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ARMY EDUCATIONAL OUTREACH PROGRAM

Apprenticeship Programs

2019 Annual Program Evaluation Report Findings

April 2020

ARMY EDUCATIONAL OUTREACH PROGRAM

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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 FY19 the apprenticeship programs were managed by the Rochester Institute of Technology (RIT). The evaluation study was performed by NC State 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 Rochester Institute of Technology (RIT), 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 and centers, 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 2019, 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 research facilities 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 research facilities 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.

Eighteen Army lab and centers accepted applications for CQL apprentices in 2019 (Table 1). Apprentices were hosted at 16 of these sites, an increase over the 13 participating host sites in 2018. A total of 662 students applied for CQL apprenticeships compared to 574 in 2018 and 575 in 2017. Of these applicants, 204 (31%) were placed in apprenticeships. This continues a gradual downward trend in the number of participating apprentices and in placement rate since 2017 (2018 - 214, or 37%, were placed; 2017 - 229, or 39% were placed.

Table 1. 2019 CQL Site Applicant and Enrollment Numbers			
2019 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	195	45	23.1%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Adelphi, MD	131	21	16%
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	168	53	31.5%
U.S. Army Medical Research Institute for Infectious Diseases (USAMRIID) – Ft. Detrick, MD	82	7	8.5%
U.S. Army Combat Capabilities Development Command (CCDC) - Aviation & Missile Center – Redstone Arsenal, AL	45	12	26.7%
U.S. Army Combat Capabilities Development Command (CCDC) – Chemical Biological Center – Aberdeen Proving Ground/Edgewood, MD	51	15	29.4%
U.S. Army Combat Capabilities Development Command (CCDC) - Chemical Biological Center – Rock Island, IL	21	4	19%
U.S. Army Engineer Research & Development Center Construction Engineering Research Laboratory (ERDC-CERL) – Champaign, IL	22	7	31.8%
U.S. Army Center for Environmental Health Research (USACEHR) – Fort Detrick, MD	38	1	2.6%
Defense Forensic Science Center (DFSC) – Forest Park, GA	49	12	24.5%
U.S. Army Engineer Research & Development Center (ERDC-MS) – Vicksburg, MS	46	16	34.8%
U.S. Army Engineer Research & Development Center (ERDC-GRL) – Alexandria, VA	42	3	7.1%
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	35	2	5.7%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Play Vista, CA	35	0	0%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – ARL-Central – Chicago, IL	29	3	10.3%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – ARL-North East – Boston, MA	30	1	3.3%
Army Cyber Institute – West Point, NY	6	2	33.3%
Total† **1028 applications received representing 662 individual applicants**		**204**	**30.8%**

†Applicants could apply for up to two locations

Table 2 provides demographic profiles for enrolled CQL apprentices. About half (51%) of participants were female, an increase as compared to 2018 when 45% were female, but a decrease as compared to 2017 when 54% of CQL apprentices were female. A somewhat smaller proportion of CQL apprentices identified themselves as White (54%) as compared to previous years (64% in 2018; 67% in 2017). Likewise, the proportion of apprentices identifying themselves as Asian decreased slightly (12%) compared to previous years (14% in both 2017 and 2018). The proportion of CQL apprentices identifying themselves as Black or African American (18%) increased as compared to 2018 (13%) and 2017 (7%), while participation by apprentices identifying as Hispanic or Latino remained relatively constant (6% in 2019; 6% in 2018; 5% in 2017). Nearly all apprentices (95%) identified English as their first language, and a small proportion (16%) were first generation college attendees. Slightly over a third (35%) of apprentices met the AEOP definition of students underserved or underrepresented (U2) in STEM,[1] an increase from the 20% who met the definition in 2018.

Table 2. 2019 CQL Student Participant Profile		
Demographic Category		
Respondent Gender (n=204)		
Female	103	50.5%
Male	101	49.5%
Respondent Race/Ethnicity (n=204)		
Asian	25	12.3%
Black or African American	37	18.1%
Hispanic or Latino	13	6.4%
Native American or Alaska Native	3	1.5%
Native Hawaiian or Other Pacific Islander	2	1.0%
White	110	53.8%
Other race or ethnicity	4	2.0%
Choose not to report	10	4.9%
Grade Level (n=204)		
12^{th} grade	3	1.5%
College freshman	40	19.6%
College sophomore	43	21.1%
College junior	60	29.4%
College senior	58	28.4%
English is First Language (n=204)		

[1] AEOP's definition of underserved (U2) includes **at least two** of the following: Underserved populations include low-income students (FARMS or Pell Grant recipients); 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. 2019 CQL Student Participant Profile		
Yes	193	94%
No	11	6%
One parent/guardian graduated from college (n=204)		
Yes	168	82%
No	36	18%
Choose not to report	0	0%
Pell Grant Recipient (n=204)		
Yes	43	21%
No	161	79%
Choose not to report	0	0%
U2 Classification (n=204)		
Yes	71	35%
No	133	65%

Table 2. 2019 CQL Student Participant Profile		
Demographic Category		
Respondent Gender (n=204)		
Female	103	50.5%
Male	101	49.5%
Respondent Race/Ethnicity (n=204)		
Asian	25	12.3%
Black or African American	37	18.1%
Hispanic or Latino	13	6.4%
Native American or Alaska Native	3	1.5%
Native Hawaiian or Other Pacific Islander	2	1.0%
White	110	53.8%
Other race or ethnicity	4	2.0%
Choose not to report	10	4.9%
Grade Level (n=204)		
12th grade	3	1.5%
College freshman	40	19.6%
College sophomore	43	21.1%
College junior	60	29.4%
College senior	58	28.4%
English is First Language (n=204)		
Yes	193	94.6%
No	11	5.4%
One parent/guardian graduated from college (n=204)		
Yes	168	82%
No	36	18%
Choose not to report	0	0%
Pell Grant Recipient (n=204)		
Yes	43	21%
No	161	79%
Choose not to report	0	0%
U2 Classification (n=204)		
Yes	71	35%
No	133	65%

Cost data for 2019 CQL activities are provided in Table 3. The total cost for CQL was $1,803,439. The cost per student participant was $8,840.

Table 3. 2019 CQL Program Costs	
Total Cost	$1,803,439
CCDC Cost	$0
IPA Cost	$1,803,439
Total Travel	$1,287
CCDC Travel	$0
IPA Travel	$1,287
Participant Travel	$0
Total Awards	$1,744,514
Student Awards/Stipends	$1,744,514
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$8,840

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 and centers. The intent of the program is that apprentices will return in future summers and continue their association with their original laboratories or centers 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 2019, SEAP was guided by the following objectives:

1. Acquaint qualified high school students with the activities of DoD research facilities 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.

Fifteen Army labs or centers accepted applications for SEAP apprentices in 2019 and apprentices were hosted at 10 of these sites (11 sites hosted apprentices in 2018). A total of 1,286 students applied for SEAP apprenticeships in 2019, a substantial increase (32%) over the 872 applications received in 2018, and a 34% increase over the 852 applications received in 2017. Of these applicants, 108, or 8%, were placed in apprenticeships, representing a slight decrease in enrollment and, because of the sharp increase in the number of applications, a substantial decrease in placement rate as compared to previous years (in 2018, 114, or 13%, of applicants were placed; in 2017, 113, or 13%, were placed). Table 4 summarizes applicants and final enrollment by site.

Table 4. 2019 SEAP Site Applicant and Enrollment Numbers			
2019 SEAP Site	**No. of Applicants**	**No. of Enrolled Participants**	**Placement Rate**
U.S. Army Combat Capabilities Development Command (CCDC) - Aviation & Missile Center – Huntsville, AL	22	2	9.1%
U.S. Army Engineer Research & Development Center – Construction Engineering Research Laboratory (ERDC-CERL) - Champaign, IL	46	13	28.2%
U.S. Army Combat Capabilities Development Command (CCDC) – Chemical Biological Center – Rock Island, IL	39	4	10.3%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory - Aberdeen Proving Ground, MD	162	8	4.9%
US Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory (ARL-Central)– Chicago, IL	86	0	0%
US Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory (ARL-Northeast) – Boston, MA	83	0	0%
US Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory (ARL-South) – Austin, TX	56	0	0%
U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) – Aberdeen Proving Ground/Edgewood, MD	167	16	9.6%
U.S. Army Combat Capabilities Development Command (CCDC) – Chemical Biological Center – Aberdeen Proving Ground, MD	129	8	6.2%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory – Adelphi, MD	466	18	3.9%
U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) – Fort Detrick, MD	266	22	8.3%
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	562	11	2.0%
U.S. Army Engineer Research & Development Center (ERDC) – Vicksburg, MS	44	6	1.4%
U.S. Army Engineer Research & Development Center – Geospatial Research Laboratory (ERDC-GRL) – Alexandria, VA	20	0	0%
U.S. Army Combat Capabilities Development Command (CCDC) - Army Research Laboratory - Playa Vista, CA	77	0	0%
Total†	**2225 applications representing 1286 individual applicants**	**108**	**8.4%**

†Applicants could apply for up to two locations

Table 5 displays demographic data for enrolled SEAP apprentices. Similar to previous years, slightly more than half of SEAP apprentices were female (52% in 2019, 53% in 2018, and 54% in 2017). Also as in previous years, the most frequently represented races/ethnicities were White (55%) and Asian (24%). The proportion of White apprentices continues to increase relative to previous years (47% in 2018, 42% in 2017), however the proportion of Asian apprentices decreased as compared to 2018 (27%) and 2017 (32%). The proportion of apprentices identifying themselves as Black or African American (10%) continues to trend downward as compared to 2018 (12%) and 2017 (17%), while a the proportion of apprentices identifying themselves as Hispanic or Latino in 2019 (4%) was similar to previous years (4% in 2018, 3% in 2017). A majority of apprentices (68%) attended suburban schools and few (10%) received free or reduced price school lunches (FARMS). Large majorities of apprentices spoke English as their first language (92%) and very few (4%) would be first generation college attendees. Nearly a third (32%) met the met the AEOP definition of U2, an increase as compared to 2018 when 27% of apprentices qualified for U2 status.

Table 5. 2019 SEAP Student Participant Profile		
Demographic Category		
Respondent Gender (n =108)		
Female	56	51.9%
Male	52	48.1%
Respondent Race/Ethnicity (n =108)		
Asian	26	24.1%
Black or African American	11	10.2%
Hispanic or Latino	4	3.7%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	2	1.8%
White	59	54.6%
Other race or ethnicity	3	2.8%
Choose not to report	3	2.8%
School Location (n=108)		
Urban (city)	21	19.5%
Suburban	74	68.5%
Rural (country)	13	12.0%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Grade Level (n=108)		
9th grade	2	1.9%
10th grade	17	15.7%
11th grade	61	56.5%
12th grade	28	25.9%
Free or Reduced Price Lunch Recipient (n =108)		
Yes	11	10.2%
No	96	88.9%
Choose not to report	1	<1%
English is First Language (n =108)		
Yes	99	91.7%
No	9	8.3%
One parent/guardian graduated from college (n =108)		
Yes	103	95.4%
No	4	3.7%
Choose not to report	1	<1%
U2 Classification (n =108)		

Yes	35	32.4%
No	73	67.6%

Cost data for 2019 SEAP activities are provided in Table 6. The total cost for SEAP was $482,304. The cost per student participant was $4,466.

Table 6. 2019 SEAP Program Costs	
Total Cost	$482,304
CCDC Cost	$0
IPA Cost	$482,304
Total Travel	$788
CCDC Travel	$0
IPA Travel	$788
Participant Travel	$0
Total Awards	$367,986
Student Awards/Stipends	$367,986
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$4,466

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. REAP is managed by the Rochester Institute of Technology (RIT). 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 apprentices) 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 2019, 857 students applied for the REAP program, an 11% decrease from the 949 applicants in 2018 and a 17% increase over the 709 applicants in 2017. Of those applicants, 168 students were placed in apprenticeships, an 18% increase over the 138 placed in 2018, and a 30% increase over the 118 apprentices placed in 2017. A total of 55 colleges and universities participated in REAP in 2019, a slight increase (4%) from the 53 institutions that participated in 2018 and a 25% increase as compared to the 41 participating institutions in 2017. Of the institutions participating in 2019, 29 (53%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 31 (57%) in 2018 and 25 (60%) in 2017. Table7 displays the number of applicants and enrollment at each site in 2019.

Table 7. 2019 REAP Site Applicant and Enrollment Numbers

2019 REAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Alabama State University *	23	6	26%
Arizona State University	8	2	25%
Augusta University	16	2	13%
Caldwell University	11	3	27%
California State University - Sacramento*	13	2	15%
City University of New York *	14	2	14%
College of Saint Benedict & Saint John's University	7	2	29%
Colorado State University*	9	2	22%
Delaware State University *	9	2	22%
Fayetteville State University*	22	1	4.5%
Florida A&M University*	17	4	24%
Georgia State University Research Foundation*	17	2	12%
Iowa State University	4	1	25%
Jackson State University *	26	6	23%
Johns Hopkins University	86	4	4.6%
Longwood University	12	2	17%
Louisiana Tech University	4	4	100%
Loyola University	15	4	27%

Table 7. 2019 REAP Site Applicant and Enrollment Numbers			
Marshall University	5	4	80%
Marshall University School of Pharmacy	4	2	50%
Morgan State University*	13	2	15%
New Jersey Institute of Technology	35	6	17%
New Mexico State University*	6	1	17%
Oakland University*	13	4	31%
Purdue University	5	3	60%
Rutgers University*	10	1	10%
Savannah State University *	6	2	33%
South Dakota School of Mines & Technology	5	2	40%
Stockton University*	12	2	17%
Texas Southern University *	51	6	12%
Texas Tech University*	17	10	59%
University of Alabama at Huntsville *	44	12	27%
University of Alabama at Tuscaloosa	2	0	0%
University of Arkansas at Pine Bluff*	7	2	29%
University of California – Berkeley*	17	1	6%
University of Central Florida*	20	1	5%
University of Houston*	24	7	30%
University of Illinois at Urbana-Champaign	7	2	29%
University of Maryland - Baltimore	64	4	6%
University of Massachusetts - Lowell	7	2	29%
University of Missouri*	7	2	29%
University of Nevada, Las Vegas	5	3	60%
University of Nevada, Reno	5	2	40%
University of New Hampshire	4	1	25%
University of New Mexico*	12	4	33%
University of North Carolina – Charlotte*	14	4	29%
University of Northern Iowa	6	3	50%
University of Pennsylvania	30	2	7%
University of Puerto Rico*	16	6	38%
University of Southern California	25	2	8%
University of Texas - El Paso*	7	2	29%
University of Texas – Arlington*	12	2	17%
University of Vermont - Burlington	4	2	50%
University of the Virgin Islands*	5	2	40%
West Texas A&M	5	2	40%
Yale University	12	2	17%
Unspecified site	1	0	0%
Total	**857**	**168**	**19.6%**

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

Table 8 displays demographics for REAP apprentices who provided this information in Cvent. The proportion of female participants (67%) increased somewhat as compared to previous years (62% in 2018, 61% in 2017). The proportion of apprentices identifying themselves as Black or African American continues to increase as compared to previous years (44% in 2019 as compared to 40% in 2018 and 29% in 2017). Likewise, participation by Hispanic or Latino apprentices continues to increase (26% in 2019 as compared to 22% in 2018 and 15% in 2017). The proportion of REAP apprentices identifying themselves as White (9%) was similar to 2018 (8%) but substantially lower than in 2017 (27%). The proportion of REAP apprentices identifying as Asian continues to decrease (14% in 2019 as compared to 20% in 2018 and 27% in 2017). More than half of REAP apprentices (56%) qualified for free or reduced-price school lunches (FARMS), over a quarter (30%) spoke a language other than English as their first language, and over a third (36%) would be first generation college attendees. Nearly all REAP apprentices (99%) qualified for U2 status under the AEOP definition (96% in 2018).

