprentices expressed positive opinions about DoD research and researchers.</td><td>CQL apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements about DoD researchers and research.</td></tr>
<tr><td rowspan="2">Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in CQL; first generation college attenders were more likely to engage in future STEM activities compared to apprentices who had a parent that attended college</td><td>Approximately 50% or more of CQL apprentices reported an increased likelihood of engaging in each STEM activity about which they were asked. The activities in which most apprentices reported being more likely or much more likely to engage were in working on STEM projects in a university setting (81%) and mentor or teach other students about STEM (72%).</td></tr>
<tr><td>There were no differences in likelihood of future engagement by U2 classification although there were significant differences by first generation college status with first generation college attenders significantly more likely to engage in STEM activities in the future than apprentices who had a parent who attended college (medium effect size).</td></tr>
<tr><td>All CQL apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.</td><td>All responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (21%) or terminal degree (48%) in their field.</td></tr>
<tr><td>CQL apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM</td><td>About two-thirds or more apprentices reported that CQL contributed to each area relating to their confidence and interest in STEM. The areas in which most apprentices reported impacts were having more awareness of Army or DoD research and careers (95%), increased confidence in their</td></tr>
</table>

careers with no differences in impact across any constituent categories of U2 status.	STEM knowledge, skills, and abilities (91%), and increased interest in pursuing a STEM career with the Army or DoD (85%).
	No significant differences were found in impact in CQL by U2 classification or by any constituent group of U2 classification.

SEAP Findings

Table 227. 2018 SEAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
SEAP enrollment remained steady at 2017 levels although the program received slightly more applications in 2018.	A total of 872 applications were received in 2018, a slight increase (2%) over the 852 applications in 2017.
	A total of 114 (13%) applicants were placed in SEAP apprenticeships as compared to 113 (13%) in 2017.
	Thirteen Army labs accepted applications for SEAP apprentices in 2018; apprentices were hosted at 11 of these sites.
Over a quarter of SEAP students met the AEOP definition of U2. SEAP continues to serve students from a variety of races and ethnicities with slight variations in enrollment of apprentices from groups historically underserved and underrepresented in STEM as compared to 2017.	Slightly over a quarter of SEAP apprentices (27%) met the AEOP definition of students underserved or underrepresented (U2) in STEM.
	Participation of females in SEAP remained relatively constant at 2017 levels (48% in 2018; 54% in 2017).
	Although the most frequently represented races/ethnicities continued to be White (47%) and Asian (27%), more students identified as White than in 2017 (42%) and slightly fewer as Asian (32% in 2017).
	Fewer students identified themselves as Black or African American (12%) than in 2017 (17%) while a similar proportion of students identified themselves as Hispanic or Latino (4%) as in 2017 (3%).
	Few students received free or reduced price school lunches (9%), did not speak English as their first language (5%), and would be first generation college attenders (2%).
SEAP mentors reported significant gains in apprentices' 21st Century Skills.	While only 5-6 apprentices were assessed for their growth in 21st Century Skills, mentors reported significant increases in these apprentices' 21st Century Skills from the beginning (pre-) to the end (post-) of their SEAP experiences in all but one skill set. Apprentices demonstrated the most growth in the skill set of Flexibility, Adaptability, Initiative, & Self-Direction.

	While mentors reported apprentice growth in critical thinking and problem solving, this growth was not statistically significant.
Apprentices reported engaging in STEM practices more frequently in SEAP than in their typical school experiences with no differences in engagement across any constituent categories of U2 status.	Most apprentices (57% - 100%) reported engaging in each STEM practice about which they were asked at least once during their SEAP experience. Apprentices were engaged particularly frequently (weekly or every day) in interacting with STEM researchers (92%) and working with a STEM researcher or company on a real-world STEM research project (92%).
	No significant differences were found in reported frequency of engaging in STEM Practices in SEAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices scores in SEAP as compared to in school (extremely large effect size), suggesting that SEAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in SEAP with no differences in gains across any constituent categories of U2 status.	Nearly all apprentices (98%-100%) reported experiencing some level of gains in their STEM knowledge as a result of participating in SEAP. Apprentices were most likely to have experienced large gains in their knowledge of what everyday research work is like in STEM (77%) and knowledge of how scientists and engineers work on real problems in STEM (66%).
	No significant differences were found in reported gains in STEM knowledge in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM competencies as a result of participating in SEAP with no differences in gains across any constituent categories of U2 status.	Most SEAP apprentices (80% - 94%) reported experiencing some level of gains in their STEM competencies as a result of participating in SEAP. Apprentices were most likely to have experienced large gains in considering different interpretations of data when deciding how data answer a question (43%) and supporting an explanation for an observation with data from experiments (43%).
	No significant differences were found in reported gains in STEM competencies in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that SEAP participation had positive impacts on their 21st Century Skills with no differences in gains across any constituent categories of U2 status.	A large majority of apprentices (91%-100%) reported experiencing some level of gains in their 21st Century Skills as a result of participating in SEAP. Apprentices were most likely to have experienced large gains in learning to work independently (69%) and making changes when things do not go as planned (69%).
	No significant differences were found in reported gains in 21st Century Skills in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM identities as a result	Most apprentices (83%-100%) reported experiencing some level of gains in their STEM identities as a result of participating in SEAP. Apprentices were

of participating in SEAP with no differences in gains across any constituent categories of U2 status.	most likely to have experienced large gains in feeling prepared for more challenging STEM activities (69%) and their desire to build relationships with mentors who work in STEM (60%). No significant differences were found in reported gains in STEM identity in SEAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors used a range of mentoring strategies with apprentices.	A majority of SEAP mentors reported using most strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Using strategies to establish relevance of learning activities (65%-100%) 2. Supporting the diverse needs of learners (35%-100%) • 65% did not integrate ideas from education literature to teach/mentor students from groups underrepresented in STEM • 60% did not highlight under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM fields 3. Supporting student development of collaboration and interpersonal skills (65%-95%) 4. Supporting student engagement in "authentic" STEM activities (70%-100%) 5. Supporting student STEM educational and career pathways (35%-100%) • 65% did not discuss the economic, political, ethical, and/or social context of a STEM career • 65% did not recommend student and professional organizations in STEM to students • 60% did not recommend AEOPs that align with students' goals • 60% did not help students with resumes, applications, personal statements, and/or interview preparations .
SEAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of SEAP. Apprentices also	More than half (66%-94%) of responding apprentices were somewhat or very much satisfied with all of the program features about which they were asked. Features apprentices reported being most satisfied with included: the physical location of program activities (97%); teaching/mentoring provided during SEAP (95%); and applying/registering for the program (94%).

offered various suggestions for program improvement.	Few apprentices expressed dissatisfaction with SEAP program features, although 20% of students were not satisfied with administrative tasks such as security clearances and issuing CAC cards.
	About half or more of apprentices (49%-86%) reported being at least "somewhat" satisfied with each element of their SEAP experience. Apprentices were most likely to be "very much" satisfied with their working relationship with their mentors (86%) and their working relationship with the group or team (71%).
	All SEAP apprentices who responded to open-ended questions made positive comments about their satisfaction with SEAP. The most frequently mentioned benefits were gaining STEM skills and/or research experience, career information and exposure, networking opportunities, and the opportunity to develop general workplace skills.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide more opportunities for apprentices to improve computer access and the security clearance process and to provide opportunities for apprentices to interact with one another.
SEAP mentors satisfied with program features that they had experienced and identified a number of strengths of the SEAP program. Mentors also offered various suggestions for program improvements.	Approximately half or more (55%-65%) of mentors reported being somewhat or very much satisfied with all program features. SEAP mentors were most likely to be "very much" satisfied with the research presentation process (50%). More than a third indicated not experiencing two features: amount of stipends (40% did not experience) and timeliness of stipend payment to apprentices (45% did not experience).
	Most mentors (77%) made positive comments about SEAP in their responses to open-ended questions. The most frequently mentioned strength of SEAP was the hands-on, real world research experiences apprentices gain.
	Mentors offered a wide variety of suggestions for program improvement; however none were mentioned by more than 4 respondents (25%). The most frequently mentioned suggestions (19%-25%) included improvements in student selection, including more flexibility, more time, or more information about students; better communication between mentors and program administrators; and more interaction between apprentices.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Both SEAP apprentices and mentors learned about AEOP	Apprentices most frequently learned about AEOP through family members (54%) and someone who works for the DoD (51%).

primarily through DoD and personal contacts.	Responding mentors most frequently learned about AEOP through someone who works with the DoD (29%), friends (14%), someone who works with the program (14%), and past participants of the program (14%).
Apprentices were motivated to participate in SEAP primarily by the learning opportunities and their interest in STEM.	The most frequently cited motivators for participating in SEAP were apprentices' interest in STEM (91%), their desire to learn something new or interesting (89%), and learning in ways that are not possible in school (86%).
Few apprentices had participated in AEOPs other than GEMS and SEAP in the past but are interested in participating in AEOPs in the future.	While 37% of SEAP apprentices indicated they had never participated in any AEOPs, 37% had participated in GEMS. Smaller proportions reported having participated in the following AEOPs: SEAP (20%), eCM (9%), Camp Invention (3%), and JSHS (3%). Almost half of responding SEAP participants reported participating in other STEM programs (46%) that were not part of AEOP.
	More than half of apprentices were at least somewhat interested in participating in CQL (54%), and SMART (63%), however nearly a quarter or more of apprentices had never heard of other AEOPs (23%-51%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in SEAP (86%) and their program mentors (77%). Approximately half or more of responding apprentices had not experienced AEOP resources such as AEOP on social media (80%) and the AEOP brochure (49%).
Few mentors discussed AEOPs other than SEAP with apprentices.	While 75% of mentors reported that they discussed SEAP with their apprentices, most SEAP mentors did not discuss other AEOPs (55%-100%) or AEOP in general (85%) with their apprentices.
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were participation in SEAP (90%) and SEAP program administrators or site coordinators (60%). Most mentors reported that they did not experience materials provided by AEOP such as social media (70%) and the AEOP brochure (55%) as resources for exposing students to AEOPs.
Apprentices learned about STEM careers generally and STEM careers within the DoD during SEAP.	A large majority of SEAP apprentices (91%) reported learning about at least one STEM job/career, and most (83%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (97%) reported learning about at least one DoD STEM job/career, and again most (86%) reported learning about 3 or more Army or DoD STEM jobs during SEAP.
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of DoD STEM careers were participation in the SEAP (89%) and their mentors (74%). A majority of apprentices reported that they had not experienced AEOP resources such as the ARO website (54%) and AEOP on social media (66%).

	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were participation in SEAP (80%) and invited speakers (50%). Most mentors had not experienced AEOP materials such as AEOP on social media (70%) and the AEOP brochure (71%) as resources for exposing students to DoD STEM careers.
Apprentices expressed positive opinions about DoD research and researchers.	SEAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than nearly 90% agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in SEAP with no difference in likelihood across any constituent category of U2 status.	Approximately 50% or more of SEAP apprentices reported an increased likelihood of engaging in each STEM activity about which they were asked. The activities in which most apprentices reported increased likelihood were working on STEM projects in a university setting (71%); talking with family or friends about STEM (74%); and mentoring or teaching other students about STEM (83%).
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any constituent group of U2 classification.
All SEAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.	All responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (31%) or terminal degree (46%) in their field.
SEAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	More than 70% of apprentices reported that SEAP contributed to each area relating to their confidence and interest in STEM. The areas in which most apprentices reported impacts were having a greater appreciation of Army or DoD STEM research (100%); increased confidence in their STEM knowledge, skills, and abilities (97%); and increased interest in pursuing a STEM career with the Army or DoD (86%).
	No significant differences were found in impact of SEAP by U2 classification or by any constituent group of U2 classification.

REAP Findings

Table 228. 2018 REAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
More students applied for and were placed in REAP apprenticeships in 2018 as compared to 2017.	In 2018, 949 students applied for the REAP program, a 25% increase over the 709 applicants in 2017.
	A total of 138 students were placed in REAP apprenticeships in 2018, a 14% increase over the 118 apprentices placed in 2017.
More colleges and universities hosted REAP apprentices in 2018 than in 2017; a slightly smaller percentages of those institutions were HBCUs/MSIs than in 2017.	A total of 53 colleges and universities participated in REAP in 2018, a 23% increase over the 41 participating institutions in 2017. Of these institutions, 31 (57%) were HBCUs or MSIs, compared to 25 (60%) in 2017.
REAP continues to serve students from groups underserved and underrepresented in STEM, with substantial increases in the participation of some racial/ethnic groups and with a large majority of students meeting the AEOP definition of U2.	A large majority of apprentices (96%) qualified for U2 status under the AEOP definition.
	As in 2017, over half (62% as compared to 61% in 2017) of participants were female.
	The proportion of students identifying themselves as Asian (20%) or White (8%) decreased compared to 2017 when 27% identified as Asian and 19% as White.
	The proportions of apprentices identifying themselves as Black or African American (40%) and Hispanic or Latino (22%) increased substantially compared to 2017 enrollment when 29% of students identified as Black or African American and 15% as Hispanic or Latino.
	Over half of REAP apprentices (55%) qualified for free or reduced price lunch, while English was a second language for over a quarter (27%) and over a third (36%) would be first generation college attenders.
REAP mentors reported significant gains in apprentices' 21st Century Skills.	Mentors assessed 10-11 apprentices' 21st Century Skills and reported significant growth from the beginning (pre-) to the end (post-) of their REAP experiences in all skills assessed. Apprentices demonstrated the most growth in the Communication, Collaboration, Social, & Cross-Cultural and the Information, Media, & Technological Literacy skill sets.
Apprentices reported engaging in STEM practices more frequently in REAP than in their	Most apprentices (67% - 98%) reported engaging in each STEM practice about which they were asked at least once during their REAP experience with the exception of presenting STEM research to a panel of judges from

typical school experiences with no significant differences in engagement across any constituent categories of U2 status.	industry or the military and building or making a computer model (57% and 54% respectively did not engage in these practices in REAP). Apprentices were engaged particularly frequently (weekly or every day) in using laboratory procedures and tools (87%) and working with a STEM researcher or company on a real-world STEM research project (87%).
	No significant differences were found in reported frequency of engaging in STEM Practices in REAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices scores in REAP as compared to in school (extremely large effect size), suggesting that REAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in REAP; males reported higher levels of gains than females.	Nearly all apprentices (98%-100%) reported experiencing some level of gains in their STEM knowledge as a result of participating in REAP. Apprentices were most likely to have experienced large gains in knowledge of what everyday research work is like in STEM (77%) and their knowledge of research conducted in a STEM topic or field (72%).
	No significant differences were found in STEM knowledge gains in REAP by U2 classification, however males reported significantly greater gains in their STEM knowledge than females (extremely large effect size).
Apprentices reported gains in their STEM competencies as a result of participating in REAP with no differences in gains across any constituent categories of U2 status.	A large majority of REAP apprentices (90% -100%) reported experiencing some level of gains in their STEM competencies as a result of participating in REAP. Apprentices were most likely to have experienced large gains in communicating about experiments and explanations in different ways (59%) and supporting an explanation for an observation with data from experiments (59%).
	No significant differences were found in reported gains in STEM competencies in REAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that REAP participation had positive impacts on their 21st Century Skills with no differences in gains across any constituent categories of U2 status.	Nearly all apprentices (98%-100%) reported experiencing some level of gains in their 21st Century Skills as a result of participating in REAP. Apprentices were most likely to have experienced large gains in communicating effectively with others (76%) and viewing failure as an opportunity to learn (75%).
	No significant differences were found in reported gains in 21st Century Skills in REAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM identities as a result	A large majority of apprentices (94%-100%) reported experiencing some level of gains in their STEM identities as a result of participating in REAP.

of participating in REAP; minority apprentices reported larger gains than non-minority apprentices.	Apprentices were most likely to have experienced large gains in their desire to build relationships with mentors who work in STEM (76%) and sense of accomplishing something in STEM (69%).
	No significant differences were found in reported gains in STEM identity in REAP by U2 classification, however minority apprentices reported significantly larger gains than non-minority apprentices (medium effect size).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors used a range of mentoring strategies with apprentices.	A majority of REAP mentors reported using most strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Using strategies to establish relevance of learning activities (73%-93%) 2. Supporting the diverse needs of learners (55%-91%) 3. Supporting student development of collaboration and interpersonal skills (72%-87%) 4. Supporting student engagement in "authentic" STEM activities (82%-97%) 5. Supporting student STEM educational and career pathways (48%-99%) • 52% did not help students with resumes, applications, personal statements, and/or interview preparations .
REAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of REAP. Apprentices also offered various suggestions for program improvement.	About three-quarters or more (75%-95%) of responding apprentices were somewhat or very much satisfied with all program features about which they were asked. Features apprentices reported being most satisfied with included: applying/registering for the program (95%); amount of the stipend (89%); and communicating with the host site organizers (89%).
	Few apprentices expressed dissatisfaction with REAP program features, although 12% of students were not satisfied with timeliness of stipend payments.
	A large majority (87%-96%) of apprentices indicated being "very much" satisfied with all elements of their REAP experience. Apprentices were most likely to be "very much" satisfied with their working relationship with their mentors (74%) and the research experience overall (71%).
	Most apprentices (84%) who responded to open-ended questions made positive comments about their satisfaction with REAP. The most frequently cited benefits of REAP were the STEM skills and research skills they gained, their STEM learning, the career information they gained, and the opportunity for real world, hands-on experience.