Table 8. 2019 REAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=165)		
Female	111	67.3%
Male	54	32.7%
Respondent Race/Ethnicity (n=165)		
Asian	23	13.9%
Black or African American	72	43.6%
Hispanic or Latino	43	26.1%
Native American or Alaska Native	2	1.2%
Native Hawaiian or Other Pacific Islander	2	1.2%
White	15	9.2%
Other race or ethnicity	5	3.0%
Choose not to report	3	1.8%
School Location (n=165)		
Urban (city)	72	43.6%
Suburban	57	34.5%
Rural (country)	31	18.8%
Frontier or tribal School	1	<1%
DoDDS/DoDEA School	0	0%
Home school	3	1.8%
Online school	1	<1%
Grade Level (n=165)		
8th Grade	1	<1%
9th grade	22	13.3%
10th grade	48	29.1%
11th grade	75	45.5%
12th grade	18	10.9%
College sophomore	1	<1%
Free or Reduced Price Lunch Recipient (n=165)		
Yes	93	56.4%

Table 8. 2019 REAP Student Participant Profile		
No	71	43.0%
Choose not to report	1	<1%
English is First Language (n=165)		
Yes	116	70.3%
No	49	29.7%
One parent/guardian graduated from college (n=165)		
Yes	102	61.8%
No	60	36.4%
Choose not to report	3	1.8%
U2 Classification (n=165)		
Yes	163	98.8%
No	2	1.2%

Cost data for 2019 REAP activities are provided in Table 9. The total cost for REAP was $450,165. The cost per student was $2,860.

Table 9. 2019 REAP Program Costs	
Total Cost	$450,165
CCDC Cost	$0
IPA Cost	$450,165
Total Travel	$2,060
CCDC Travel	$0
IPA Travel	$2,060
Participant Travel	$0
Total Awards	$353,000
Student Awards/Stipends	$239,000
Adult/Teacher/Mentor Awards	$114,000
Cost Per Student	$2,680

High School Apprenticeship Program (HSAP)

HSAP, managed by the Rochester Institute of Technology (RIT) 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 2019, 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 2019, the program received a total of 670 student applications for HSAP apprenticeships, a 17% increase as compared to the 559 applicants in 2018 and a 6% increase over the 629 students who applied to HSAP in 2017. Of these applications, 651 were forwarded to sites, and 29 (4%) students were placed in apprenticeships, a 66% decrease in enrollment as compared to 2018 when 48 students were placed in HSAP apprenticeships and an 86% decrease in enrollment compared to 2017 when 54 apprentices were placed. A total of 25 colleges and universities hosted HSAP apprentices, a 32% decrease from 2018 when 33 hosted apprentices, a 44% decrease as compared to 2017 when 36 colleges and universities hosted HSAP apprentices. Ten of the 25 host institutions (40%) were HBCU/MSIs, compared to the 13 of the 33 host institutions (39%) in 2018 and 19 of 36 (53%) in 2017. Table 10 displays the number of applicants and enrollment at each site in 2019.

Table 10. 2019 HSAP Site Applicant and Enrollment Numbers

2019 HSAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Columbia University	66	1	1.5%
Cornell University	24	1	4.2%
Dartmouth College	17	1	5.9%
Duke University	58	2	3.4%
Florida International University*	20	3	15.0%
Louisiana State University*	12	1	8.3%
New York University	80	2	2.5%
Ohio State University	20	1	5.0%
Purdue University	8	1	12.5%
Rice University	58	1	1.7%
Savannah State University*	11	1	9.1%
Stony Brook University	6	1	16.7%

Texas State University*	20	1	5.0%
University of California – San Diego	61	1	1.6%
University of Illinois - Chicago	38	1	2.6%
University of New Hampshire	9	1	11.1%
University of North Carolina - Charlotte*	16	1	6.3%
University of Notre Dame	5	1	20.0%
University of Puerto Rico-Mayaguez*	7	1	14.3%
University of Southern California	56	1	1.8%
University of Tennessee	15	1	6.7%
University of Virgin Island	9	1	11.1%
Washington State University	14	1	7.1%
Wesleyan University	7	1	14.3%
Yale University	14	1	7.1%
Total**	**651**	**29**	**4%**

*Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)
**This total does not include applicants whose applications were not forwarded to sites because of eligibility issues or applicants who submitted applications after the application deadline.

Table 11 contains an overview of demographic information for enrolled HSAP apprentices in 2019. As in previous years, over half of apprentices were female (62% in 2019, 60% in both 2018 and 2017). HSAP served apprentices from a variety of races and ethnicities. As in previous years, the most commonly reported races/ethnicities were White (31% in 2019, 31% in 2018, 42% in 2017) and Asian (21% in 2019, 33% in 2018, 25% in 2017). Also similar to previous years, 14% of apprentices identified themselves as Black or African American (15% in both 2018 and 2017). The percentage of apprentices identifying as Hispanic or Latino (24%) increased as compared to previous years' enrollment (15% in 2018, 14% in 2017). A large majority of HSAP apprentices (86%) spoke English as their first language, and relatively few (14%) would be first generation college attendees. Nearly two-thirds of apprentices (66%) qualified for U2 status under the AEOP definition, an increase as compared to 2018 when 54% met the AEOP definition of underserved.

Table 11. 2019 HSAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=29)		
Female	18	62.1%
Male	10	34.5%
Choose not to report	1	3.4%
Respondent Race/Ethnicity (n=29)		
Asian	6	20.7%
Black or African American	4	13.8%
Hispanic or Latino	7	24.2%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	9	31.0%
Other race or ethnicity	2	6.9%
Choose not to report	1	3.4%
School Location (n=29)		
Urban (city)	14	48.3%
Suburban	11	37.9%
Rural (country)	4	13.8%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Grade Level (n=29)		
10th grade	3	10.3%
11th grade	25	86.3%
12th grade	1	3.4%
Free or Reduced Price Lunch Recipient (n=29)		
Yes	6	20.7%
No	23	79.3%
Choose not to report	0	0%
English is First Language (n=29)		
Yes	25	86.2%
No	4	13.8%
Choose not to report	0	0%
One parent/guardian graduated from college (n=29)		
Yes	24	82.8%
No	4	13.8%
Choose not to report	1	3.4%
U2 Classification (n=29)		
Yes	19	65.5%
No	10	34.5%

Cost data for 2019 HSAP activities are provided in Table 12. The total cost for HSAP was $102,785. The cost per student participant was $3,544.

Table 12. 2019 HSAP Program Costs	
Total Cost	$102,785
CCDC Cost	$0
IPA Cost	$102,785
Total Travel	$788
CCDC Travel	$0
IPA Travel	$788
Participant Travel	$0
Total Awards	$77,700
Student Awards/Stipends	$77,700
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$3,544

University Research Apprenticeship Program (URAP)

The Undergraduate Research Apprenticeship Program (URAP), managed by Rochester Institute of Technology (RIT) and the U.S. Army Research Office (ARO), 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 2019, 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 2019, the program received a total of 281 student applications for URAP apprenticeships, a 14% decrease as compared to the 321 who applied in 2018 and a 15% increase in applicants as compared to the 239 students who applied in 2017. Of these applications, 265 were forwarded to sites, and 54 (20%) students were placed in apprenticeships, a 24% decrease in number of apprentices placed compared to 2018 when 67 were placed, and a 9% decrease compared to 2017 when 59 apprentices were placed. A total of 41 colleges and universities hosted URAP apprentices in 2018 (compared to 48 in 2018, and 39 in 2017). Of these institutions, 10 (24%) were HBCU/MSIs, a notable decrease as compared to 2018 (22, or 46% of institutions) and 2017 (17, or 44% of institutions). Table 13 displays the number of applicants and enrollment at each site in 2019.

Table 13. 2019 URAP Site Applicant and Enrollment Numbers

2019 URAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Augusta University	17	2	12%
Columbia University	5	1	20%
Cornell University	5	1	20%
Dartmouth College	5	1	20%
Duke University	2	1	50%
Florida International University*	15	1	7%
Johns Hopkins University	26	1	4%
Louisiana State University*	2	1	50%
McGill University	1	1	100%
New York University	13	1	8%
North Carolina Agricultural and Technical State University*	1	1	100%
Ohio State University	12	1	8%
Purdue University	1	1	100%
Rice University	3	1	33%
Rutgers University - Piscataway	2	2	100%
Stony Brook University	6	1	17%
Texas A&M University, TX - San Antonio**	5	1	20%
Texas State University – San Marcos**	3	1	33%
University of Alabama	7	2	29%
University of California - Davis	7	1	14%
University of California - Irvine	3	2	67%

University of California – San Diego	13	1	8%
University of California - Santa Barbara**	13	6	46%
University of Delaware*	8	3	38%
University of Florida	4	1	25%
University of Houston**	5	2	40%
University of Illinois - Chicago	7	1	14%
University of Memphis	4	1	25%
University of New Hampshire	2	1	50%
University of North Carolina - Charlotte*	4	1	25%
University of Notre Dame	3	1	33%
University of Oklahoma	2	2	100%
University of Pittsburgh	3	1	33%
University of Puerto Rico Mayaguez**	12	1	8%
University of Rochester	3	1	33%
University of Southern California	6	1	17%
University of Tennessee	6	1	17%
University of Virgin Islands*	3	1	33%
Virginia Polytechnic Institute	4	1	25%
Washington State University	19	1	5%
Yale University	3	1	33%
Total**	**265**	**54**	**20%**

*Historically Black Colleges and Universities/Minority Serving Institution

**This total does not include applicants whose applications were not forwarded to sites because of eligibility issues or applicants who submitted applications after the application deadline.

Table 14 contains an overview of demographic information for enrolled URAP apprentices. The proportion of female apprentices was the same as in 2018 but smaller than in 2017 (39% in 2019, 39% in 2018, 58% in 2017). The proportion of apprentices identifying as White (57%) decreased as compared to 2018 (64%) but was higher than in 2017 (53%). The proportion of apprentices identifying as Asian (19%) increased as compared to both 2018 (9%) and 2017 (14%). The proportion of apprentices identifying as Black or African American (6%) was smaller than in previous years (9% in 2018; 8% in 2017), although the proportion of apprentices identifying as Hispanic or Latino (15%) increased as compared to 2018 (10%) and was the same as in 2017 (15%). Most apprentices (82%) spoke English as their first language, and few (13%) were first generation college attendees. Just over a fifth (22%) of URAP apprentices met the AEOP definition of U2, compared to 18% in 2018.

Table 14. 2019 URAP Student Participant Profile		
Demographic Category		
Respondent Gender (n=54)		
Female	21	38.9%
Male	32	59.3%
Choose not to report	1	1.8%
Respondent Race/Ethnicity (n=54)		
Asian	10	18.5%
Black or African American	3	5.6%
Hispanic or Latino	8	14.8%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	31	57.4%
Other race or ethnicity	2	3.7%
Choose not to report	0	0%
Grade Level (n=54)		
College freshman	8	14.8%
College sophomore	21	38.9%
College junior	19	35.2%
College senior	6	11.1%
Other	0	0%
English is First Language (n=54)		
Yes	44	81.5%
No	10	18.5%
Choose not to report	0	0%
One parent/guardian graduated from college (n=54)		
Yes	46	85.2%
No	7	13.0%
Choose not to report	1	1.8%
U2 Classification (n=54)*		
Yes	12	22.2%
No	42	77.8%

*Since Pell Grant status data was not collected for URAP in 2019, low-income status was not included in the criteria for participants' U2 status.

Cost data for 2019 URAP activities are provided in Table 15. The total cost for URAP was $256,654. The cost per student participant was $$4,753.

Table 15. 2019 URAP Program Costs	
Total Cost	$256,654
CCDC Cost	$0
IPA Cost	$256,654
Total Travel	$952
CCDC Travel	$0
IPA Travel	$952
Participant Travel	$0
Total Awards	$209,347
Student Awards/Stipends	$209,347
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$4,753

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, 3,876 students applied for AEOP apprenticeship programs and 563 (15%) were placed in apprenticeships. This represents a 16% increase in applicants as compared to 2018 when 3,275 apprenticeship applications were received, and a 3% decrease in the overall number of apprentices as compared to 2018 when 581 applicants were placed in apprenticeships. Because of the increase in applicants and slight decrease in enrollment, there was a decrease in placement rate in 2019 (15%) as compared to 2018 (18%). Of those placed, 53% met the AEOP definition of U2, as compared to 42% in 2018.

Table 16. 2019 Apprenticeship Participation

Type of Program	No. of Applicants	No. of Participants	Percentage of U2
Army Laboratory-Based Programs (CQL, SEAP)	1,948	312	34%
University-Based Programs (REAP, HSAP, URAP)	1,928	251	79%
Total	**3,876**	**563**	**53%**

The total cost of 2019 apprenticeship programs was $3,095,347. The average cost per apprentice for 2019 apprenticeship programs overall was $5,498. Table 17 summarizes these and other 2019 apprenticeship program costs.

Table 17. 2019 Apprenticeship Program Costs	
Total Program Costs	
Total Cost	$3,095,347
CCDC Cost	$0
IPA Cost	$3,095,347
Total Travel	$5,875
CCDC Travel	$0
IPA Travel	$5,875
Participant Travel	$0
Total Awards	$2,752,548
Student Awards/Stipends	$2,638,548
Adult/Teacher/Mentor Awards	$114,000
Cost Per Apprentice	$5,498
	Total Costs Per Type of Program
Army Laboratory-Based Programs – Total Cost	$2,285,743
University-Based Programs – Total Cost	$809,604
	Cost Per Student Participant By Type of Program
Cost Per Apprentice Army Laboratory & Center-Based Programs	$7,326
Cost Per Apprentice – University-Based Programs	$3,226

4 | Evaluation At-A-Glance

NC State University, in collaboration with RIT, 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 Army laboratories and centers and Army-funded university/ college labs across the U.S. and Canada • 312 apprentices participating in Army laboratory-hosted apprenticeships • 251 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 two SEAP and CQL sites, four focus groups with SEAP and CQL apprentices, four focus groups with SEAP and CQL mentors, 27 phone interviews with apprentices at university-hosted apprenticeship sites and 22 phone interviews with mentors at university-hosted apprenticeship sites. In addition, program administrators provided Annual Program Reports (APRs) and other data from 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. 2019 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. 2019 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. 2019 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. 2019 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. 2019 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 scientists and 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

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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.

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 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). The instrument used by mentors to assess apprentices' 21st Century skills is included in Appendix D. Sample apprentice and mentor questionnaires for each program are in Appendices E and F.

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). Fewer apprentices and mentors responded to questionnaires than in 2018 when 229 apprentices and 135 mentors responded (39% and 27% participation rate respectively). The margins of error for both apprentices and mentors overall are somewhat larger than is generally acceptable, indicating that the samples may not be representative of the overall population, and therefore conclusions should be interpreted with caution.

Table 23. 2019 Apprenticeship Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[4]
Apprentices	139	563	25%	±7.22%
Mentors	108	524	21%	±8.41%

[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.

Army Laboratory-Based Programs

Study Sample and Respondent Profiles

CQL

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). 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. 2019 CQL Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	48	204	23.5%	±12.40%
Mentors	15	178	8.4%	±24.28%

Two apprentice focus groups and two mentor focus groups were conducted at two CQL sites. Five apprentices, two male and three female, participated in the apprentice focus groups. Four apprentices were participating in CQL for the first time. One was a rising college sophomores, two were juniors, one a senior, and one a recent college graduate. Three mentors, all Army S&Es, also participated in two focus groups. All three mentors were male. Two of the mentors had over five years of experience mentoring CQL apprentices and one had mentored for three years. All three have also mentored SEAP apprentices, and one of the mentors had participated as an apprentice in CQL. 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 the 44-47 apprentice questionnaire respondents who provided that information is summarized in Table 25. Slightly more females (55%) completed the survey compared to males (45%). The majority of CQL apprentices reported being White (57%), followed by Asian (20%) and Black/African American (9%). Most apprentices (77%) were college juniors and seniors. Nearly all apprentices reported speaking English as a first language (91%) and having a parent who had attended college (80%). Over a third (41%) of survey respondents meet the AEOP criteria for U2 status. Although the proportion of Asian apprentices responding to the survey was somewhat greater than in the overall population (20% of respondents versus 12% overall) and the proportion of Black or African American apprentices was somewhat lower than in the overall population (9% of respondents versus 18% overall), most other respondent demographics are similar to the demographic distribution for the overall population of CQL apprentices.

Table 25. 2019 CQL Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=44)		
Female	24	54.5%
Male	20	45.5%
Respondent Race/Ethnicity (n=44)		
Asian	9	19.6%
Black or African American	4	8.7%
Hispanic or Latino	3	6.5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	26	56.6%
Other race or ethnicity	2	4.3%
Choose not to report	2	4.3%
Respondent Grade Level (n=47)		
College freshman	1	2.1%
College sophomore	8	17.0%
College junior	15	31.9%
College senior	21	44.7%
Choose not to report	2	4.3%
Other	0	0%
First Generation Status (n=44)		
Yes	9	20.5%
No	35	79.5%
Choose not to report	0	0%
English as First Language (n=44)		
Yes	40	90.9%
No	4	9.1%
Choose not to report	0	0%
Pell Grant Recipient (n=44)		
Yes	14	31.8%
No	30	68.2%
Choose not to report	0	0%
U2 Classification (n=44)		
Yes	18	41%
No	26	59%

CQL Mentor Respondent Demographics

Demographic data for CQL mentors who responded to the survey are provided in Table 26. Considerably more male mentors (80%) than females (20%) responded. More than three-quarters of the mentors (87%) reported being White. All mentors reported being professional scientists, engineers, or mathematicians.

Table 26. 2019 CQL Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 15)		
Female	3	20%
Male	12	80%
Choose Not to Report	0	0%
Respondent Race/Ethnicity (n = 15)		
Asian	0	0%
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	13	86.6%
Other race or ethnicity	1	6.7%
Choose not to report	1	6.7%
Respondent Occupation (n = 15)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	15	100%
Other	0	0%
Respondent Primary Area of Research (n = 15)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	4	26.7%
Biological science	0	0%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	0	0%
Computer science	0	0%
Technology	2	13.3%
Engineering	8	53.3%
Mathematics or statistics	0	0%
Medical, health, or behavioral science	0	0%
Social Science (psychology, sociology, anthropology)	1	6.7%
Other, (specify):	0	0%

SEAP

Table 27 shows SEAP apprentice and mentor participation in the questionnaire, the response rate, and the margin of error. 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. 2019 SEAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	11	108	10.2%	±28.13%
Mentors	11	123	8.9%	±28.31%

Two apprentice focus groups and two mentor focus groups were conducted at two SEAP sites. Twenty-two apprentices participated in the two apprentice focus groups. Of these apprentices, seven were male and 15 were female. Twenty apprentices were first time participants, and one had participated once previously; apprentices had participated in Camp Invention (2), GEMS (3), GEMS Near-Peer Mentors (1), and REAP (1) in the past. Seven Army S&Es and one contractor serving as mentors also participated in two focus groups. Four of these mentors were male and four female. Three were mentoring for the first time, three had mentored for three previous years, one had mentored for four years, and one had mentored for over five years. Mentors in focus groups had previously participated in GEMS (1), JSS (1), CQL (3), and RESET (1). 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 data for the eight SEAP apprentices who provided demographic information in their responses to the questionnaire are summarized in Table 28. Three-quarters of respondents self-identified as female (75%). More than three-quarters of participants indicated they were either White (63%) or Asian (25%), with only one Hispanic/Latino (13%). Most responding apprentices were 11th grade students (50%) followed by 10th (25%). All apprentices (100%) reported attending suburban schools, not receiving free or reduced lunch (100%), and having a parent who attended college (100%). All but one participant reported speaking English as a First Language (88%). Only one (12%) of SEAP apprentices who responded to the questionnaire were classified as underprivileged according to AEOP U2 standards. Overall, survey respondents were demographically somewhat different than the overall population of SEAP apprentices since more respondents were female (75% of respondents versus 52% overall), White (63% of respondents versus 55% overall), and Hispanic or Latino (13% of respondents versus 4% overall). In addition, no Black or African American apprentices responded to the survey (10% in the overall population), and only one apprentice (12%) who responded to the survey met the AEOP definition of underserved (32% in the overall population).

Table 28. 2019 SEAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=8)		
Female	6	75%
Male	2	25%
Respondent Race/Ethnicity (n=8)		
Asian	2	25%
Black or African American	0	0%
Hispanic or Latino	1	12.5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	5	62.5%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Respondent Grade Level (n=8)		
10th	2	25%
11th	4	50%
12th	1	12.5%
College – Freshman	0	0%
College - Sophomore	1	12.5%
Choose not to report	0	0%
Other	0	0%
School Location (n=6)		
Urban	0	0%
Suburban	6	100%
Rural	0	0%
First Generation Status (n=8)		
Yes	0	0%
No	8	100%
Choose not to report	0	0%
English as First Language (n=8)		
Yes	7	87.5%
No	1	12.5%
Choose not to report	0	0%
Free or Reduced Lunch Price Recipient (n=7)		
Yes	0	0%
No	7	100%
Choose not to report	0	0%

Table 28. 2019 SEAP Apprentice Respondent Profile		
U2 Classification (n=8)		
Yes	1	12%
No	7	88%

SEAP Mentor Respondent Demographics

Demographic information for SEAP mentors who responded to the 2019 survey is listed in Table 29. All responding mentors were professional scientists, engineers, or mathematicians (100%) and all had served as research mentors (100%). Gender was split evenly with nearly half identifying as female (46%) and male (46%). Most mentors reported being White (60%) or Asian (20%).

Table 29. 2019 SEAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (**n = 11)**		
Female	5	45.5%
Male	5	45.5%
Choose not to report	1	9%
Respondent Race/Ethnicity (n = 10)		
Asian	2	20%
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	6	60%
Other	0	0%
Choose not to report	2	20%
Respondent Occupation (n = 11)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	11	100%
Other, (specify)	0	0%
Role in SEAP (n = 11)		
Research Mentor	11	100%
Other	0	0%

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. 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. 2019 REAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	31	168	18.5%	±15.94%
Mentors	40	132	30.3%	±12.99%

Phone interviews were conducted with ten REAP apprentices and eight REAP 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

Demographic information for the 28 REAP apprentice survey respondents who provided that information is displayed in Table 31. More females (64%) than males (36%) completed the questionnaire. Nearly two-thirds of REAP survey participants self-identified as either Black/African American (36%) or Hispanic/ Latino (29%). Most apprentices completing the questionnaire were either high school seniors (47%) or juniors (30%). School location was diverse, with locations reported as follows: suburban (36%), rural (36%), and urban (29%). More than half of participants indicated English was their first language (65%) and that they received free/reduced lunch (71%). More than one third indicated that they would be first generation college going students (39%). Overall, three-quarters (89%) of respondents met the AEOP definition of U2 . Although somewhat more respondents qualified for free lunch than in the overall population (71% of respondents versus 57% overall, and somewhat fewer met the AEOP definition of U2 (89% of respondents versus 99% overall), the demographics of questionnaire respondents are similar to the population of participating apprentices.

Table 31. 2019 REAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=28)		
Female	18	64.3%
Male	10	35.7%
Respondent Race/Ethnicity (n=28)		
Asian	4	14.3%
Black or African American	10	35.7%
Hispanic or Latino	8	28.6%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	3	10.7%
Other race or ethnicity	0	0%
Choose not to report	3	10.7%
Respondent Grade Level (n=30)		
High school freshman	0	0%
High school sophomore	3	10%
High school junior	9	30%
High school senior	14	46.7%
Other	4	13.3%
School Location (n=28)		
Urban	8	28.6%
Suburban	10	35.7%
Rural	10	35.7%
Home	0	0%
First Generation Status (n=28)		
Yes	11	39.3%
No	15	53.5%
Choose not to report	2	7.2%
English as First Language (n=28)		
Yes	6	21.4%
No	22	78.6%
Free or Reduced Lunch Price Recipient (n=28)		
Yes	20	71.4%
No	8	28.6%
Choose not to report	0	0%
U2 Classification (n=27)		
Yes	24	89%
No	3	11%

REAP Mentor Respondent Demographics

Demographics for REAP mentors who responded to the survey are shown in Table 32. Slightly fewer females (45%) responded than males (55%). Most responding mentors reported being either White (50%), Asian (24%), or Black/African American (21%). Mentors' primary areas of research interest were wide-spread with physical sciences (43%) and engineering (15%) being the most frequently reported areas.

Table 32. 2019 REAP Mentor Respondent Profiles		
Demographic Category	**Questionnaire Respondents**	
Gender (n = 40)		
Female	18	45%
Male	22	55%
Choose not to report	1	3.2%
Race/Ethnicity (n = 40)		
Asian	9	23.6%
Black or African American	8	21.1%
Hispanic or Latino	0	0%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	19	50%
Choose not to report	2	5.3%
Other race or ethnicity	0	0%
Primary Area of Research (n = 40)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	17	42.5%
Biological science	5	12.5%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	4	10%
Computer science	3	7.5%
Technology	1	2.5%
Engineering	6	15%
Mathematics or statistics	0	0%
Medical, health, or behavioral science	2	5%
Social Science (psychology, sociology, anthropology)	0	0%
Other	2	5%

HSAP

Table 33 provides an analysis of apprentice and mentor participation in the HSAP questionnaires, the response rate, and the margin of error. 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. 2019 HSAP Questionnaire Participation				
Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	18	29	62.1%	±14.48%
Mentors	14	40	35.0%	±21.39%

Individual phone interviews were conducted with eight apprentices and five mentors recruited by the ARO. 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 for HSAP apprentices who completed the survey is in Table 34. More females (61%) completed the survey than males (39%). Participant race/ethnicity was reported to be largely White (44%) followed by Hispanic or Latino (28%), Asian (17%), and Black/African American (11%). Most respondents reported being high school juniors (61%), attending an urban school (60%), speaking English as a first language (83%), having a parent who went to college (78%), and not receiving free or reduced lunch (79%). Among HSAP apprentices who completed the questionnaire, 44% were classified as underrepresented according to AEOP U2 standards. Although fewer respondents met the AEOP definition of U2 than in the overall population (44% of respondent versus 66% overall), most respondent demographics are similar to the demographic data for the overall population of HSAP apprentices.

Table 34. 2019 HSAP Apprentice Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n=18)		
Female	11	61.1%
Male	7	38.9%
Respondent Race/Ethnicity (n=18)		
Asian	3	16.7%

Black or African American	2	11.1%
Hispanic or Latino	5	27.8%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	8	44.4%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Respondent Grade Level (n=18)		
High school freshman	1	5.6%
High school sophomore	5	27.7%
High school junior	11	61.1%
High school senior	1	5.6%
Choose not to report	0	0%
Other	0	0%
School Location (n=15)*		
Urban	9	60%
Suburban	4	26.7%
Rural	2	13.3%
Choose not to report	0	0%
First Generation Status (n=18)*		
Yes	3	16.7%
No	14	77.7%
Choose not to report	1	5.6%
English as First Language (n=18)*		
Yes	15	83.3%
No	3	16.7%
Choose not to report	0	0%
Free or Reduced Lunch Price Recipient (n=14)*		
Yes	3	21.4%
No	11	78.6%
Choose not to report	0	0%
U2 Classification (n=18)*		
Yes	8	44%
No	10	56%

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

HSAP Mentor Respondent Demographics

Table 35 summarizes demographic data for HSAP mentors who completed the survey. Most respondents indicated they were male (64%) and White (64%). More than half reported being university educators (57%) followed by either professional (21%) or in training (21%) scientists, engineers, or mathematicians.

Table 35. 2019 HSAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 14)		
Female	4	28.6%
Male	9	64.3%
Choose not to report	1	7.1%
Respondent Race/Ethnicity (n = 14)		
Asian	4	28.6%
Black or African American	0	0%
Hispanic or Latino	1	7.1%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	9	64.3%
Choose not to report	0	0%
Respondent Occupation (n = 14)		
University educator	8	57.2%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	3	21.4%
Scientist, Engineer, or Mathematics professional	3	21.4%
Teacher	0	0%
Other	0	0%

URAP

Table 36 provides an analysis of apprentice and mentor participation in the URAP questionnaires, the response rates, and the margin of error. 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. 2019 URAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	31	54	57.4%	±11.60%
Mentors	28	51	54.9%	±12.56%

Nine phone interviews were conducted with URAP apprentices and nine 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 for the 30 URAP apprentices who provided this information are shown in Table 37. Most respondents were male (67%) and White (60%). More than half of respondents reported being college juniors (55%). Most apprentices reported that at least one of their parents had attended college (87%) and that English was their first language (80%). Slightly more than a fifth (22%) of URAP apprentices who responded to the questionnaire were classified met the AEOP definition of U2. Demographics of responding apprentices are similar to those of all enrolled URAP apprentices.

Table 37. 2019 URAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=30)		
Female	10	33.3%
Male	20	66.6%
Choose not to report	0	0%
Respondent Race/Ethnicity (n=30)		
Asian	10	10%
Black or African American	3	3.3%
Hispanic or Latino	8	20%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	31	60%
Other race or ethnicity	22	6.7%
Choose not to report	0	0%
Respondent Grade Level (n=31)		
College freshman	0	0%
College sophomore	3	9.7%
College junior	17	54.8%
College senior	10	32.3%
Choose not to report	1	3.2%
Other	0	0%
First Generation Status (n=30)		
Yes	3	10%
No	26	86.7%
Choose not to report	1	3.3%
English as First Language (n=30)		
Yes	24	80%
No	6	20%
Choose not to report	0	0%
U2 Classification (n=27)		
Yes	6	22%
No	21	78%

URAP Mentor Respondent Demographics

Table 38 summarizes URAP demographics for the 28 mentor respondents who provided this information. Three-quarters of responding mentors were male (75%). Most mentors indicated they were either Asian (39%) or White (39%). Mentors primarily identified as university educators (50%), and 96% reported that they served as research mentors.

Table 38. 2019 URAP Mentor Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 28)		
Female	6	21.4%
Male	21	75%
Choose not to report	1	3.6%
Respondent Race/Ethnicity (n = 28)		
Asian	11	39.3%
Black or African American	1	3.6%
Hispanic or Latino	2	7.1%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	11	39.3%
Choose not to report	1	3.6%
Other race or ethnicity, (specify):*	2	7.1%
Respondent Occupation (n = 28)		
University educator	14	50%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	9	32.1%
Scientist, Engineer, or Mathematics professional	5	17.9%
Other, (specify):	0	0%
Respondent Role in URAP (n = 27)		
Research Mentor	27	96.4%
Research Team Member but not a Principal Investigator	1	3.6%
Other, (specify)	0	0%

*Bangladesh; Black and White

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 FY19 apprenticeship 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 Appendix D.