	In open-ended responses, the improvements most frequently suggested by apprentices were for apprentices to have more input into the choice of topic or project, that there be more specific guidelines or clearer instructions for projects, and that the program expand to include more participants and/or more locations.
REAP mentors satisfied with program features that they had experienced and identified a number of strengths of the REAP program. Mentors also offered various suggestions for program improvements.	More than three-quarters of mentors (81%-87%) reported being somewhat or very much satisfied with all program features. Mentors were most likely to be very much satisfied with communicating with REAP organizers (81%), the application or registration process (72%), and support for instruction or mentorship during program activities (72%).
	All mentors made positive comments about REAP in their responses to open-ended questions. The most frequently mentioned strengths of REAP were apprentices' exposure to STEM research and technology, the opportunity for hands-on laboratory experiences, and the stipend.
	In open-ended responses, the improvements most frequently suggested by mentors were increasing program funding to provide larger stipends, financial support for mentors, and/or a longer program, and creating more apprentice positions.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
REAP apprentices and mentors learned about AEOP primarily through communications through their school or workplace and professional contacts.	Apprentices most frequently learned about AEOP through a school/university newsletter, email or website (38%) or someone who works at the school/university they attend (24%).
	Mentors most frequently learned about AEOP through a STEM conference or STEM education course (39%); AAS (36%); or a colleague (32%).
Apprentices were motivated to participate in REAP primarily by the learning opportunities and their interest in STEM.	The most frequently cited motivators for participating in REAP were apprentices' interest in STEM (98%), a desire to learn something new or interesting (91%), the opportunity to use advanced laboratory technology (82%), and learning in ways that are not possible in school (80%).
Most apprentices had not participated in AEOPs other than REAP, and most did not report interest in participating in other AEOPs in the future.	While 62% of REAP apprentices indicated they had never participated in any AEOP programs, smaller proportions reported having participated in the following AEOPs: UNITE (21%), GEMS (5%), and REAP (5%). Twenty percent of responding REAP participants reported participating in other STEM programs that were not part of AEOP.
	Less than half of apprentices reported being at least somewhat interested in participating in AEOPs listed (22%-49%). This is likely because at least a third of apprentices had never heard of the programs (35%-59%).

	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in REAP (87%); their program mentors (75%); and the AEOP website (74%). More than half of responding apprentices had not experienced AEOP on social media (53%).
Few mentors discussed AEOPs other than REAP with apprentices.	While 79% of mentors discussed REAP with their apprentices, a large majority of mentors did not discuss any other specific AEOPs with their REAP apprentices (61%-87%), and less than half of mentors (45%) reported discussing AEOPs in general but without reference to any specific program.
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were participation in REAP (88%), REAP program administrators (78%), STEM career information (67%), and the AEOP website (67%). Approximately half of mentors reported not experiencing AEOP on social media (52%).
Apprentices learned about STEM careers during REAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	All REAP apprentices (100%) reported learning about at least one STEM job/career, and most (76%) reported learning about 3 or more general STEM careers. A large majority of apprentices (77%) reported learning about at least one DoD STEM job/career, although somewhat fewer (43%) reported learning about 3 or more Army or DoD STEM jobs during REAP.
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of DoD STEM careers were participating in REAP (76%), presentations or information shared in REAP (64%), their REAP mentors (63%), and the AEOP website (59%). A majority of apprentices reported that they had not experienced AEOP on social media (54%).
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were participation in REAP (87%), REAP program administrators or site coordinators (72%), STEM career information (61%), the AEOP website (60%), and AEOP brochure (51%).
Apprentices expressed positive opinions about DoD research and researchers.	REAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 80% agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in REAP; low-SES students reported higher likelihood of future engagement than apprentices who did not qualify for free or reduced-price school lunches.	Approximately 50% or more of REAP apprentices reported an increased likelihood of engaging in each STEM activity about which they were asked. The activities in which most apprentices reported increased likelihood were working on STEM projects in a university setting (88%) and taking an elective STEM class (81%).
	No differences were found in future STEM engagement by overall U2 classification, however low-SES apprentices reported significantly more likelihood of engaging in future STEM activities compared to students who did not receive free or reduced lunch (medium effect size).

All REAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.	All responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (28%) or terminal degree (55%) in their field.
REAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	About two-thirds or more apprentices reported that REAP contributed to each area relating to their confidence and interest in STEM. The areas in which most apprentices reported impacts were increased confidence in their STEM knowledge, skills, and abilities (95%), increased interest in participating in STEM activities outside of school requirements (87%), and greater appreciation of Army and DoD STEM research (86%).
	No significant differences were found in impact in REAP by U2 classification or by any constituent group of U2 classification.

HSAP Findings

Table 229. 2018 HSAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Fewer students applied for and were placed in HSAP apprentices in 2018 than in 2017.	In 2018, 559 students applied for the HSAP program, a decrease of 13% as compared to the 629 applicants in 2017.
	Forty eight applicants were placed in HSAP apprenticeships, a 13% decrease in enrollment compared to 2017 when 54 apprentices were served.
Slightly fewer colleges and universities hosted HSAP apprentices in 2018 than in 2017, and fewer of those institutions were HBCUs/MSIs.	Thirty three colleges and universities placed HSAP apprentices in 2018, a 9% decrease as compared to 2017 when 36 colleges and universities hosted HSAP apprentices. Thirteen of the 33 host institutions (39%) were HBCU/MSIs, a slight decrease from 2017 when 19 (53%) of the sites were HBCUs/MSIs.
More than half of HSAP apprentices met the AEOP definition of U2. Enrollment demographics show slight variations from 2017 levels.	More than half of apprentices (54%) qualified for U2 status under the AEOP definition.
	As in 2017, over half of apprentices were female (60% in both 2017 and 2018).
	As in 2017, the most commonly reported races/ethnicities were White and Asian, although fewer apprentices identified as White (31% in 2018; 42% in

	2017) and more apprentices identified themselves as Asian (33% in 2018; 25% in 2017).
	The percentage of apprentices identifying as Hispanic or Latino was also similar to 2017 enrollment data (15% in 2018; 14% in 2017).
	Relatively few students received free or reduced price school lunch (17%), spoke English as a second language (10%), and would be first generation college attenders (8%).
HSAP mentors reported significant gains in apprentices' 21st Century Skills.	While only 4-6 apprentices were assessed for their growth in 21st Century Skills, mentors reported significant increases in these apprentices' 21st Century Skills from the beginning (pre-) to the end (post-) of their HSAP experiences in all but two skill sets. Apprentices demonstrated the most growth in the Critical Thinking & Problem Solving skill set. While mentors observed growth in apprentices' Information, Media, & Technological Literacy skills, it was not significant, and apprentices' skills in Productivity, Accountability, Leadership, & Responsibility had a slight non-significant negative change from pre to post.
Apprentices reported engaging in STEM practices more frequently in HSAP than in their typical school experiences with no significant differences in engagement across any constituent categories of U2 status.	Most apprentices (53% - 100%) reported engaging in each STEM practice about which they were asked at least once during their HSAP experience with the exception of presenting STEM research to a panel of judges from industry or the military (74% did not engage in this practice in HSAP). Apprentices were engaged particularly frequently (weekly or every day) in working with a STEM researcher or company on a real-world STEM research project (100%); interacting with STEM researchers (95%); identifying questions or problems to investigate (90%); and analyzing data or information and drawing conclusions (90%).
	No significant differences were found in reported frequency of engaging in STEM Practices in HSAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices scores in HSAP as compared to in school (extremely large effect size), suggesting that HSAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in HSAP with no differences in gains across any constituent categories of U2 status.	All apprentices (100%) reported experiencing some level of gains in their STEM knowledge as a result of participating in HSAP. Apprentices were most likely to have experienced large gains in their knowledge of what everyday research work is like in STEM (84%) and knowledge of research conducted in a STEM topic or field (68%).
	No significant differences were found in reported gains in STEM knowledge in HSAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM competencies as a	A large majority of HSAP apprentices (95% -100%) reported experiencing some level of gains in their STEM competencies as a result of participating