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 161 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 differences existed in apprentice skills by program level (high school vs. undergraduate) and setting (Army lab vs. university-based). Positive growth was seen from pre to post in each skill set regardless of grouping. 2-Between, 2-Within Repeated-Measures ANOVAs revealed no significant differences in any of the 21st Century skill sets from pre- to post-observation by program level or setting. This means that apprentices at the high school and undergraduate level as well as in army labs and universities all demonstrated statistically similar growth. 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	125	1.84 (0.50)	2.53 (0.47)	+0.69	1.20
Undergraduate	33	1.99 (0.45)	2.46 (0.48)	+0.47	
Setting					
Army-Based	16	2.07 (0.37)	2.32 (0.50)	+0.25	0.00
University-Based	142	1.85 (0.50)	2.54 (0.46)	+0.69	
Critical Thinking & Problem Solving					
Level					
High School	127	1.89 (0.39)	2.49 (0.44)	+0.60	2.30
Undergraduate	34	2.08 (0.51)	2.58 (0.39)	+0.50	
Setting					
Army-Based	18	2.05 (0.44)	2.42 (0.45)	+0.37	0.02
University-Based	143	1.91 (0.42)	2.52 (0.43)	+0.61	
Communication, Collaboration, Social, & Cross-Cultural					
Level					
High School	121	2.04 (0.51)	2.62 (0.43)	+0.58	0.11
Undergraduate	34	2.28 (0.51)	2.70 (0.37)	+0.43	
Setting					
Army-Based	18	2.26 (0.43)	2.55 (0.43)	+0.28	0.00
University-Based	137	2.07 (0.53)	2.65 (0.41)	+0.58	
Information, Media, & Technological Literacy					
Level					
High School	85	1.97 (0.54)	2.34 (0.48)	+0.38	0.87
Undergraduate	33	2.14 (0.44)	2.64 (0.41)	+0.50	
Setting					
Army-Based	17	2.20 (0.43)	2.57 (0.36)	+0.37	0.51
University-Based	101	1.98 (0.52)	2.39 (0.49)	+0.40	
Flexibility, Adaptability, Initiative, & Self-Direction					
Level					
High School	125	1.90 (0.46)	2.54 (0.48)	+0.64	0.35
Undergraduate	33	2.16 (0.42)	2.63 (0.47)	+0.47	
Setting					
Army-Based	16	2.36 (0.39)	2.61 (0.47)	+0.24	3.37
University-Based	142	1.91 (0.44)	2.55 (0.46)	+0.64	
Productivity, Accountability, Leadership, & Responsibility					
Level					
High School	123	1.86 (0.49)	2.50 (0.44)	+0.64	1.84
Undergraduate	32	2.17 (0.39)	2.60 (0.36)	+0.42	
Setting					
Army-Based	16	2.25 (0.35)	2.44 (0.39)	+0.20	0.22
University-Based	139	1.89 (0.49)	2.53 (0.43)	+0.64	

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

CQL

Between 11 and 12 CQL apprentices were assessed on skills related to each of the six domains at pre and post. Table 40 presents an overall summary of mentor observation assessment findings for each of the 21st Century skills domains. Chart 1 displays these results graphically.

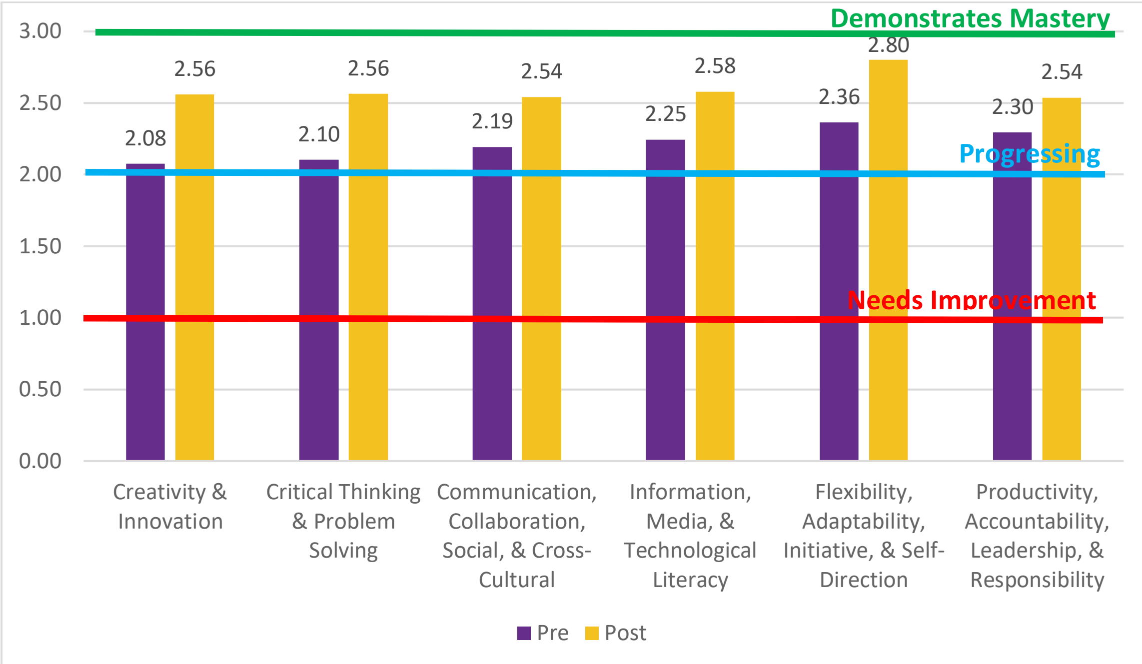
In all areas CQL students assessed showed positive growth (see Table 40). Apprentices demonstrated statistically significant ($p<.05$) growth in all domains except Information, Media, & Technology Literacy and Productivity, Accountability, Leadership, & Responsibility. Regardless of the domain, apprentices were observed to be slightly above the Progressing level at pre-observation (average 2.07 to 2.36), and by final observation CQL participants' skill ratings were closer to the Demonstrates Mastery level (average 2.53 to 2.80).

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	11	2.07(0.38)	2.56(0.42)	+0.48	4.04**
Critical Thinking & Problem Solving	12	2.10(0.51)	2.56(0.40)	+0.45	3.34**
Communication, Collaboration, Social, & Cross-Cultural	12	2.19(0.45)	2.54(0.43)	+0.34	2.43*
Information, Media, & Technological Literacy	12	2.24(0.49)	2.57(0.36)	+0.33	2.03
Flexibility, Adaptability, Initiative, & Self-Direction	11	2.36(0.44)	2.80(0.32)	+0.43	2.82*
Productivity, Accountability, Leadership, & Responsibility	11	2.29(0.40)	2.53(0.36)	+0.24	1.63

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

Table 41 displays pre-post-observation findings for each of the 24 specific skills associated with the six areas of 21st Century skills. All skills showed an increase from pre- to post-observations (100%), and 11 of the specific skills observed (46%) significantly increased from pre- to post-observation. While apprentices improved in all tested 21st Century skills over time, skills associated with creativity and problem solving saw the largest increases from pre- to post- observations.

Table 41. 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	11	2.00(0.63)	2.63(0.50)	+0.64	4.18**
Work creatively with others	10	2.20(0.42)	2.40(0.51)	+0.20	1.00
Implement innovations	9	2.11(0.33)	2.66(0.50)	+0.56	3.16*
Critical Thinking & Problem Solving					
Reason effectively	12	2.08(0.66)	2.58(0.51)	+0.50	2.57*
Use systems thinking	11	2.18(0.75)	2.63(0.50)	+0.45	2.19
Make judgments and decisions	11	1.90(0.53)	2.54(0.52)	+0.64	3.13**
Solve problems	11	2.27(0.46)	2.63(0.50)	+0.36	2.39*
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	12	2.08(0.66)	2.41(0.51)	+0.33	1.77
Communicate with others	10	2.30(0.48)	2.60(0.51)	+0.30	1.96
Interact effectively with others	11	2.27(0.46)	2.63(0.50)	+0.36	1.78
Information, Media, & Technological Literacy					
Access and evaluate information	11	2.36(0.50)	2.72(0.46)	+0.36	2.39*
Use and manage information	11	2.36(0.50)	2.63(0.50)	+0.27	1.40
Analyze media	9	2.22(0.83)	2.66(0.50)	+0.44	1.32
Create media products	8	2.12(0.64)	2.50(0.53)	+0.38	1.43
Apply technology effectively	11	2.27(0.64)	2.81(0.40)	+0.55	2.63*
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	10	2.40(0.51)	2.90(0.31)	+0.50	3.00*
Be flexible	10	2.50(0.52)	2.90(0.31)	+0.40	2.45*
Manage goals and time	10	2.30(0.48)	2.70(0.48)	+0.40	2.45*
Work independently	11	2.54(0.52)	2.81(0.40)	+0.27	1.40
Be a self-directed learner	11	2.18(0.60)	2.63(0.50)	+0.45	2.89*
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	7	2.14(0.69)	2.57(0.53)	+0.43	1.16
Produce results	10	2.30(0.48)	2.60(0.51)	+0.30	1.41
Guide and lead others	7	2.28(0.48)	2.57(0.53)	+0.29	1.55
Be responsible to others	10	2.40(0.51)	2.70(0.48)	+0.30	1.96

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

SEAP

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

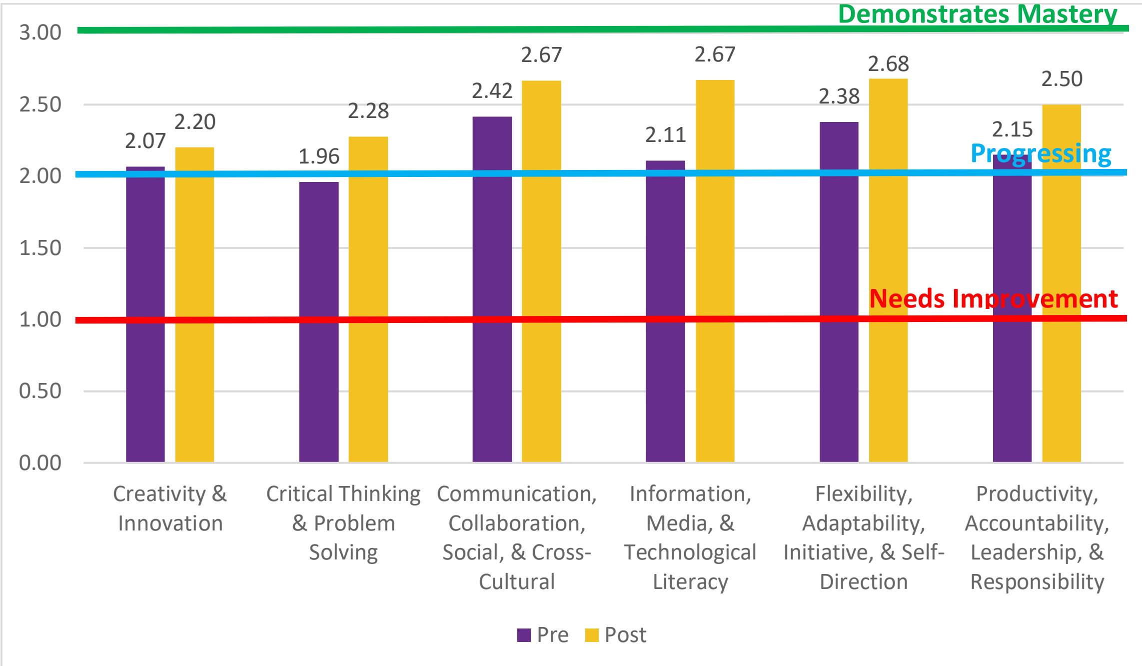
While apprentices demonstrated an increase in all 21st Century skills domains, only one (Information, Media, & Technological Literacy) had large enough average increases to be considered statistically significant growth (p<.05) (see Table 42). Chart 2 shows that, on average, mentors initially rated apprentices' skills at or slightly above the Progressing level. Final observations resulted in skill ratings at, on average, an approaching Demonstrates Mastery level (approximately 2.50) for four of the six skill sets. Critical Thinking & Problem Solving (2.27) along with Creativity & Innovation (2.20) skill sets were only slightly above Progressing levels at post-observation.

Table 42. 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	5	2.06(0.36)	2.20(0.18)	+0.13	0.78
Critical Thinking & Problem Solving	6	1.95(0.24)	2.27(0.47)	+0.31	1.21
Communication, Collaboration, Social, & Cross-Cultural	6	2.41(0.39)	2.66(0.42)	+0.25	1.24
Information, Media, & Technological Literacy	5	2.11(0.27)	2.67(0.35)	+0.56	2.99*
Flexibility, Adaptability, Initiative, & Self-Direction	5	2.38(0.30)	2.68(0.30)	+0.30	1.46
Productivity, Accountability, Leadership, & Responsibility	5	2.15(0.22)	2.50(0.39)	+0.35	2.06

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 43 displays findings for each of the 24 specific skills associated with the six areas of 21st Century skills. Among these items, three could not be tested for pre-post change (13%) due to insufficient data. All tested skills showed an increase from pre- to post-observations (100%), with the exception of "Think creatively" which showed a very slight decline over time and "Communicate clearly" which had no growth. None of the items tested demonstrated enough growth with the small sample size to be considered statistically significant change. While apprentices improved in nearly all tested 21st Century skills over time, skills associated with flexibility and productivity saw the largest increases from pre- to post-observations.

Table 43. 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	2.20(0.44)	2.00(0.00)	-0.20	1.00
Work creatively with others	5	2.00(0.00)	2.40(0.54)	+0.40	1.63
Implement innovations	5	2.00(0.70)	2.20(0.44)	+0.20	0.54
Critical Thinking & Problem Solving					
Reason effectively	6	2.00(0.00)	2.50(0.54)	+0.50	2.24
Use systems thinking	4	1.75(0.50)	2.25(0.50)	+0.50	1.00
Make judgments and decisions	5	1.80(0.44)	2.20(0.44)	+0.40	1.00
Solve problems	5	2.20(0.44)	2.40(0.54)	+0.20	1.00
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	6	2.50(0.54)	2.50(0.83)	0.00	0.00
Communicate with others	4	2.50(0.57)	3.00(0.00)	+0.50	1.73
Interact effectively with others	6	2.33(0.51)	2.83(0.40)	+0.50	2.24
Information, Media, & Technological Literacy					
Access and evaluate information	5	2.40(0.54)	2.80(0.44)	+0.40	1.63
Use and manage information	4	2.00(0.00)	2.50(0.57)	+0.50	1.73
Analyze media	2	-	-	-	-
Create media products	3	-	-	-	-
Apply technology effectively	4	2.00(0.00)	2.50(0.57)	+0.50	1.73
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	4	2.50(0.57)	2.75(0.50)	+0.25	1.00
Be flexible	5	2.20(0.44)	2.80(0.44)	+0.60	2.50
Manage goals and time	5	2.40(0.54)	2.80(0.44)	+0.40	1.63
Work independently	5	2.60(0.54)	2.80(0.44)	+0.20	1.00
Be a self-directed learner	5	2.20(0.44)	2.20(0.44)	+0.00	0.00
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	4	2.00(0.00)	2.50(0.57)	+0.50	1.73
Produce results	5	2.00(0.00)	2.60(0.54)	+0.60	2.45
Guide and lead others	3	-	-	-	-
Be responsible to others	5	2.40(0.54)	2.80(0.44)	+0.40	1.63

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 65 and 106 apprentices were assessed for skills related to each of the 21st Century skills domains at pre and post observation. Table 44 presents an overall summary of mentors' assessment findings for each of the domains, and Chart 3 provides a graphical depiction of the observation outcomes.

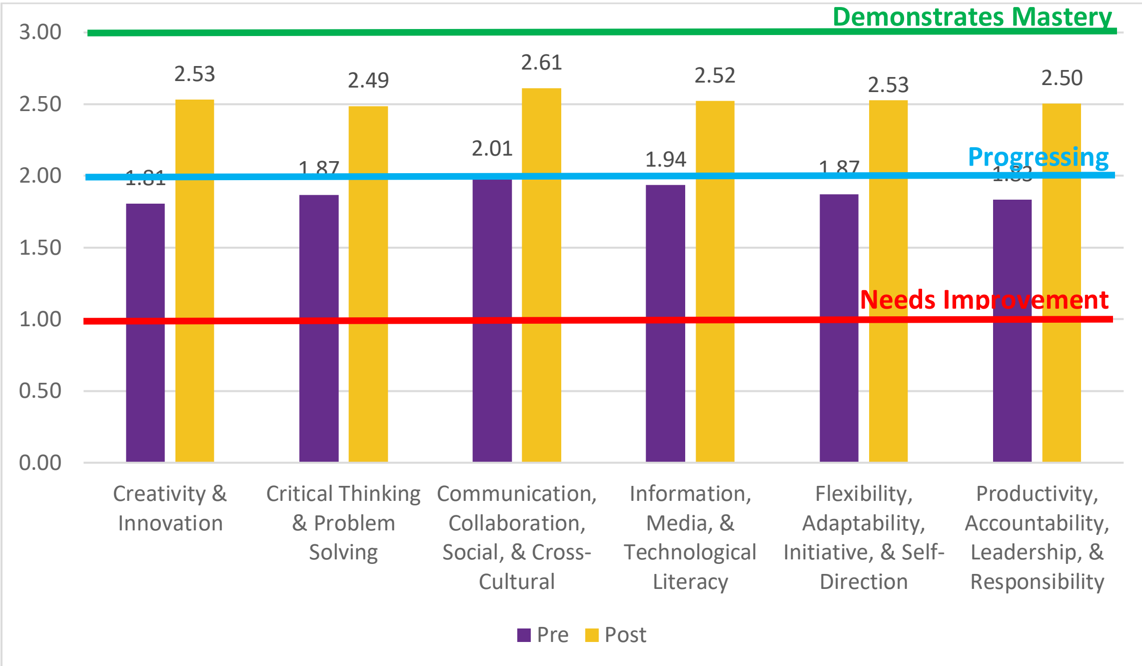
Statistically significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their REAP experiences (p<.001) were found in all six skill sets of 21st Century skills (see Table 43). Apprentices demonstrated the most growth in the Creativity & Innovation skill set. Chart 2 shows that, on average, mentors initially rated apprentices' skills at slightly below or at the Progressing level. Final observations resulted in skill ratings at, on average, above Progressing and moving towards Approaching Mastery (2.50).

Table 44. 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	99	1.80(0.51)	2.53(0.47)	+0.72	15.27***
Critical Thinking & Problem Solving	106	1.86(0.41)	2.48(0.45)	+0.61	14.96***
Communication, Collaboration, Social, & Cross-Cultural	100	2.01(0.51)	2.61(0.44)	+0.60	10.98***
Information, Media, & Technological Literacy	65	1.93(0.53)	2.52(0.49)	+0.58	9.69***
Flexibility, Adaptability, Initiative, & Self-Direction	105	1.87(0.45)	2.52(0.48)	+0.65	14.24***
Productivity, Accountability, Leadership, & Responsibility	105	1.83(0.50)	2.50(0.44)	+0.66	15.18***

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 45 displays findings for each of the 24 specific skills associated with the six areas of 21st Century skills. All skills showed a statistically significant increase ($p<.001$) from pre- to post-observations (100%). While apprentices significantly improved in all tested 21st Century skills over time, skills associated with creating media, creativity, and independence saw the largest increases from pre- to post- observations.

Table 45. 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	102	1.75(0.58)	2.49(0.55)	+0.74	13.66***
Work creatively with others	103	1.87(0.57)	2.58(0.55)	+0.71	11.59***
Implement innovations	103	1.78(0.55)	2.47(0.57)	+0.69	12.12***
Critical Thinking & Problem Solving					
Reason effectively	105	1.91(0.52)	2.59(0.53)	+0.68	12.69***
Use systems thinking	65	1.86(0.60)	2.46(0.56)	+0.60	8.33***
Make judgments and decisions	103	1.80(0.50)	2.50(0.54)	+0.70	12.00***
Solve problems	104	1.89(0.51)	2.43(0.57)	+0.54	9.31***
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	105	1.83(0.63)	2.53(0.57)	+0.70	10.46***
Communicate with others	102	2.09(0.60)	2.62(0.52)	+0.53	7.64***
Interact effectively with others	105	2.10(0.55)	2.64(0.49)	+0.54	9.45***
Information, Media, & Technological Literacy					
Access and evaluate information	63	1.88(0.72)	2.46(0.64)	+0.57	6.82***
Use and manage information	60	1.95(0.62)	2.46(0.62)	+0.52	5.52***
Analyze media	43	1.95(0.68)	2.53(0.50)	+0.58	5.75***
Create media products	42	1.88(0.70)	2.66(0.52)	+0.79	7.89***
Apply technology effectively	57	2.10(0.55)	2.66(0.51)	+0.56	7.92***
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	102	1.98(0.54)	2.60(0.59)	+0.63	9.85***
Be flexible	101	2.04(0.51)	2.65(0.51)	+0.60	9.58***
Manage goals and time	98	1.88(0.55)	2.53(0.55)	+0.64	9.61***
Work independently	102	1.83(0.59)	2.43(0.57)	+0.60	9.54***
Be a self-directed learner	102	1.61(0.66)	2.43(0.58)	+0.81	13.15***
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	95	1.78(0.63)	2.46(0.56)	+0.68	10.78***
Produce results	100	1.77(0.63)	2.44(0.55)	+0.67	11.41***
Guide and lead others	93	1.69(0.56)	2.40(0.55)	+0.71	12.56***
Be responsible to others	103	2.02(0.49)	2.71(0.45)	+0.69	11.77***

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

HSAP

Between 13 and 16 HSAP apprentices were assessed for skills related to each of the 21st Century skills domains at pre- and post-observation. Table 46 presents apprentice observation average scores over time and Chart 4 displays these graphically.

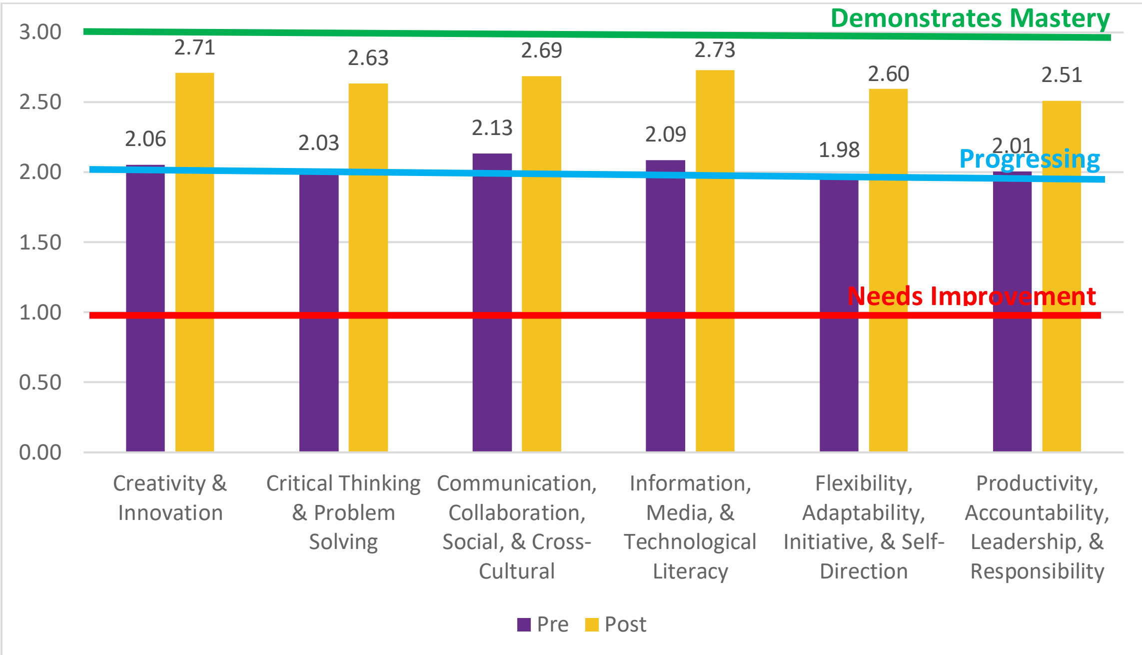
There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their HSAP experiences (p<.01-.001) for all areas of 21st Century skills (see Table 45). Chart 4 shows that mentors initially rated apprentices' skills at or slightly above the Progressing level at pre-observation. Final observation skills ratings, on average, were approaching the Demonstrates Mastery level.

Table 46. 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	15	2.05(0.37)	2.71(0.39)	+0.65	5.46***
Critical Thinking & Problem Solving	15	2.02(0.34)	2.63(0.37)	+0.60	5.89***
Communication, Collaboration, Social, & Cross-Cultural	15	2.13(0.51)	2.68(0.36)	+0.55	5.22***
Information, Media, & Technological Literacy	15	2.09(0.63)	2.73(0.63)	+0.64	5.76***
Flexibility, Adaptability, Initiative, & Self-Direction	15	1.97(0.46)	2.59(0.45)	+0.61	5.28***
Productivity, Accountability, Leadership, & Responsibility	13	2.00(0.39)	2.51(0.52)	+0.50	3.50**

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 47 displays findings for each of the 24 specific skills associated with the 21st Century skills. All of the individual skills showed an increase from pre- to post-observations, and all but one of the increases were statistically significant (96%). While apprentices improved in all 21st Century skills over time, skills associated with media and information management saw the largest increases from pre- to post-observations.

Table 47. 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	15	2.00(0.53)	2.66(0.48)	+0.67	4.18***
Work creatively with others	13	2.15(0.55)	2.69(0.48)	+0.54	3.74**
Implement innovations	12	2.08(0.28)	2.83(0.38)	+0.75	5.75***
Critical Thinking & Problem Solving					
Reason effectively	15	2.06(0.25)	2.66(0.48)	+0.60	4.58***
Use systems thinking	13	2.15(0.37)	2.69(0.48)	+0.54	3.74**
Make judgments and decisions	14	1.92(0.73)	2.71(0.46)	+0.79	4.20***
Solve problems	14	2.00(0.39)	2.50(0.51)	+0.50	2.88*
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	15	2.00(0.53)	2.73(0.45)	+0.73	4.04***
Communicate with others	15	2.20(0.67)	2.53(0.63)	+0.33	2.65*
Interact effectively with others	15	2.20(0.67)	2.80(0.41)	+0.60	4.58***
Information, Media, & Technological Literacy					
Access and evaluate information	14	2.14(0.53)	2.71(0.46)	+0.57	4.16***
Use and manage information	13	2.00(0.70)	2.84(0.37)	+0.85	4.43***
Analyze media	10	1.90(0.56)	2.70(0.48)	+0.80	4.00**
Create media products	6	1.83(0.40)	2.66(0.51)	+0.83	2.71*
Apply technology effectively	13	2.15(0.68)	2.76(0.43)	+0.62	2.89*
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	11	2.00(0.63)	2.72(0.46)	+0.73	5.16***
Be flexible	11	2.18(0.60)	2.63(0.50)	+0.45	2.89*
Manage goals and time	11	2.09(0.53)	2.81(0.40)	+0.73	3.73**
Work independently	13	1.92(0.49)	2.38(0.65)	+0.46	3.21**
Be a self-directed learner	14	1.85(0.53)	2.50(0.65)	+0.64	3.80**
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	9	2.00(0.70)	2.55(0.72)	+0.56	2.29*
Produce results	10	1.80(0.63)	2.50(0.70)	+0.70	2.69*
Guide and lead others	8	2.00(0.00)	2.25(0.46)	+0.25	1.53
Be responsible to others	13	2.07(0.49)	2.61(0.65)	+0.54	2.94*

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

URAP

Between 21 and 22 apprentices were assessed for skills related to the 21st Century skills domains at pre and post observation. Table 48 presents pre-post observation findings for each of the six domains, and Chart 5 displays these results graphically.

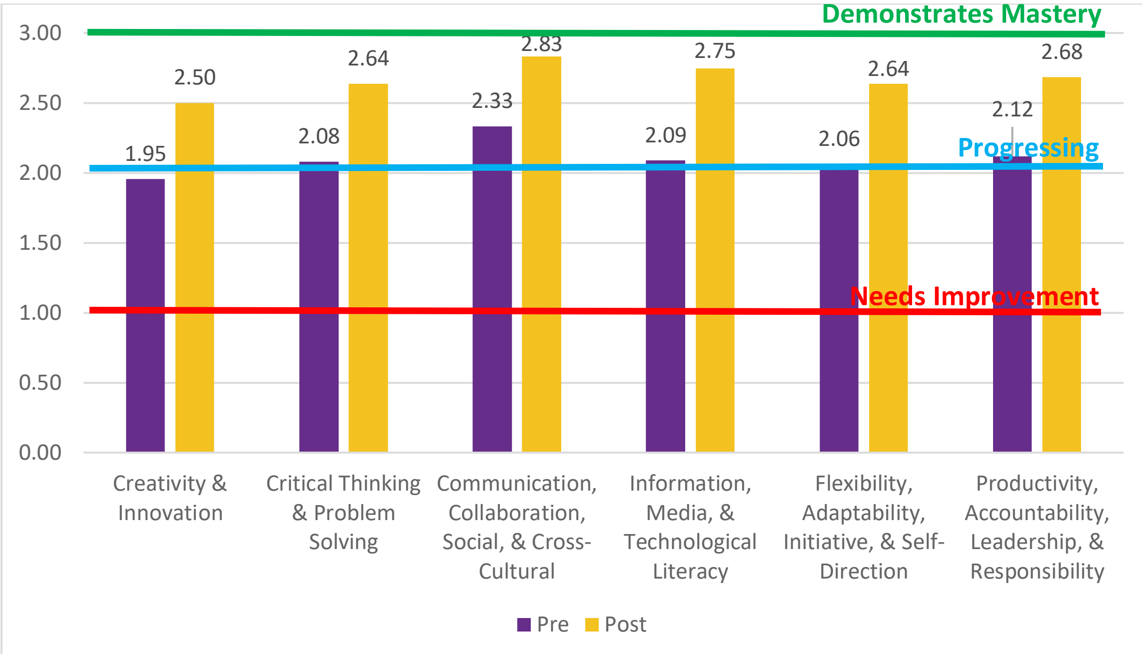
Significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their URAP experiences ($p<.001$) were found for all six skill sets of 21st Century skills (see Table 48). Chart 5 shows that mentors initially rated apprentices' skills at or slightly above the Progressing level. At final observations, skill ratings were on average approaching the Demonstrates Mastery level.

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

Skill Set	*n*	Assessment Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	22	1.95(0.48)	2.50(0.41)	+0.54	5.12***
Critical Thinking & Problem Solving	22	2.07(0.52)	2.63(0.36)	+0.55	4.83***
Communication, Collaboration, Social, & Cross-Cultural	22	2.33(0.55)	2.83(0.26)	+0.50	4.51***
Information, Media, & Technological Literacy	21	2.08(0.41)	2.74(0.40)	+0.66	5.62***
Flexibility, Adaptability, Initiative, & Self-Direction	22	2.06(0.38)	2.63(0.45)	+0.57	5.51***
Productivity, Accountability, Leadership, & Responsibility	21	2.11(0.39)	2.68(0.33)	+0.56	6.81***

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 49 displays findings for each of the 24 specific skills associated with the six areas of 21st Century skills. All skills showed an increase from pre- to post-observations (100%), and 23 of the specific skills observed (96%) significantly increased from pre- to post-observation. While apprentices improved in all tested 21st Century skills over time, skills associated with accessing information and applying technological skills saw the largest increases from pre- to post- observations.

Table 49. 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	20	1.90(0.55)	2.40(0.50)	+0.50	3.68**
Work creatively with others	21	2.14(0.65)	2.66(0.48)	+0.52	3.99***
Implement innovations	18	1.94(0.53)	2.50(0.51)	+0.56	3.83***
Critical Thinking & Problem Solving					
Reason effectively	19	2.26(0.56)	2.63(0.49)	+0.37	2.35*
Use systems thinking	19	2.00(0.57)	2.47(0.51)	+0.47	4.03***
Make judgments and decisions	17	2.17(0.52)	2.58(0.50)	+0.41	2.38*
Solve problems	19	2.10(0.56)	2.73(0.45)	+0.63	4.03***
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	20	2.15(0.58)	2.70(0.47)	+0.55	3.58**
Communicate with others	22	2.36(0.65)	2.86(0.35)	+0.50	3.17**
Interact effectively with others	22	2.45(0.67)	2.90(0.29)	+0.45	3.18**
Information, Media, & Technological Literacy					
Access and evaluate information	19	2.05(0.62)	2.78(0.41)	+0.74	4.38***
Use and manage information	19	2.10(0.65)	2.68(0.47)	+0.58	3.28**
Analyze media	11	2.09(0.30)	2.72(0.64)	+0.64	3.13**
Create media products	9	2.11(0.33)	2.55(0.72)	+0.44	1.84
Apply technology effectively	18	2.05(0.53)	2.77(0.42)	+0.72	4.58***
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	22	2.13(0.46)	2.68(0.47)	+0.55	3.81***
Be flexible	19	2.21(0.63)	2.73(0.45)	+0.53	3.29**
Manage goals and time	20	2.20(0.61)	2.80(0.41)	+0.60	3.94***
Work independently	21	1.9(0.70)	2.61(0.58)	+0.71	5.84***
Be a self-directed learner	21	1.85(0.35)	2.52(0.51)	+0.67	6.33***
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	16	2.00(0.73)	2.68(0.47)	+0.69	3.91***
Produce results	18	2.22(0.54)	2.77(0.54)	+0.56	4.61***
Guide and lead others	12	1.91(0.28)	2.50(0.52)	+0.58	3.92**
Be responsible to others	19	2.26(0.45)	2.73(0.45)	+0.47	4.03***

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

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). Statistically significant differences in STEM Engagement were not found by program level or setting.