result of participating in HSAP with no differences in gains across any constituent categories of U2 status.	in HSAP. Apprentices were most likely to have experienced large gains in communicating about their experiments and explanations in different ways (57%).
	No significant differences were found in reported gains in STEM competencies in HSAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that HSAP participation had positive impacts on their 21st Century Skills; U2 apprentices reported higher gains than non-U2 apprentices.	A large majority of apprentices (95%-100%) reported experiencing some level of gains in their 21st Century Skills as a result of participating in HSAP. Apprentices were most likely to have experienced large gains in sticking with a task until it is finished (68%) and making changes when things do not go as planned (68%).
	Significant differences in 21st Century Skills gains were found by overall U2 status with underrepresented HSAP apprentices reporting significantly greater gains than non-underrepresented apprentices. No significant differences were found between any of the constituent groups compared.
Apprentices reported gains in their STEM identities as a result of participating in HSAP with no differences in gains across any constituent categories of U2 status.	Most apprentices (89%-100%) reported experiencing some level of gains in their STEM identities as a result of participating in HSAP. Apprentices were most likely to have experienced large gains in their desire to build relationships with mentors who work in STEM (68%) and sense of accomplishing something in STEM (68%).
	No significant differences were found in reported gains in STEM identity in HSAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors used a range of mentoring strategies with apprentices.	A majority of HSAP mentors reported using each strategy associated with each of the five areas of effective mentoring about which they were asked: 1. Using strategies to establish relevance of learning activities (75%-100%) 2. Supporting the diverse needs of learners (75%-100%) 3. Supporting student development of collaboration and interpersonal skills (75%-100%) 4. Supporting student engagement in "authentic" STEM activities (50% - 100%) 5. Supporting student STEM educational and career pathways (100%)
HSAP apprentices were satisfied with program features that they had experienced and	About two-thirds (63%-95%) or more (75%-95%) of responding apprentices were somewhat or very much satisfied with all program features about which they were asked. Apprentices were most likely to report being very

identified a number of benefits of HSAP. Apprentices also offered various suggestions for program improvement.	much satisfied with the teaching or mentoring provided during HSAP (90%) and the amount of stipends (84%).
	No apprentices expressed dissatisfaction with any feature except for timeliness of stipend payments (16% were "not at all" satisfied).
	A large majority of apprentices (79%-100%) were somewhat or very much satisfied with all elements of their HSAP experience. Apprentices were most likely to be "very much" satisfied with the research experience overall (90%) and their working relationship with the group or team (79%).
	All apprentices who responded to open-ended questions made positive comments about their satisfaction with HSAP. The most frequently cited benefits of HSAP were the research exposure and experience and the STEM skills they gained during HSAP.
	In open-ended responses, the improvements most frequently suggested by apprentices focused on communication, including improving communication about stipend payments; sending more frequent (weekly) newsletters; and improving communication about program requirements, dates, and resources required for the apprenticeship (e.g., laptops).
HSAP mentors satisfied with program features that they had experienced and identified a number of strengths of the HSAP program. Mentors also offered various suggestions for program improvements.	Three-quarters or more of mentors (75%-100%) reported being somewhat or very much satisfied with all program features. Three-quarters of respondents had not experienced communicating with AAS.
	The few mentors who responded to open-ended questions all made positive comments about HSAP. Mentors cited as program strengths apprentices' research exposure and experience, the college and career information apprentices gain, the DoD career information apprentices receive, the fact that the program allows time for apprentices to experience growth and learning, and the stipend.
	The few mentors who responded to open-ended questions suggested improvements that focused on program logistics such as providing clearer expectations to apprentices in terms of deadlines and requirements, more opportunities for apprentices to present their research, providing supports for mentors regarding working with high school students, and providing additional support to sites in their local outreach efforts.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices learned about AEOP through their school, the	Apprentices most frequently learned about AEOP through someone who works at their school/university (59%); the AEOP website (41%); and past program participant (35%).

AEOP website, or a past program participant.	The one mentor who responded learned about AEOP through a past participant of the program.
Apprentices were motivated to participate in HSAP primarily by the learning opportunities and their interest in STEM.	The most frequently cited motivators for participating in HSAP were apprentices' interest in STEM (100%); desire to learn something new or interesting (94%); and desire to expand laboratory or research skills (94%).
Very few apprentices reported participating in any AEOPs other than HSAP, although many were interested in participating in AEOPs in the future.	While 76% of apprentices indicated they had never participated in any AEOP programs, one apprentice reported having participated in Camp Invention (6%) and one in GEMS (6%). Over a quarter of responding HSAP participants reported participating in other STEM programs (29%) that were not part of AEOP.
	Approximately two-thirds or more of apprentices reported being interested in URAP (74%) and SMART (63%), however more than half of HSAP apprentices indicated they had never heard of CQL (74%), GEMS-NPM (58%), and NDSEG (53%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in HSAP (74%) and the AEOP website (74%). More than half of responding apprentices had not experienced AEOP on social media (58%).
Few mentors reported discussing AEOPs with students.	Of the four mentors who provided a response, 75%-100% indicated they did not discuss any specific AEOP with their participants. Three of the four mentors (75%) reported discussing AEOP with their apprentices, but not any specific programs
	The resources the four responding mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were the AEOP website (100%), HSAP program administrators (100%), participation in HSAP (75%). Most mentors reported that they did not experience materials provided by AEOP such as social media (75%) and invited speakers or career events (75%) as resources for exposing students to AEOPs.
Apprentices learned about STEM careers during HSAP, although they learned about more STEM careers generally	All HSAP apprentices (100%) reported learning about at least one STEM job/career, and most (58%) reported learning about 3 or more general STEM careers. A large majority of apprentices (84%) reported learning about at least one DoD STEM job/career, although somewhat fewer (26%) reported learning about 3 or more Army or DoD STEM jobs during HSAP.

than STEM careers specifically within the DoD.	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of DoD STEM careers were participation in the apprenticeship program (63%), their mentors (53%), and the AEOP website (53%). A majority of apprentices reported that they had not experienced AEOP on social media (63%).
	The resources the four responding mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were the AEOP website (100%), the ARO website (75%), HSAP program administrators or site coordinators (75%), and participation in HSAP (75%). No mentors had experienced AEOP materials such as AEOP on social media (100%) and most had not experienced invited speakers or career events (75%) as resources for exposing students to DoD STEM careers.
Apprentices expressed positive opinions about DoD research and researchers.	HSAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with 90% or more agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in HSAP with no difference in likelihood across any constituent category of U2 status.	Approximately 50% or more of HSAP apprentices reported an increased likelihood of engaging in each STEM activity about which they were asked. The activities in which most apprentices reported increased likelihood were working on STEM projects in a university setting (95%) and mentoring or teaching other students about STEM (90%). No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any constituent group of U2 classification.
All HSAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.	All responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (21%) or terminal degree (66%) in their field.
HSAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers; males	About two-thirds or more apprentices reported that HSAP contributed to each area relating to their confidence and interest in STEM. The areas in which most apprentices reported impacts were increased confidence in their STEM knowledge, skills, and abilities (100%), greater appreciation of Army and DoD STEM research (95%), and increased interest in participating in STEM activities outside of school requirements (90%).

reported greater overall impact than females.	No significant differences were found in overall impact by U2 classification, however males reported significantly greater overall impact than females (large effect size).