STEM Practices – Army Laboratory-Based Programs

CQL

CQL apprentices reported being actively engaged in STEM practices during their program experiences (Table 50). More than half of apprentices (58%-98%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (26%) and building/making a computer model (45%). STEM practices CQL apprentices reported being most frequently (weekly or every day) engaged with during the program were interacting with STEM researchers (98%) and working with a STEM researcher or company on a real-world STEM research project (96%).

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[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 0.802.

Table 50. Apprentice Engagement in STEM Practices in CQL (n=47)

	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	2.1%	2.1%	0.0%	6.4%	89.4%	
	1	1	0	3	42	**47**
Work with a STEM researcher on a research project of your own choosing	25.5%	8.5%	6.4%	19.1%	40.4%	
	12	4	3	9	19	**47**
Design my own research or investigation based on my own question(s)	23.4%	19.1%	8.5%	19.1%	29.8%	
	11	9	4	9	14	**47**
Present my STEM research to a panel of judges from industry or the military	19.1%	55.3%	14.9%	2.1%	8.5%	
	9	26	7	1	4	**47**
Interact with STEM researchers	0.0%	2.1%	0.0%	10.6%	87.2%	
	0	1	0	5	41	**47**
Use laboratory procedures and tools	19.1%	4.3%	2.1%	14.9%	59.6%	
	9	2	1	7	28	**47**
Identify questions or problems to investigate	0.0%	10.6%	8.5%	14.9%	66.0%	
	0	5	4	7	31	**47**
Design and carry out an investigation	6.4%	19.1%	6.4%	23.4%	44.7%	
	3	9	3	11	21	**47**
Analyze data or information and draw conclusions	2.1%	2.1%	10.6%	29.8%	55.3%	
	1	1	5	14	26	**47**
Work collaboratively as part of a team	4.3%	10.6%	2.1%	14.9%	68.1%	
	2	5	1	7	32	**47**
Build or make a computer model	46.8%	8.5%	0.0%	17.0%	27.7%	
	22	4	0	8	13	**47**
Solve real world problems	0.0%	8.5%	2.1%	19.1%	70.2%	
	0	4	1	9	33	**47**

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, race/ethnicity, or English as a first language. There was, however, a significant difference in STEM Engagement by first generation college classification, with apprentices who did not have a parent who completed college reporting significantly greater engagement on average compared to apprentices with college-going parents (effect size is medium with d = 0.647).[5]

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 51). These responses were also combined into a composite variable[6] 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 = 2.22).[7] These data indicate that CQL provides apprentices with more intensive engagement in STEM than they typically experience in school.

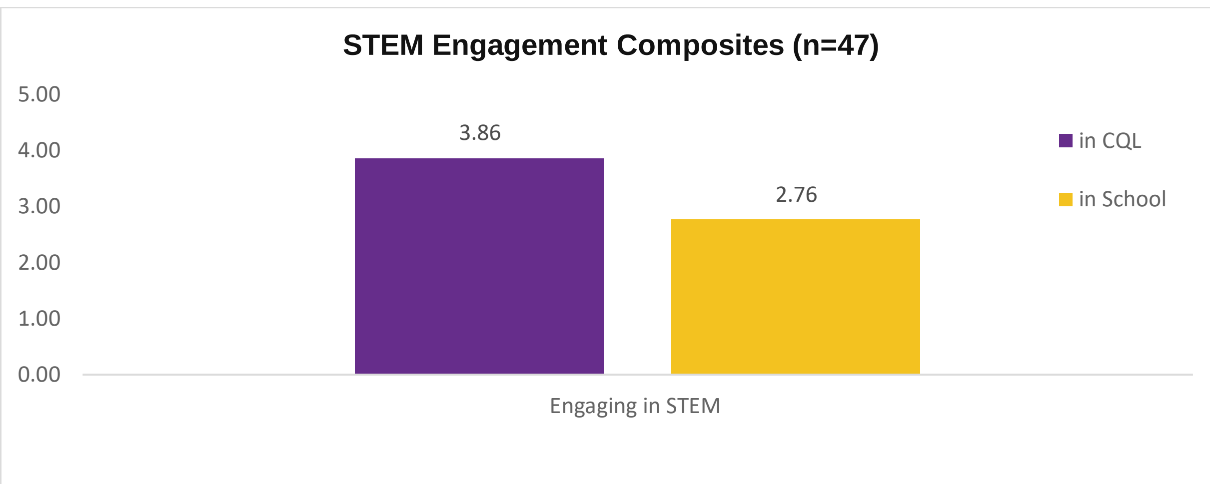
Table 51. Apprentice Engagement in STEM Practices in School (n=47)

	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	46.8%	12.8%	6.4%	14.9%	19.1%	
	22	6	3	7	9	**47**
Work with a STEM researcher on a research project of your own choosing	55.3%	17.0%	4.3%	6.4%	17.0%	
	26	8	2	3	8	**47**
Design my own research or investigation based on my own question(s)	42.6%	27.7%	10.6%	10.6%	8.5%	
	20	13	5	5	4	**47**
Present my STEM research to a panel of judges from industry or the military	68.1%	27.7%	0.0%	2.1%	2.1%	
	32	13	0	1	1	**47**
Interact with STEM researchers	17.0%	21.3%	8.5%	23.4%	29.8%	
	8	10	4	11	14	**47**
Use laboratory procedures and tools	27.7%	6.4%	10.6%	29.8%	25.5%	
	13	3	5	14	12	**47**

[5] Independent Samples t-test for CQL STEM Engagement by college first generation status: t(41)=2.07, p=.044.
[6] Cronbach's alpha reliability for these 12 items was 0.904.
[7] Dependent Samples t-test for STEM Engagement: t(46)=7.52, p=.000.

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Identify questions or problems to investigate	8.5%	27.7%	12.8%	29.8%	21.3%	
	4	13	6	14	10	**47**
Design and carry out an investigation	12.8%	31.9%	19.1%	25.5%	10.6%	
	6	15	9	12	5	**47**
Analyze data or information and draw conclusions	6.4%	14.9%	23.4%	31.9%	23.4%	
	3	7	11	15	11	**47**
Work collaboratively as part of a team	4.3%	10.6%	14.9%	42.6%	27.7%	
	2	5	7	20	13	**47**
Build or make a computer model	46.8%	25.5%	10.6%	14.9%	2.1%	
	22	12	5	7	1	**47**
Solve real world problems	10.6%	34.0%	17.0%	14.9%	23.4%	
	5	16	8	7	11	**47**

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 in STEM. Participants indicated that their STEM work in CQL was substantially different than that in their college experiences. Apprentices cited the access to high-tech equipment and cutting edge research, the one-to-one mentoring they received, and the availability of their mentors as ways that their CQL experiences differed from their school experiences. Apprentices said, for example,

> *"College lab work is very different from actually working in a lab like five to seven hours a day or eight hours a day. I think the general knowledge that I've gained has been great."* (CQL Apprentice)

> *"It's a lot different when working with professors, especially since a lot of the times I wanted to spend time in the lab, but my professor would be teaching a class, so I'd be working by myself. Here, it's obvious the people are working in a lab; that's their job. They don't have to worry about preparing for class or preparing for other lectures."* (CQL Apprentice)

SEAP

SEAP apprentices were asked how often they engaged in various STEM practices during their program (Table 52). More than half of SEAP apprentices (55%-100%) reported participating in all activities at least monthly. STEM practices SEAP apprentices reported being engaged in most frequently (weekly or every day) during their program were using laboratory procedures and tools (91%) and solving real world problems (91%).

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 or there were not enough data to compare groups.

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 53). 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 = 2.57).[8] These data indicate that SEAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

[8] Dependent Samples t-test for STEM Engagement: t(10)=4.07, p=.002.

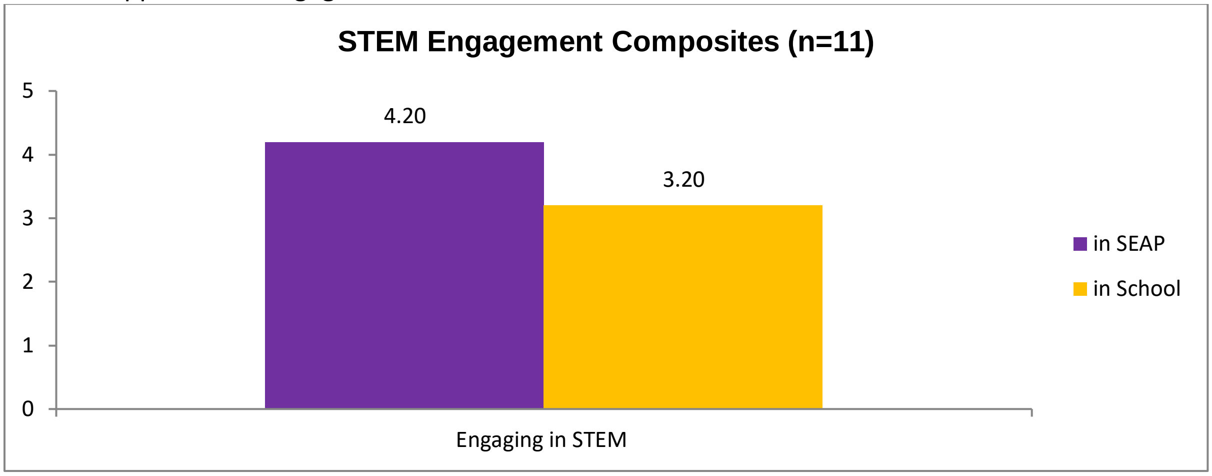
Table 52. Apprentice Engagement in STEM Practices in SEAP (n=11)

	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%	18.2%	9.1%	0.0%	72.7%	
	0	2	1	0	8	**11**
Work with a STEM researcher on a research project of your own choosing	0.0%	18.2%	9.1%	0.0%	72.7%	
	0	2	1	0	8	**11**
Design my own research or investigation based on my own question(s)	0.0%	18.2%	0.0%	18.2%	63.6%	
	0	2	0	2	7	**11**
Present my STEM research to a panel of judges from industry or the military	9.1%	36.4%	18.2%	9.1%	27.3%	
	1	4	2	1	3	**11**
Interact with STEM researchers	0.0%	18.2%	0.0%	0.0%	81.8%	
	0	2	0	0	9	**11**
Use laboratory procedures and tools	0.0%	9.1%	0.0%	18.2%	72.7%	
	0	1	0	2	8	**11**
Identify questions or problems to investigate	0.0%	9.1%	9.1%	9.1%	72.7%	
	0	1	1	1	8	**11**
Design and carry out an investigation	0.0%	18.2%	9.1%	18.2%	54.5%	
	0	2	1	2	6	**11**
Analyze data or information and draw conclusions	0.0%	0.0%	18.2%	9.1%	72.7%	
	0	0	2	1	8	**11**
Work collaboratively as part of a team	0.0%	0.0%	18.2%	0.0%	81.8%	
	0	0	2	0	9	**11**
Build or make a computer model	27.3%	9.1%	18.2%	9.1%	36.4%	
	3	1	2	1	4	**11**
Solve real world problems	0.0%	0.0%	9.1%	18.2%	72.7%	
	0	0	1	2	8	**11**

Table 53. Apprentice Engagement in STEM Practices in School (n=11)

	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	45.5%	27.3%	0.0%	0.0%	27.3%	
	5	3	0	0	3	11
Work with a STEM researcher on a research project of your own choosing	54.5%	18.2%	0.0%	9.1%	18.2%	
	6	2	0	1	2	11
Design my own research or investigation based on my own question(s)	45.5%	27.3%	0.0%	9.1%	18.2%	
	5	3	0	1	2	11
Present my STEM research to a panel of judges from industry or the military	36.4%	27.3%	9.1%	0.0%	27.3%	
	4	3	1	0	3	11
Interact with STEM researchers	18.2%	36.4%	9.1%	0.0%	36.4%	
	2	4	1	0	4	11
Use laboratory procedures and tools	0.0%	18.2%	27.3%	27.3%	27.3%	
	0	2	3	3	3	11
Identify questions or problems to investigate	9.1%	0.0%	27.3%	27.3%	36.4%	
	1	0	3	3	4	11
Design and carry out an investigation	9.1%	0.0%	27.3%	36.4%	27.3%	
	1	0	3	4	3	11
Analyze data or information and draw conclusions	0.0%	0.0%	27.3%	45.5%	27.3%	
	0	0	3	5	3	11
Work collaboratively as part of a team	0.0%	0.0%	18.2%	18.2%	63.6%	
	0	0	2	2	7	11
Build or make a computer model	27.3%	27.3%	18.2%	9.1%	18.2%	
	3	3	2	1	2	11
Solve real world problems	9.1%	9.1%	18.2%	27.3%	36.4%	
	1	1	2	3	4	11

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



SEAP apprentices participating in focus groups commented that their learning in SEAP was substantially different than in school. Apprentices noted that SEAP offers more open-ended problem solving opportunities and that their learning had more real-world applicability than their school STEM experiences. Apprentices also noted that the pace of learning was slower in SEAP than in school, that learning from failure is encouraged in SEAP to a greater extent than in school, and that there was more accountability for their work in SEAP as compared to in school. Apprentices said, for example,

> *"[In] school it's like everybody's doing a similar thing, you're all trying to get the same answer, here you're given an individual project and you're trying to find the answer because no one else has found it yet."* (SEAP Apprentice)

> *"In school, we do a lot of busy work. Here, everything I do actually needs to be done."* (SEAP Apprentice)

> *"In school, everything's structured. You do the work. You get the grade. You know the outcome. Here it's like, 'Oh, I have to learn this on the fly,' or 'I didn't know I needed this application.' You have to brainstorm solutions."* (SEAP Apprentice)

> *"In school, it's all about trying to get it the most right you can because you want the grade for it. Here, it's just as important to get things wrong as it is to get things right."* (SEAP Apprentice)

STEM Practices – University-Based Programs

REAP

REAP apprentices were asked how often they engaged in various STEM practices during their program (Table 54). More than half of REAP apprentices (61%-90%) reported participating at least monthly in all activities except for the following: presenting their STEM research to a panel of judges (23%), designing research investigations based on their own questions (45%), and building/making a computer model (45%). Nearly all REAP apprentices reported regularly (weekly or every day) working collaboratively as part of a team (90%).

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 55). 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 = 2.11).[9] These data indicate that REAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

[9] Dependent Samples t-test for STEM Engagement: t(30)=5.80, p=.000.

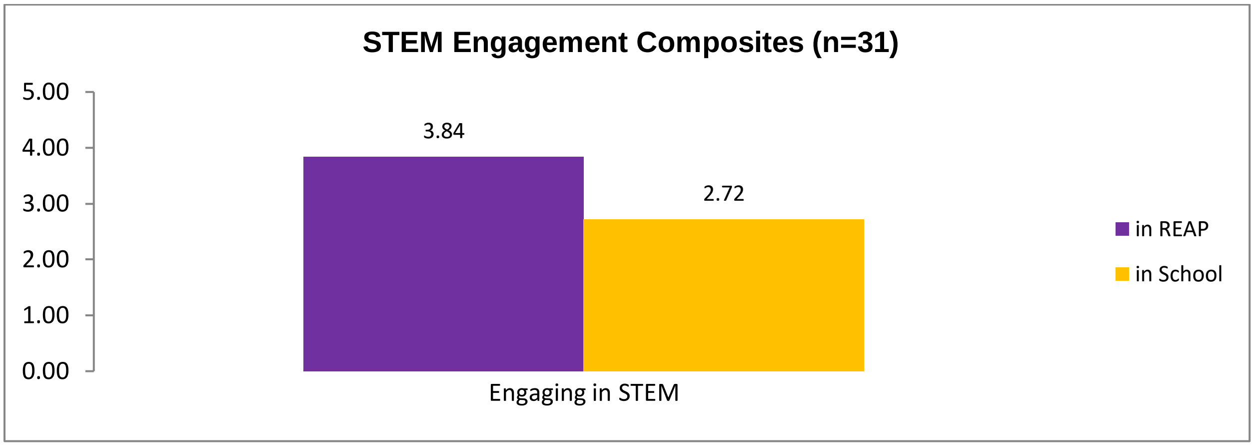
Table 54. Apprentice Engagement in STEM Practices in REAP (n=31)

	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	12.9%	6.5%	0.0%	3.2%	77.4%	
	4	2	0	1	24	**31**
Work with a STEM researcher on a research project of your own choosing	25.8%	12.9%	0.0%	9.7%	51.6%	
	8	4	0	3	16	**31**
Design my own research or investigation based on my own question(s)	25.8%	29.0%	0.0%	16.1%	29.0%	
	8	9	0	5	9	**31**
Present my STEM research to a panel of judges from industry or the military	48.4%	29.0%	3.2%	3.2%	16.1%	
	15	9	1	1	5	**31**
Interact with STEM researchers	12.9%	9.7%	0.0%	3.2%	74.2%	
	4	3	0	1	23	**31**
Use laboratory procedures and tools	3.2%	6.5%	3.2%	9.7%	77.4%	
	1	2	1	3	24	**31**
Identify questions or problems to investigate	3.2%	6.5%	3.2%	22.6%	64.5%	
	1	2	1	7	20	**31**
Design and carry out an investigation	3.2%	9.7%	3.2%	19.4%	64.5%	
	1	3	1	6	20	**31**
Analyze data or information and draw conclusions	3.2%	6.5%	3.2%	16.1%	71.0%	
	1	2	1	5	22	**31**
Work collaboratively as part of a team	3.2%	6.5%	0.0%	12.9%	77.4%	
	1	2	0	4	24	**31**
Build or make a computer model	32.3%	22.6%	3.2%	22.6%	19.4%	
	10	7	1	7	6	**31**
Solve real world problems	6.5%	9.7%	3.2%	19.4%	61.3%	
	2	3	1	6	19	**31**

Table 55. Apprentice Engagement in STEM Practices in School (n=31)

	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	58.1%	9.7%	0.0%	9.7%	22.6%	
	18	3	0	3	7	**31**
Work with a STEM researcher on a research project of your own choosing	61.3%	16.1%	0.0%	12.9%	9.7%	
	19	5	0	4	3	**31**
Design my own research or investigation based on my own question(s)	45.2%	35.5%	3.2%	6.5%	9.7%	
	14	11	1	2	3	**31**
Present my STEM research to a panel of judges from industry or the military	80.6%	9.7%	6.5%	3.2%	0.0%	
	25	3	2	1	0	**31**
Interact with STEM researchers	41.9%	19.4%	9.7%	3.2%	25.8%	
	13	6	3	1	8	**31**
Use laboratory procedures and tools	9.7%	9.7%	29.0%	22.6%	29.0%	
	3	3	9	7	9	**31**
Identify questions or problems to investigate	3.2%	29.0%	19.4%	16.1%	32.3%	
	1	9	6	5	10	**31**
Design and carry out an investigation	16.1%	32.3%	9.7%	29.0%	12.9%	
	5	10	3	9	4	**31**
Analyze data or information and draw conclusions	3.2%	19.4%	12.9%	38.7%	25.8%	
	1	6	4	12	8	**31**
Work collaboratively as part of a team	6.5%	6.5%	6.5%	32.3%	48.4%	
	2	2	2	10	15	**31**
Build or make a computer model	61.3%	9.7%	9.7%	12.9%	6.5%	
	19	3	3	4	2	**31**
Solve real world problems	25.8%	25.8%	6.5%	9.7%	32.3%	
	8	8	2	3	10	**31**

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



REAP apprentices participating in phone interviews were asked to reflect on how their REAP experiences compared with their typical school STEM experiences. Apprentices noted that REAP provided more STEM learning, more hands-on and more interesting experiences, more access to equipment and materials, and a unique exposure to a professional STEM research atmosphere that is not available to them in school. Apprentices said, for example,

> *"I've learned a lot [in REAP]. I probably would never [have] learned anything like [it in] the classroom."* (REAP Apprentice)

> *"[REAP mentors' showed me a lot of stuff that [I learned about] before, but they taught me how to learn it, but with materials. I couldn't do that in my school, since we don't have that money to use this stuff."* (REAP Apprentice)

HSAP

HSAP apprentices were asked how often they engaged in various STEM practices during their apprenticeships (Table 56). Half or more of HSAP apprentices (67%-94%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (11%). STEM practices HSAP apprentices reported being most frequently (weekly or every day) engaged in during their program were interacting with STEM researchers (94%), working with a STEM researcher or company on a real-world STEM research project (89%), and analyzing data or information and drawing conclusions (89%).

Table 56. Apprentice Engagement in STEM Practices in HSAP (n=18)

	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%	11.1%	0.0%	0.0%	88.9%	
	0	2	0	0	16	**18**
Work with a STEM researcher on a research project of your own choosing	27.8%	5.6%	5.6%	0.0%	61.1%	
	5	1	1	0	11	**18**
Design my own research or investigation based on my own question(s)	27.8%	5.6%	5.6%	5.6%	55.6%	
	5	1	1	1	10	**18**
Present my STEM research to a panel of judges from industry or the military	44.4%	44.4%	0.0%	11.1%	0.0%	
	8	8	0	2	0	**18**
Interact with STEM researchers	0.0%	5.6%	0.0%	0.0%	94.4%	
	0	1	0	0	17	**18**
Use laboratory procedures and tools	11.1%	5.6%	0.0%	5.6%	77.8%	
	2	1	0	1	14	**18**
Identify questions or problems to investigate	11.1%	11.1%	5.6%	16.7%	55.6%	
	2	2	1	3	10	**18**
Design and carry out an investigation	5.6%	16.7%	0.0%	11.1%	66.7%	
	1	3	0	2	12	**18**
Analyze data or information and draw conclusions	5.6%	5.6%	0.0%	16.7%	72.2%	
	1	1	0	3	13	**18**
Work collaboratively as part of a team	0.0%	16.7%	5.6%	16.7%	61.1%	
	0	3	1	3	11	**18**
Build or make a computer model	27.8%	22.2%	16.7%	5.6%	27.8%	
	5	4	3	1	5	**18**
Solve real world problems	0.0%	22.2%	5.6%	22.2%	50.0%	
	0	4	1	4	9	**18**

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, or there were not enough data to determine group differences.

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 57). 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 = 3.02).[10] These data indicate that HSAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

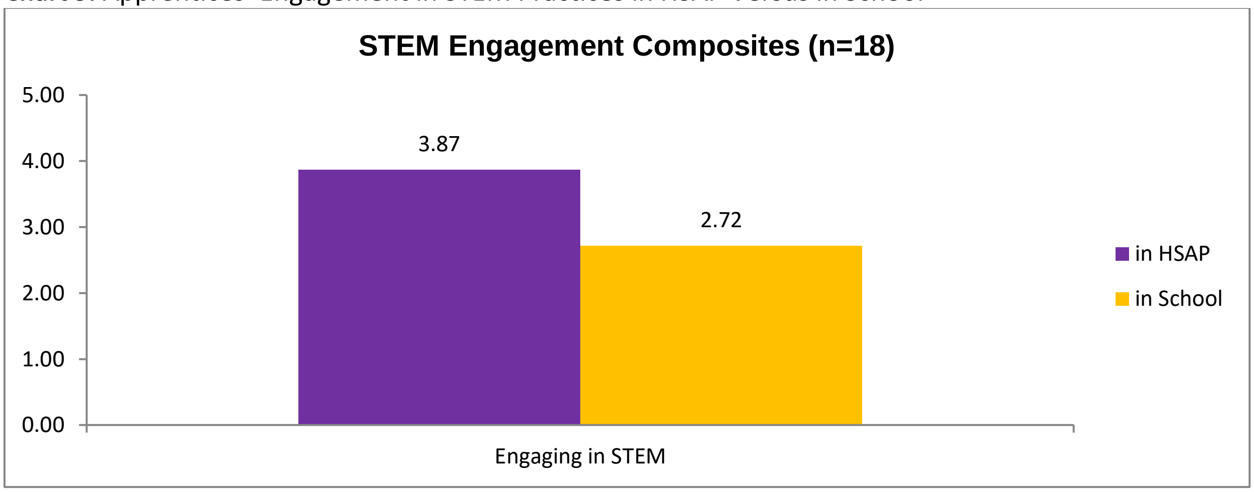
Table 57. Apprentice Engagement in STEM Practices in School (n=18)

	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	72.2%	5.6%	0.0%	11.1%	11.1%	
	13	1	0	2	2	**18**
Work with a STEM researcher on a research project of your own choosing	61.1%	5.6%	11.1%	11.1%	11.1%	
	11	1	2	2	2	**18**
Design my own research or investigation based on my own question(s)	44.4%	22.2%	11.1%	5.6%	16.7%	
	8	4	2	1	3	**18**
Present my STEM research to a panel of judges from industry or the military	83.3%	5.6%	11.1%	0.0%	0.0%	
	15	1	2	0	0	**18**
Interact with STEM researchers	55.6%	11.1%	5.6%	5.6%	22.2%	
	10	2	1	1	4	**18**
Use laboratory procedures and tools	11.1%	5.6%	22.2%	44.4%	16.7%	
	2	1	4	8	3	**18**
Identify questions or problems to investigate	0.0%	16.7%	11.1%	33.3%	38.9%	
	0	3	2	6	7	**18**
Design and carry out an investigation	16.7%	22.2%	16.7%	22.2%	22.2%	

[10] Dependent Samples t-test for STEM Engagement: t(17)=6.22, p=.000.

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
	3	4	3	4	4	**18**
Analyze data or information and draw conclusions	11.1%	11.1%	16.7%	44.4%	16.7%	
	2	2	3	8	3	**18**
Work collaboratively as part of a team	0.0%	11.1%	11.1%	44.4%	33.3%	
	0	2	2	8	6	**18**
Build or make a computer model	50.0%	22.2%	5.6%	16.7%	5.6%	
	9	4	1	3	1	**18**
Solve real world problems	5.6%	38.9%	22.2%	27.8%	5.6%	
	1	7	4	5	1	**18**

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



Apprentices participating in interviews indicated that their HSAP experiences differed in several significant ways from their typical in-school STEM experiences. Apprentices indicated that they had more hands-on learning opportunities, more opportunities to apply their learning to real-world situations, deeper learning, more opportunities to work independently, and a greater sense of accomplishment in HSAP as compared to in school. Apprentices said, for example:

> *"[In HSAP] It's less of a classroom learning and more hands on coding which I really enjoy…I have access to more resources I think here than in my classroom setting because I have the postdocs and the graduates, they can all answer my questions as well."* (HSAP Apprentice)

"It was very interesting to use my knowledge that I've learned in school in a practical application, where it's not just taking tests or getting grades. It's actually completing my own project, creating my own ideas, and following what I'm interested in, rather than just take what is on the assignment sheet...I can generate my own ideas and… investigate what I'm interested in." (HSAP Apprentice)

"This is definitely different. It's more in depth [in HSAP compared to] to what I'm used when I'm in school." (HSAP Apprentice)

URAP

URAP apprentices were asked how often they engaged in various STEM practices during their program (Table 58). More than half of URAP apprentices (61%-97%) reported participating at least monthly in all activities except presenting their STEM research to a panel of judges (16%) and building or making a computer model (45%). STEM practices URAP apprentices reported being most frequently (weekly or every day) engaged with during their program were working with a STEM researcher or company on a real-world STEM research project (97%) and interacting with STEM researchers (94%).

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 any of the individual demographic components of U2 status. However, U2 apprentices reported significantly greater gains compared to non-U2 apprentices (effect size is large with d = 0.844).[11]

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 59). 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 very large with d = 2.05).[12] These data indicate that URAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

[11] Independent Samples t-test for STEM Engagement by U2 status: t(25)=2.11, p=.045.

[12] Dependent Samples t-test for STEM Engagement: t(30)=5.61, p=.000.

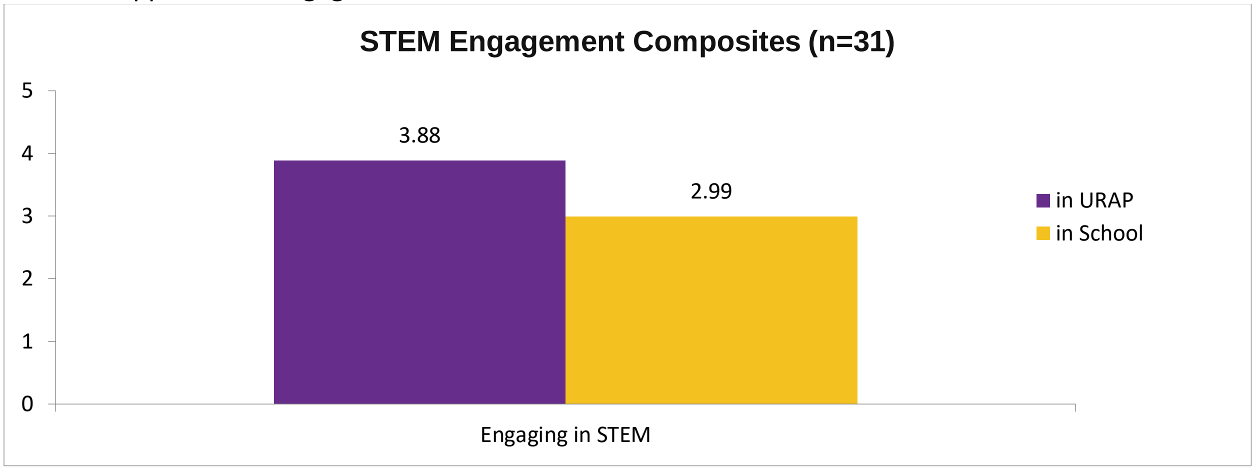
Table 58. Apprentice Engagement in STEM Practices in URAP (n=31)

	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%	3.2%	0.0%	12.9%	83.9%	
	0	1	0	4	26	**31**
Work with a STEM researcher on a research project of your own choosing	32.3%	12.9%	3.2%	9.7%	41.9%	
	10	4	1	3	13	**31**
Design my own research or investigation based on my own question(s)	22.6%	16.1%	16.1%	16.1%	29.0%	
	7	5	5	5	9	**31**
Present my STEM research to a panel of judges from industry or the military	51.6%	32.3%	0.0%	12.9%	3.2%	
	16	10	0	4	1	**31**
Interact with STEM researchers	0.0%	3.2%	3.2%	12.9%	80.6%	
	0	1	1	4	25	**31**
Use laboratory procedures and tools	6.5%	3.2%	0.0%	12.9%	77.4%	
	2	1	0	4	24	**31**
Identify questions or problems to investigate	0.0%	3.2%	6.5%	19.4%	71.0%	
	0	1	2	6	22	**31**
Design and carry out an investigation	0.0%	9.7%	19.4%	22.6%	48.4%	
	0	3	6	7	15	**31**
Analyze data or information and draw conclusions	0.0%	6.5%	3.2%	32.3%	58.1%	
	0	2	1	10	18	**31**
Work collaboratively as part of a team	3.2%	3.2%	3.2%	32.3%	58.1%	
	1	1	1	10	18	**31**
Build or make a computer model	35.5%	19.4%	3.2%	19.4%	22.6%	
	11	6	1	6	7	**31**
Solve real world problems	0.0%	9.7%	9.7%	32.3%	48.4%	
	0	3	3	10	15	**31**