URAP Findings

Table 230. 2018 URAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
More students applied to and were placed in URAP apprenticeships in 2018 than in 2017.	In 2018, 321 students applied for URAP apprenticeships, a 26% increase in applicants as compared to the 239 students who applied in 2017.
	A total of 67 applicants were placed in URAP apprenticeships in 2018, a 12% increase in number of students placed compared to 2017 when 59 apprentices were placed. It is noteworthy that although the number of students placed increased, the percentage of applicants placed decreased from 25% in 2017 to 21% in 2018.
More colleges and universities hosted URAP apprentices in 2018 than in 2017, and slightly more of these institutions were HBCUs/MSIs.	A total of 48 colleges and universities hosted URAP apprentices in 2018, a 19% increase over the 39 participating institutions in 2017. Of these institutions, 22 (46%) were HBCUs/Mis, compared to 17 (44%) in 2017. Six institutions received applications from prospective apprentices but did not host any URAP apprentices.
Less than one fifth of URAP apprentices met the AEOP definition of U2, and fewer females and Hispanic Latino students participated in 2017 than in 2018.	Of the enrolled URAP apprentices in 2018, 18% met the AEOP definition of U2.
	A smaller proportion of apprentices were female in 2018 (39%) as compared to 2017 (58%).
	The proportion of students identifying as White increased as compared to 2017 (64% in 2018; 53% in 2017) while the proportion of students identifying as Asian decreased as compared to 2017 (9% in 2018; 14% in 2017).
	The proportion of apprentices identifying as Black or African American was similar to in 2017 (9% in 2018; 8% in 2017), and the proportion of students identifying as Hispanic or Latino decreased somewhat as compared to 2017 (10% in 2018; 15% in 2017).

	Few students spoke English as a second language (6%) and relatively few were first generation college attenders (15%).
URAP mentors reported significant gains in apprentices' 21st Century Skills.	Mentors assessed 5-8 apprentices' 21st Century Skills and reported significant growth from the beginning (pre-) to the end (post-) of their URAP experiences in all skills assessed. Apprentices demonstrated the most growth in the skill sets related to Critical Thinking, Communication, and Productivity.
Apprentices reported engaging in STEM practices more frequently in URAP than in their typical school experiences with no significant differences in engagement across any constituent categories of U2 status.	Most apprentices (62% - 100%) reported engaging in each STEM practice about which they were asked at least once during their URAP experience with the exception of presenting STEM research to a panel of judges from industry or the military (71% did not engage in this practice in URAP). Apprentices were engaged particularly frequently (weekly or every day) in working with a STEM researcher or company on a real-world STEM research project (100%); interacting with STEM researchers (88%); and interacting with STEM researchers (88%).
	No significant differences were found in reported frequency of engaging in STEM Practices in URAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices scores in URAP as compared to in school (large effect size), suggesting that URAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in URAP; apprentices who had a parent who attended college were more likely to report gains than apprentices who were first generation college attenders.	A large majority of apprentices (94% - 100%) reported experiencing some level of gains in their STEM knowledge as a result of participating in URAP. Apprentices were most likely to have experienced large gains in their knowledge of what everyday research work is like in STEM (74%) and knowledge of research conducted in a STEM topic or field (62%).
	No significant differences were found in reported gains in STEM knowledge in URAP by U2 classification, however students who had a parent who attended college reported significantly greater gains than first generation college attenders (medium effect size).
Apprentices reported gains in their STEM competencies as a result of participating in URAP with no differences in gains across any constituent categories of U2 status.	Most URAP apprentices (82% -97%) reported experiencing some level of gains in their STEM competencies as a result of participating in URAP. Apprentices were most likely to have experienced large gains in supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge (44%) and using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation (41%).
	No significant differences were found in reported gains in STEM competencies in URAP by U2 classification or by any constituent group of U2 classification.

Apprentices reported that URAP participation had positive impacts on their 21st Century Skills with no differences in gains across any category of U2 status.	A large majority of apprentices (91%-98%) reported experiencing some level of gains in their 21st Century Skills as a result of participating in URAP. Apprentices were most likely to have experienced large gains in making changes when things do not go as planned (62%).
	No significant differences were found in reported gains in 21st Century Skills in URAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM identities as a result of participating in URAP with no differences in gains across any constituent categories of U2 status.	Most apprentices (79%-97%) reported experiencing some level of gains in their STEM identities as a result of participating in URAP. Apprentices were most likely to have experienced large gains in their desire to build relationships with mentors who work in STEM (62%) and feeling prepared for more challenging STEM activities (56%).
	No significant differences were found in reported gains in STEM identity in URAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors used a range of mentoring strategies with apprentices.	A majority of URAP mentors reported using most strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Using strategies to establish relevance of learning activities (44%-96%) • 56% had not helped students understand how STEM can help them improve their own community 2. Supporting the diverse needs of learners (41%-89%) • 59% did not highlight under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM fields 3. Supporting student development of collaboration and interpersonal skills (70%-93%) 4. Supporting student engagement in "authentic" STEM activities (89%-100%) 5. Supporting student STEM educational and career pathways (44%-100%) • 56% did not discuss the economic, political, ethical, and/or social context of a STEM career
URAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of URAP. Apprentices also	More than three-quarters (77%-91%) of responding apprentices were somewhat or very much satisfied with all URAP program features. Apprentices were most likely to be "very much" satisfied with the physical location of URAP activities (82%) and the amount of stipend (77%).
	Few apprentices expressed dissatisfaction with any feature, although 12% reported being "not at all" satisfied with timeliness of payments.

offered various suggestions for program improvement.	A large majority of apprentices (85%-88%) reported being somewhat or very much satisfied with all elements of their experience. Apprentices were most likely to be "very much" satisfied with their working relationship with their mentor (82%) and the research experience overall (77%).
	Most apprentices (94%) who responded to open-ended questions made positive comments about their satisfaction with URAP. The most frequently cited benefits of URAP were the research experience and skills and the specific STEM skills (such as 3D printing or learning new computer programs) apprentices gained.
	Apprentices suggested a wide variety of improvements in open-ended responses. The most frequently mentioned improvements were communication with the program, including better communication about stipends, abstract and poster requirements; providing more project or topic choices; providing more opportunities for connections between AEOP participants; and providing more or more varied webinars or DoD speakers.
URAP mentors satisfied with program features that they had experienced and identified a number of strengths of the URAP program. Mentors also offered various suggestions for program improvements.	Two-thirds or more (70%-89%) of mentors reported being somewhat or very much satisfied with all program features they had experienced. Over half of mentors (59%) reported that they had not experienced communicating with AAS. Mentors were most likely to be "very much" satisfied with communicating with the Army Research Office (74%), communicating with URAP organizers (67%), and stipends (67%).
	Most mentors (89%) made positive comments about URAP in their responses to open-ended questions. The most frequently mentioned strength of URAP was apprentices' access to hands-on, cutting edge research in URAP.
	In open-ended responses, the most frequently mentioned suggestions were to provide an earlier application and acceptance process and an earlier funding stream and to provide better communication about deadlines, abstract requirements and goals, and other programs.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices learned about AEOP primarily through school contacts or communications through their school or workplace; the ARO website was a primary source of AEOP information for mentors.	Apprentices most frequently learned about AEOP through someone who works at the university they attend (59%) and a school/university newsletter, email, or website (47%).
	Mentors most frequently learned about AEOP through the ARO website (59%) and through their supervisors (30%) and the AEOP website (22%).

Apprentices were motivated to participate in URAP primarily by the learning opportunities and their interest in STEM.	The most frequently cited motivators for participating in URAP were apprentices' interest in STEM (100%); desire to learn something new or interesting (85%); and learning in ways that are not possible in school (74%).
No URAP apprentices reported having participated in other AEOPs and expressed limited interest in participating in AEOPs in the future.	No URAP apprentices reported participating in any other AEOP, and only 15% of URAP participants indicated they had previously participated in a STEM program not associated with AEOP.
	While some apprentices reported being interested in URAP again (56%) and SMART (44%), large proportions of apprentices indicated they had not heard of CQL (56%), GEMS-NPM (56%), and NDSEG (41%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in URAP (65%) and their program mentors (68%). More than half of responding apprentices had not experienced AEOP on social media (72%).
Mentors discussed AEOPs with apprentices, but with only limited reference to specific programs.	A majority of mentors (76%) reported discussing AEOPs in general, without reference to specific programs. Large proportions of mentors reported not discussing any specific AEOPs with their apprentices (70%-96%).
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were participation in URAP (89%), the URAP program administrator (70%), and the AEOP website (74%). Most mentors reported that they did not experience AEOP on social media (67%) as a resource for exposing students to AEOPs.
Apprentices learned about STEM careers during URAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	A large majority of URAP apprentices (82%) reported learning about at least one STEM job/career, and half (50%) reported learning about 3 or more general STEM careers. Similarly, a majority of apprentices (53%) reported learning about at least one DoD STEM job/career, although somewhat fewer (24%) reported learning about 3 or more Army or DoD STEM jobs during URAP.
	The resource apprentices most frequently cited as being somewhat or very much useful for their awareness of DoD STEM careers was participation in URAP (53%). A majority of apprentices reported that they had not experienced AEOP on social media (71%).
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were participation in URAP (78%), HSAP program administrators or site coordinators (56%), and the AEOP website (56%). Most mentors had not

	experienced AEOP on social media (74%) as a resource for exposing students to DoD STEM careers.
Apprentices expressed positive opinions about DoD research and researchers.	URAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 85% agreeing to all statements.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in URAP with no difference in likelihood across any constituent category of U2 status.	Approximately 50% or more of URAP apprentices reported an increased likelihood of engaging in each STEM activity about which they were asked. The activities in which most apprentices reported increased likelihood were working on STEM projects in a university setting (71%) and mentoring or teaching other students about STEM (68%).
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any constituent group of U2 classification.
All HSAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.	All responding apprentices reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (32%) or terminal degree (44%) in their field.
URAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	Half or more apprentices reported that URAP contributed to each area relating to their confidence and interest in STEM. The areas in which most apprentices reported impacts were increased confidence in their STEM knowledge, skills, and abilities (94%); greater appreciation of Army and DoD STEM research (85%); and increased awareness of Army or DoD STEM research and careers (82%).
	No significant differences were found in impact of URAP by U2 classification or by any constituent group of U2 classification.

Responsiveness to FY17 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY17 to programs and summarize efforts and outcomes reflected in the FY18 APR toward these areas.

Army Laboratory-Based Programs

CQL

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY17 Finding: As recommended in FY17, CQL should continue in FY18 to focus on growing the pool of applicants overall as well as for underserved groups. There were some gains in participation of females (54% compared to 46% in FY16) and Hispanic or Latino apprentices (5% compared to 3% in FY16). However, it is warranted to invest more focus and effort on broadening the participation of ethnic/racial groups including Hispanic or Latinos (beyond 5% overall) and Black or African American (only 7% of FY17 CQL group).

CQL FY18 Efforts and Outcomes: Outreach was made to over 300 universities; 100 of those are HBCU/MSIs. University directors and PIs also assisted in posting apprenticeship flyers online to promote the program. Again, although there is no directive in FY18, lab coordinators were encouraged, through several communications, to consider U2 students when selecting CQL students. 58 or 10% of CQL applicants met the U2 criteria and 10, or 10% were selected as CQL participants. It may also benefit this effort if this subject was discussed during a regularly scheduled lab coordinator/AEOP phone call.

FY17 Finding: As in FY16, personal relationships continued to play a major role in FY17 in how students were recruited into CQL. AAS should continue investments that were started in FY17 to recruit more broadly and also follow up to provide expectations to labs that students outside of those mentors know of are included in program participation in FY18.

CQL FY18 Efforts and Outcomes: Although lab coordinators are encouraged to broaden the pool of students selected, through several communications, personal relationships still play a role in student selections in FY18. The directive to broaden the pool of students selected must come from the Army. Several lab coordinators have commented that there is an expectation to hire a co-worker's relative, although some do so reluctantly.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY17 Finding: CQL should continue to recruit and grow the pool of available mentors to support apprentices. The CQL program goal of one-to-one mentoring provides deep and meaningful experiences for apprentices. However, without growing the number of adults to serve as mentors, the program will continue to have unmet need.

CQL FY18 Efforts and Outcomes: Mentor recruitment is at the discretion of the DoD lab coordinator and directly correlates with the lab's funding. If funding decreases, then mentor and student participation decreases and in many instances in FY18 that was the case. It is also important to note there is a continuous challenge for lab coordinators to recruit mentors. Based on comments made by mentors, required paperwork and lab requirements impede mentor participation. A mentor is also allowed to mentor multiple students, at different times, for example, alternating days and changing blocks of time.

FY17 Finding: In light of the program goal to have SEAP apprentices progress into CQL apprentice positions, the low percentage of CQL apprentices who had participated in SEAP is an area with room for growth. The program may wish to work with the SEAP program to ensure that the pipeline between the two programs is clear to both apprentices and mentors. Apprentice responses indicated that mentors are key resources in learning about other AEOPs and therefore efforts should be made to ensure that mentors are informed about the range of AEOPs and that GEMS and SEAP mentors are equipped with information about CQL. Because of the time constraints mentors face in working with students, however, the program should also consider ways to educate participants about AEOP opportunities that do not rely on mentors. Given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with targeted program information.

CQL FY18 Efforts and Outcomes: No response or data available in the FY18 APR.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY17 Finding: As in FY16, mentor FY17 participation in the CQL evaluation is still below the desirable level (20% of population). Apprentice participation improved in FY17 to 47%. It is recommended that CQL continue to strongly emphasize the importance of both mentor and apprentice participation in the CQL evaluation.

CQL FY18 Efforts and Outcomes: CQL is the only year-round apprenticeship opportunity. AAS will develop a communication plan for those CQL students who are in labs year-round so that they receive the same AEOP information and instructions. CQL evaluation should increase in years to come.

SEAP

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY17 Finding: The AEOP goal of attracting students from groups historically underserved in STEM continues to be met with limited success in SEAP. As in FY16, many apprentices report learning about SEAP through personal connections, suggesting that marketing efforts may have limited effectiveness and may not be widely reaching outside of laboratory connections. Participation of underserved groups decreased somewhat in FY17. There was a 2% decrease (17% compared to 19%) in Black or African-American apprentices and similarly, Hispanic or Latino participation also decreased 2% (3% compared to 5%). In sum, the program should consider additional/alternate means of broadening the pool of applicants and consider devising strategies for recruiting and selecting apprentices to ensure that SEAP includes diverse groups of highly talented participants.

SEAP FY18 Efforts and Outcomes: Outreach was made by phone or email to over 5,000 counselors, science teachers at 600 high schools; 300 of those are Title I high schools, where there is a high population of U2 students. In addition, as indicated above, STEM/ Minority organizations provided outreach to their U2 students. Although there is no mandate, in FY18 lab coordinators were encouraged, through several communications, to consider U2 students when selecting SEAP students. 92 or 11% of SEAP applicants met the U2 criteria and 31, or 27% were selected as SEAP participants. It is important to note that of the SEAP students selected to participate, 51% attended Title I high schools. The directive to choose more diverse pool of applicants must come from Army leadership.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY17 Finding: As in FY16, there is a continued need for SEAP to grow the number of participating mentors in the program. There was an 8% decrease in the number of mentors for SEAP in FY17 with a 20% increase in applicants, resulting in a substantial unmet need in terms of mentor capacity with only 113 students (16% of applicants) being placed out of 852 applicants. Program expansion will require active recruitment of additional Army S&Es to serve as mentors. It is recommended that AAS investigate the procedures and resources used to recruit SEAP mentors and identify factors that motivate and discourage Army S&Es from assuming this role.

SEAP FY18 Efforts and Outcomes: Mentor recruitment is at the discretion of the DoD lab coordinator and directly correlates with the lab's funding. If funding decreases, then mentor and student participation decreases and in many instances in FY18 that was the case. It is also important to note there is a continuous challenge for lab coordinators to recruit mentors. Based on comments made by mentors, required paperwork and lab requirements impede mentor participation. A mentor is also allowed to mentor multiple students, at different times, for example, alternating days and changing blocks of time.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY17 Finding: Both apprentices and mentors reported lack of information regarding other AEOPs being conveyed in SEAP in FY17. Two-thirds (66%) of mentors reported they did not discuss other AEOPs to apprentices. More than 33% of apprentices had not heard of CQL, URAP, and the NDSEG Fellowship. SEAP should work to invest efforts in FY18 to address this communication and marketing issue. It is critical that participants are informed of other opportunities available to them in the AEOP pipeline.

SEAP FY18 Efforts and Outcomes: In FY17 and FY18, students and mentors received AEOP news throughout the summer, such as, other program information, spotlights that highlight other programs and webinar information. Mentors have been asked to talk to their students about other Army programs and STEM careers.

FY17 Finding: Apprentice participation in the SEAP evaluation improved in FY17 to 54%. However, mentor participation should be increased in FY18 to reach a level of at least 40% participation (compared to 29% in FY16).

SEAP FY18 Efforts and Outcomes: Due to increased direct contact with mentors, FY18 mentor survey results should be improved. It is important to note that one lab has requested no direct contact be made to mentors.

University-Based Programs

REAP

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY17 Finding: REAP has experienced great success with reaching historically underserved students in the program. However, in FY17 REAP experienced a slight decrease in female participants (61% compared to 73% in FY16), as well as Black/African-American participants (29% compared to 46% in FY16). REAP should continue to invest effort in this area to strengthen representation from these groups in FY18.

REAP FY18 Efforts and Outcomes: REAP experiences great success with reaching underserved students each year since it is a requirement for student participation. All students must meet 2 criteria to participate. If the U2 criteria are not met the student is disqualified and referred to another apprenticeship or other AEOP program. Female REAP participants in FY18 is 62% (85), a respectable percentage. Total female applicants for REAP is 61% (579), again a respectable percentage. Since students are required to meet two criteria, outreach emphasis is on U2 and not specific to race. However, it is important to note that 62% of the FY18 REAP participants are either African American or Hispanic/Latino.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY17 Finding: REAP apprentices reported an overall positive experience in the program in FY17. Participants did share some suggestions for improving the program for the future. Suggestions included providing apprentices with more choice in the project they work on. Additionally, there were suggestions to improved communication and guidance received from the mentors. Similarly, mentors suggested considering having a contract with apprentices for accountability, and “selecting more serious students”. It is unclear how much of this feedback can be integrated into the REAP model. However, it is recommended that REAP consider developing supports for students and mentors in these areas.

REAP FY18 Efforts and Outcomes: Best practice/guidelines for mentors and universities were created in FY17 and updated in FY18, with university directors to improve communication and guidance with mentors. All mentors receive this and continuous communication throughout the summer. Universities are more than welcome to “select more serious students”, as student selection is entirely up to the mentors, once AAS screens for U2 criteria. In addition, students are instructed to follow the guidelines of the university. If students are not “accountable” and not following guidelines, discussions should take place between the student and the mentor. AAS will help facilitate, if necessary. The intent is to make this a learning experience in STEM practice, as well as soft skills.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY17 Finding: Despite continued efforts to integrate more resources into REAP for promoting other AEOPs, this remains an area of need for additional effort in FY18. Less than half of mentors (39%) reported discussing AEOP in general with participants. Similarly, only a small percentage of mentors reported discussing Unite (27%) and URAP (23%) with participants. As a result, participants had little knowledge of other AEOPs, as 50% had heard of CQL, 46% eCM, and 39% JSHS. It is recommended that REAP focus on establishing additional supports for local programs to emphasize the AEOP pipeline frequently in the apprenticeship program – in meaningful ways.

REAP FY18 Efforts and Outcomes: FY17 and again in FY18, mentors were part of the full REAP experience. Mentors received a large pre summer document outlining requirements and expectations, guidelines, policies and tips. In addition, summer news is emailed to mentors.

HSAP

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY17 Finding: Despite considerable growth in interest in HSAP, evidenced by the nearly 50% increase in applications for FY17, there was a 20% decrease in the actual number of participants in FY17. HSAP failed to meet their enrollment goal of 70 apprentices as a result. HSAP should focus on growing infrastructure to support more potential participation in FY18.

HSAP FY18 Efforts and Outcomes: ARO has amended its Broad Agency Announcement to move the HSAP/URAP proposal deadline to 30 Sep from 10 Nov, in an effort to streamline the apprenticeship process from proposal submission through student placement in university labs next summer. Among other things this will expand the apprenticeship marketing window for PIs by expediting the proposal review/approval process by giving PIs ~60 additional days to drive students to the AEOP application portal.

FY17 Finding: The demographics of actual participants in HSAP reveal the program has more work to do to reach a greater percentage of underrepresented students. It is commendable that HSAP has been able to accommodate a majority of female apprentices. However, White and Asian groups are the majority in participants (42% and 25% respectively). This is a slight increase from FY16 in fact, while the percentage of African American students has remained at 15% and Hispanic/Latino apprentices held at 14%. HSAP should invest resources in FY18 to target underrepresented groups more strategically to recruit more diverse participation for the program.

HSAP FY18 Efforts and Outcomes: Outreach was made by phone or email to over 5,000 counselors, science teachers at 600 high schools; 300 of those are Title I high schools, where there is a high population of U2 students. In addition, as indicated above, many STEM/Minority organizations provided outreach to their U2 students. In FY18, 20% (111) of student applicants met the U2 criteria and 48 were selected to participate (overall 54% of HSAP selected population) in FY18. During the application and selection process, HSAP/URAP PC will communicate to PIs via email to strongly consider selecting qualified U2 and those previously in AEOP pipeline as apprentices, IAW AEOP goals. HSAP/URAP PC will assist the PI by identifying AEOP pipeline participants using their application information. HSAP/URAP PC will continue to partner with ARO HBCU PC to promote HSAP/URAP and encourage program participation.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY17 Finding: In FY17, HSAP apprentices and mentors both echoed findings that have been prevalent across the AEOP portfolio. Only a very few number of participants and mentors are accessing and/or utilizing AEOP social media, including the website. In regards to HSAP, 63% of mentors and 71% of apprentices did not experience AEOP social media at all. Therefore, the evaluation team recommends that HSAP work with the consortium members to determine a plan for the future utilization and marketing of AEOP social media and the website.

HSAP FY18 Efforts and Outcomes: HSAP implemented bi-weekly summer communication to encourage social media postings and provides taglines.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY17 Finding: The FY17 evaluation findings indicate collective desire of the apprentices and mentors to improve communication across the program. This includes improving the delivery of information from the program leadership to the mentors and site directors, as well as information (program requirements, stipend payments, that is transmitted between AAS/ARO and the apprentices directly. It is recommended that AAS and ARO take steps to examine communication channels and determine how communication can be improved for HSAP.

HSAP FY18 Efforts and Outcomes: HSAP/URAP PC submitted proposed changes to ARO HSAP/URAP BAA language to better communicate program requirements – ARO approved and published recommended changes June 2018. HSAP/URAP PC amended and distributed an updated program timeline to all active PIs with 2018 RFP.

FY17 Finding: HSAP made progress in growing apprentice awareness of AEOPs, as 97% indicated that they had learned about AEOPs during the program. 74% indicated they were interested in URAP. However, HSAP participants were not made cognizant of some applicable AEOP opportunities during the program in FY17. In fact, 65% of HSAP apprentices had not heard of CQL, and 42% had not heard of the NDSEG Fellowship. Mentors reported that they did not discuss other AEOPs with their apprentices including: JSHS (88%), SEAP (88%), and CQL (92%). It is strongly recommended that HSAP work with their staff and the consortium to develop a plan for marketing and informing participants frequently about other AEOP opportunities and resources.

HSAP FY18 Efforts and Outcomes: During outreach events, site visits and meet & greets, HSAP provided attendees and participants with the apprenticeship flyer and presented an AEOP portfolio overview.

URAP

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY17 Finding: AEOP Priority #1 is focused on growing the diversity of the pool of STEM talent in deep and meaningful ways. AEOP programs are charged with making this a primary focus of their recruitment and enrollment for the program. In FY17, the URAP program had only 24% of participants that were from underrepresented groups as defined by the AEOP. Additionally, while participation of White students decreased slightly, African American participation decreased by 2% (8% of total in FY17) while Hispanic/Latino apprentices grew to 15% in FY17 (from 13% in FY16). It is recommended that URAP invest considerable effort in FY18 in continuing to reach out to underrepresented populations to encourage their applications and participation in the program. It may be worthwhile to work with REAP, another AEOP apprentice program that has had great results in reaching diverse participant groups.

URAP FY18 Efforts and Outcomes: Outreach was made to over 300 universities; 100 of those are HBCU/MSIs. University directors and PIs also assisted in posting apprenticeship flyers online on university websites and in student work areas to promote the program. Fifty six, or 18% URAP applicants met the U2 criteria and only 12, or 18% of actual participants met the U2 criteria. In collaboration with the ARO's HBCU/MSI Program Manager continue to establish relationships with HBCU/MSI University partners (Department chairs, Chancellors, Deans and STEM professors) to introduce the HSAP/URAP and encourage participation.

FY17 Finding: Findings from the FY16 evaluation suggested that URAP develop a resource for mentors to utilize to promote AEOP opportunities, as well as other resources within the DoD. It does not appear that URAP followed this guidance, as the only mention of activities aligned with this was having universities post apprenticeship opportunities on their career assistance pages, which isn't related at all. In FY17, mentors did not report going beyond discussing AEOP in general with apprentices (77%). Only 32% of mentors discussed NDSEG and only 24% shared information about SMART. Therefore, it is again recommended that URAP (or apprenticeship programs collectively) develop tools for mentors to use to teach or inform their participants about AEOP programs including specific information on each opportunity.

URAP FY18 Efforts and Outcomes: In FY18, the apprenticeship DoD STEM Webinar was expanded and offered to students and mentors. Through several communications, university partners received the apprenticeship one page promo flyer, PI/mentor newsletters included information on other AEOP opportunities (travel award, REAP, SMART, etc.)

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY17 Finding: In FY17, URAP apprentices and mentors both echoed findings that have been prevalent across the AEOP portfolio. Only a very few number of participants and mentors are accessing and/or utilizing AEOP social media, including the website. In regards to URAP, 68% of mentors and 56% of apprentices did not experience AEOP social media at all. Therefore, the evaluation team recommends that URAP work with the consortium members to determine a plan for the future utilization and marketing of AEOP social media and the website.

URAP FY18 Efforts and Outcomes: URAP implemented bi-weekly summer communication to encourage social media postings and provides taglines.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY17 Finding: The FY17 evaluation findings indicate collective desire of the apprentices and mentors to improve communication across the program. This includes improving the delivery of information from the program leadership to the mentors and site directors, as well as information (program requirements, stipend payments, that is transmitted between AAS/ARO and the apprentices directly. It is recommended that AAS and ARO take steps to examine communication channels and determine how communication can be improved for URAP.

URAP FY18 Efforts and Outcomes: HSAP/URAP PC submitted proposed changes to ARO HSAP/URAP BAA language to better communicate program requirements – ARO approved and published recommended changes June 2018. HSAP/URAP PC amended and distributed an updated program timeline to all active PIs with 2018 RFP. PI and student newsletter distribution plan executed in FY18 to enhance communication between all parties.

FY17 Finding: URAP participants were not made cognizant of other applicable AEOP opportunities during the program in FY17. In fact, 50% of URAP apprentices had not heard of CQL, the other college level apprenticeship program within AEOP. Further, less than 50% had been made aware of important scholarship programs including NDSG and SMART. It is strongly recommended that URAP work with their staff and the consortium to develop a plan for marketing and informing participants frequently about other AEOP opportunities and resources.

URAP FY18 Efforts and Outcomes: During outreach events, site visits and meet & greets, HSAP provided attendees and participants with the apprenticeship flyer, presented an overview of the SMART and NDSEG opportunities and directed students to those websites and POCs.

Overall Recommendations for FY18 Program Improvement/Growth

Evaluation findings for apprenticeship programs overall were very positive. All programs (CQL, SEAP, REAP, HSAP, URAP) enabled participants to experience growth in their STEM practices, STEM knowledge, STEM competencies, and STEM identities. In fact, there were significant differences in growth for some programs (i.e., CQL) in 21st Century Skills and STEM Competencies for first generation college students. Further, students in REAP from low socio-economic status background were significantly more likely to engage in future STEM opportunities than other students in REAP. These opportunities open doors for underserved students and this should continue to be a primary focus of AEOP apprenticeship programs.

Overall, participant satisfaction with the programs was positive. Apprenticeship programs improved their processing of stipends resulting in decreased reports of dissatisfaction in this area. Some programs experienced increased applications and placements for apprentices in FY18 (REAP, URAP) while others held steady (SEAP). While these successes are commendable, there are some areas that remain with potential for growth and/or improvement for apprenticeship programs. The evaluation team therefore offers the following recommendations for FY19 and beyond:

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

1. Apprenticeship programs should continue to focus in on growing the pool of underserved applicants and participants overall. The REAP program should be used as a guide for making progress in this area. REAP has successfully reached underserved populations for several years now. In FY18, REAP was comprised of 96% underserved student population, including 62% female, 55% free and/or reduced lunch recipients, and 36% prospective first generation college students. By comparison, other apprenticeship programs included much lower percentages of underserved students (CQL, 20%; SEAP 27%; HSAP 54%; and URAP 18%). CQL, SEAP, and HSAP included less than 20% of potential first generation students (16%, 2%, and 8% respectively) for example. It is imperative that apprenticeship programs work to become more inclusive of underserved students in the future.

2. CQL and SEAP continue to be programs that recruit and include participants through connections to past participants, DoD employees, and personal connections. It is recommended that these programs invest more effort to require laboratory sites to utilize a more open recruitment and acceptance policy to bring in new students who are not connected to the laboratories or DoD employees to broaden the ability for others to benefit from these high-quality experiences.

AEOP Priority: Support and empower educators with unique Army research and technology resources

Across the apprenticeship programs, mentors did not implement effective mentoring strategies with their apprentices in a consistent manner. Individual programs ranged on the low end of implementation from less than 40% use (SEAP), to less than 50% use (CQL, REAP, URAP) and around 50% use (HSAP). Though the importance of the use of these strategies has been communicated, mentors continue to report the lack of full implementation within the apprenticeship program. It is recommended that the consortium leadership (Battelle and CCDC) and the AEOP programs work together to develop a formal mentor online training (not live) that is brief in duration (15-20 minutes) that mentors are required to complete prior to becoming a mentor (one time). This can also be used for other programs such as Unite, JSHS, etc. The evaluation team has hosted webinars for mentors for the past three years to train them on the use of the 21st Century Assessment and several have been willing to attend. Other components of the training could also include other challenging areas of program implementation, including teaching about the AEOP portfolio programs (which will be included as a recommendation under Priority Three below.

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

1. Apprenticeshp program participation in the annual AEOP evaluation is still much lower than desirable. In FY18, only four mentors completed the HSAP survey. Another concern is the very low participation for FY18 in the 21st Century Skills Assessment. Despite a good pilot year in FY17, apprenticeship programs individually had less than 20 students who had a pre and post assessment completed in FY18 (CQL, 3; SEAP, 6; REAP, 11; HSAP, 6; URAP, 8). This is our most important data to collect in the AEOP evaluations for apprentices, as it provides an actual assessment of student growth. It is strongly recommended that the apprenticeship program administrators convey the requirement to mentors and hold them accountable for providing this data in FY19.

2. Across all apprenticeship programs in FY18, the majority of mentors are not discussing specific AEOP programs with students (CQL, 65%; SEAP, 85%; REAP 55%; HSAP, 75%; URAP, 70%). This is very concerning, as it impedes student ability to learn about future opportunites within AEOP, including college-level program, mentoring opportunities, and scholarships. It is strongly recommended that the apprenticeship programs require mentors to provide students with a full orientation to the AEOP programs and resources that are available to them.

3. Multiple apprenticeship programs (CQL, SEAP, URAP) suggested an improvement to the program would be to provide opportunities for apprentices to connect in meaningful ways. Therefore, it is recommended that the program administrator connect with alumni management and marketing/communications to explore ways to connect apprentices while they are in programs, which will help to facilitate connections after the program when they become alumni. We also recommend that the consortium consider an annual event/meeting to bring together apprentices either virtually or face-to-face to share their research with others in a “conference” format.

4. Apprentices from all programs indicated very little engagement with AEOP on social media. Given the investment in building up social media presence on things such as Twitter and Facebook, it is recommended that the consortium explore ways to engage more apprentices and participants overall in social media. This is a missed opportunity to connect and provide more learning opportunities to participants, as well as a way to grow their knowledge of the AEOPs.