Table 59. Apprentice Engagement in STEM Practices in School (n=31)

	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	41.9%	6.5%	0.0%	35.5%	16.1%	
	13	2	0	11	5	**31**
Work with a STEM researcher on a research project of your own choosing	51.6%	16.1%	3.2%	12.9%	16.1%	
	16	5	1	4	5	**31**
Design my own research or investigation based on my own question(s)	35.5%	22.6%	19.4%	6.5%	16.1%	
	11	7	6	2	5	**31**
Present my STEM research to a panel of judges from industry or the military	87.1%	9.7%	0.0%	3.2%	0.0%	
	27	3	0	1	0	**31**
Interact with STEM researchers	12.9%	16.1%	3.2%	29.0%	38.7%	
	4	5	1	9	12	**31**
Use laboratory procedures and tools	16.1%	0.0%	9.7%	48.4%	25.8%	
	5	0	3	15	8	**31**
Identify questions or problems to investigate	12.9%	16.1%	12.9%	19.4%	38.7%	
	4	5	4	6	12	**31**
Design and carry out an investigation	19.4%	29.0%	9.7%	22.6%	19.4%	
	6	9	3	7	6	**31**
Analyze data or information and draw conclusions	6.5%	9.7%	19.4%	35.5%	29.0%	
	2	3	6	11	9	**31**
Work collaboratively as part of a team	3.2%	0.0%	16.1%	48.4%	32.3%	
	1	0	5	15	10	**31**
Build or make a computer model	32.3%	29.0%	9.7%	22.6%	6.5%	
	10	9	3	7	2	**31**
Solve real world problems	16.1%	16.1%	25.8%	19.4%	22.6%	
	5	5	8	6	7	**31**

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



Apprentices participating in interviews were also asked to reflect on how their URAP experiences compared with their typical course experiences in STEM at their colleges or universities. These apprentices noted that URAP provided them more hands-on and focused laboratory experience than their typical school lab experiences, and that they had more access to equipment in URAP. Apprentices also indicated that their college coursework and URAP were complementary in nature, since they learned concepts in their courses that they were then able to apply in their apprenticeship work. Apprentices said, for example,

> *"[URAP] is definitely more hands-on. You're actually doing research, you're doing the reactions and watching them happen, as opposed to in class, where I just, kind of, learn about them or read about them but not see them happen."* (URAP Apprentice)

> *"A lot of my courses, they're very general compared to the research I'm doing. [In] the research I'm doing [in URAP], I get to apply maybe a handful of the skills that I've taken from my courses, and apply them to a very narrow area."* (URAP Apprentice)

> *"[My coursework and URAP] complement each other. Lots of things that I learned in the courses; I've been applying them in the research. For example, programming… and also the theoretical knowledge of physics...[And] what I have learned here in the laboratory, the theoretical knowledge I am learning, I can apply it in the next physics course that I am taking."* (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 apprentices' 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 apprenticeships. 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 each area 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. There were, however, significant differences found in 21st Century skills gains by program level with high school apprentices reporting greater gains compared to university level apprentices (effect size is medium with $d = 0.539$).[14]

CQL

Nearly all apprentices reported some degree of STEM knowledge gains as a result of participating in CQL (Table 60). More than 80% reported either some gains or large gains in every area of STEM knowledge on the survey. For example, all apprentices reported at least some gains in their in-depth knowledge of STEM topics (100%), and nearly all reported similarly about their gains in knowledge of research conducted in STEM fields (98%). STEM knowledge gain composites were used to test for differential impacts by overall U2 classification and across demographic subgroups of apprentices. A significant difference was found by overall U2 classification with U2 apprentices reporting greater gains (effect size is medium with $d = 0.659$).[15] The only demographic subgroup difference in STEM knowledge gains found was by gender, with

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[13] Cronbach's alpha reliabilities for: STEM knowledge (0.873), STEM competencies (0.899), and 21st Century Skills (0.924).

[14] Independent Samples t-test for 21st Century Skills by program level: $t(136)=3.14$, $p=.002$.

[15] Independent Samples t-test for STEM knowledge by U2 status: $t(41)=2.11$, $p=.041$.

significantly more male apprentices reporting gains than female apprentices (effect size is large with d = 0.950).[16]

Table 60. Student Report of Impacts on STEM Knowledge (n=47)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	21.3%	78.7%	
	0	0	10	37	**47**
Knowledge of research conducted in a STEM topic or field	0.0%	2.1%	14.9%	83.0%	
	0	1	7	39	**47**
Knowledge of research processes, ethics, and rules for conduct in STEM	6.4%	8.5%	34.0%	51.1%	
	3	4	16	24	**47**
Knowledge of how scientists and engineers work on real problems in STEM	2.1%	4.3%	25.5%	68.1%	
	1	2	12	32	**47**
Knowledge of what everyday research work is like in STEM	0.0%	8.5%	14.9%	76.6%	
	0	4	7	36	**47**

To assess the impact of CQL on apprentices' STEM competencies, a series of survey questions were asked (Table 61). More than half of the responding apprentices (57%-89%) reported at least some gain in all competencies. Competencies most frequently reported as having been impacted (some or large gains) by CQL apprentices were defining a problem that can be solved by developing a new or improved product or process (92%), using knowledge/creativity to suggest a solution to a problem (89%), and supporting an explanation with STEM knowledge (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 in STEM competencies were found by overall U2 or any of the individual demographic variables investigated.

[16] Independent Samples t-test for STEM knowledge by gender: $t(41)=3.04$, $p=.004$.

Table 61. Apprentices Reporting Gains in Their STEM Competencies (n=47)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	8.5%	44.7%	46.8%	
	0	4	21	22	**47**
Creating a hypothesis or explanation that can be tested in an experiment/problem	12.8%	17.0%	40.4%	29.8%	
	6	8	19	14	**47**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	10.6%	40.4%	48.9%	
	0	5	19	23	**47**
Making a model to show how something works	17.0%	25.5%	17.0%	40.4%	
	8	12	8	19	**47**
Designing procedures or steps for an experiment or designing a solution that works	0.0%	17.0%	36.2%	46.8%	
	0	8	17	22	**47**
Identifying the limitations of the methods and tools used for collecting data	0.0%	12.8%	27.7%	59.6%	
	0	6	13	28	**47**
Carrying out an experiment and recording data accurately	10.6%	14.9%	19.1%	55.3%	
	5	7	9	26	**47**
Creating charts or graphs to display data and find patterns	6.4%	12.8%	23.4%	57.4%	
	3	6	11	27	**47**
Considering multiple interpretations of data to decide if something works as intended	2.1%	14.9%	38.3%	44.7%	
	1	7	18	21	**47**
Supporting an explanation with STEM knowledge	2.1%	8.5%	27.7%	61.7%	
	1	4	13	29	**47**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	14.9%	34.0%	51.1%	
	0	7	16	24	**47**
Presenting an argument that uses data and/or findings from an experiment or investigation	2.1%	23.4%	23.4%	51.1%	
	1	11	11	24	**47**
Defending an argument based upon findings from an experiment or other data	6.4%	23.4%	21.3%	48.9%	
	3	11	10	23	**47**
Integrating information from technical or STEM texts and other media to support your explanation of an experiment or solution to problem	4.3%	17.0%	21.3%	57.4%	
	2	8	10	27	**47**

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 62). Approximately two-thirds or more of apprentices (68%-94%) reported at least some gains on each item with the exception of the following: creating media products (15%), analyzing media (32%), and leading others in a team (45%). Items with the greatest growth (at least some gains) were solving problems (94%), interacting effectively in a professional manner (94%), adapting to change when things do not go as planned (94%), and incorporating feedback into their work effectively (94%). 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 individual variables making up the U2 variable. However, significant differences were found by overall U2 status with U2 apprentices reporting greater 21st Century skills gains (effect size is medium with d = 0.653).[17]

Table 62. Apprentice Report of Impacts on 21st Century Skills (n=47)

	No gain	A little gain	Some gain	Large gain	Response Total
Thinking creatively	2.1%	10.6%	38.3%	48.9%	
	1	5	18	23	**47**
Working creatively with others	4.3%	12.8%	42.6%	40.4%	
	2	6	20	19	**47**
Using my creative ideas to make a product	8.5%	23.4%	25.5%	42.6%	
	4	11	12	20	**47**
Thinking about how systems work and how parts interact with each other	2.1%	12.8%	17.0%	68.1%	
	1	6	8	32	**47**
Evaluating others' evidence, arguments, and beliefs	4.3%	19.1%	27.7%	48.9%	
	2	9	13	23	**47**
Solving problems	0.0%	6.4%	31.9%	61.7%	
	0	3	15	29	**47**
Communicating clearly (written and oral) with others	2.1%	8.5%	23.4%	66.0%	
	1	4	11	31	**47**
	0.0%	10.6%	38.3%	51.1%	

[17] Independent Samples t-test for 21st Century Skills by U2 status: $t(41)=2.09$, $p=.043$.

	No gain	A little gain	Some gain	Large gain	Response Total
Collaborating with others effectively and respectfully in diverse teams	0	5	18	24	**47**
Interacting effectively in a respectful and professional manner	0.0%	6.4%	27.7%	66.0%	
	0	3	13	31	**47**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	2.1%	8.5%	31.9%	57.4%	
	1	4	15	27	**47**
Analyzing media (news) - understanding points of view in the media	44.7%	23.4%	12.8%	19.1%	
	21	11	6	9	**47**
Creating media products like videos, blogs, social media	78.7%	6.4%	4.3%	10.6%	
	37	3	2	5	**47**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	27.7%	23.4%	48.9%	
	0	13	11	23	**47**
Adapting to change when things do not go as planned	0.0%	6.4%	23.4%	70.2%	
	0	3	11	33	**47**
Incorporating feedback into my work effectively	0.0%	6.4%	17.0%	76.6%	
	0	3	8	36	**47**
Setting goals and using time wisely	2.1%	19.1%	19.1%	59.6%	
	1	9	9	28	**47**
Working independently and completing tasks on time	2.1%	21.3%	6.4%	70.2%	
	1	10	3	33	**47**
Taking initiative and doing work without being told to	2.1%	14.9%	19.1%	63.8%	
	1	7	9	30	**47**
Prioritizing, planning, and managing projects to achieve completion	6.4%	12.8%	23.4%	57.4%	
	3	6	11	27	**47**
Producing results - sticking with a task until it is finished	0.0%	14.9%	14.9%	70.2%	
	0	7	7	33	**47**
	25.5%	29.8%	17.0%	27.7%	

	No gain	A little gain	Some gain	Large gain	Response Total
Leading and guiding others in a team or group	12	14	8	13	**47**
Being responsible to others - thinking about the larger community	10.6%	25.5%	14.9%	48.9%	
	5	12	7	23	**47**

SEAP

Nearly all SEAP apprentices (91%-100%) reported at least some gains in their STEM knowledge as a result of participating in their apprenticeships (Table 63). Knowledge of how scientists and engineers work on real problems in STEM (91%) is the only item for which not all SEAP apprentices reported at least some gains. 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, or there were not enough data to compare groups.

Table 63. Student Report of Impacts on STEM Knowledge (n=11)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Knowledge of research conducted in a STEM topic or field	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	9.1%	9.1%	81.8%	
	0	1	1	9	**11**
Knowledge of what everyday research work is like in STEM	0.0%	0.0%	9.1%	90.9%	
	0	0	1	10	**11**

More than 80% of SEAP apprentices (82%-100%) reported at least some gains in all STEM competencies (Table 64) as a result of participation in the program. For all items except one (making a model to show how something works – 82%), 90% or more of apprentices reported at least some gains. 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, or there were not enough data to compare groups.

Table 64. Apprentices Reporting Gains in Their STEM Competencies (n=11)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	9.1%	18.2%	72.7%	
	0	1	2	8	**11**
Creating a hypothesis or explanation that can be tested in an experiment/problem	0.0%	9.1%	18.2%	72.7%	
	0	1	2	8	**11**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Making a model to show how something works	9.1%	9.1%	27.3%	54.5%	
	1	1	3	6	**11**
Designing procedures or steps for an experiment or designing a solution that works	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Identifying the limitations of the methods and tools used for collecting data	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Carrying out an experiment and recording data accurately	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Creating charts or graphs to display data and find patterns	0.0%	0.0%	45.5%	54.5%	
	0	0	5	6	**11**
Considering multiple interpretations of data to decide if something works as intended	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Supporting an explanation with STEM knowledge	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Presenting an argument that uses data and/or findings from an experiment or investigation	0.0%	9.1%	18.2%	72.7%	
	0	1	2	8	**11**
Defending an argument based upon findings from an experiment or other data	0.0%	9.1%	18.2%	72.7%	
	0	1	2	8	**11**
	0.0%	0.0%	18.2%	81.8%	

	No gain	A little gain	Some gain	Large gain	Response Total
Integrating information from technical or STEM texts and other media to support your explanation	0	0	2	9	**11**

Nearly three-quarters or more of SEAP apprentices (73%-100%) reported at least some gains in all 21st Century skills items except for creating media products (46%) as a result of their program participation (Table 65). 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, or there were not enough data to compare groups.

Table 65. Apprentice Report of Impacts on 21st Century Skills (n=11)

	No gain	A little gain	Some gain	Large gain	Response Total
Thinking creatively	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Working creatively with others	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Using my creative ideas to make a product	0.0%	0.0%	9.1%	90.9%	
	0	0	1	10	**11**
Thinking about how systems work and how parts interact with each other	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Evaluating others' evidence, arguments, and beliefs	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Solving problems	0.0%	0.0%	9.1%	90.9%	
	0	0	1	10	**11**
Communicating clearly (written and oral) with others	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Collaborating with others effectively and respectfully in diverse teams	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Interacting effectively in a respectful and professional manner	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
	0.0%	0.0%	27.3%	72.7%	

	No gain	A little gain	Some gain	Large gain	Response Total
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0	0	3	8	**11**
Analyzing media (news) - understanding points of view in the media	0.0%	27.3%	27.3%	45.5%	
	0	3	3	5	**11**
Creating media products like videos, blogs, social media	54.5%	0.0%	18.2%	27.3%	
	6	0	2	3	**11**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Adapting to change when things do not go as planned	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Incorporating feedback into my work effectively	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Setting goals and using time wisely	0.0%	0.0%	36.4%	63.6%	
	0	0	4	7	**11**
Working independently and completing tasks on time	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Taking initiative and doing work without being told to	0.0%	0.0%	9.1%	90.9%	
	0	0	1	10	**11**
Prioritizing, planning, and managing projects to achieve completion	0.0%	0.0%	9.1%	90.9%	
	0	0	1	10	**11**
Producing results - sticking with a task until it is finished	0.0%	0.0%	18.2%	81.8%	
	0	0	2	9	**11**
Leading and guiding others in a team or group	9.1%	27.3%	9.1%	54.5%	
	1	3	1	6	**11**
Being responsible to others - thinking about the larger community	0.0%	9.1%	9.1%	81.8%	
	0	1	1	9	**11**

STEM Knowledge and Skills - University-Based Programs

REAP

A large majority of REAP apprentices (90%-94%) reported at least some gains in their STEM knowledge as a result of participating in the program (Table 66). For example, nearly all apprentices reported at least some gain in their in-depth knowledge of STEM topics (94%); knowledge of research conducted in STEM fields (94%); and knowledge of research processes, ethics, and roles for conduct in STEM (94%). 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 individual demographics investigated.

Table 66. Apprentice Report of Impacts on STEM Knowledge (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	6.5%	22.6%	71.0%	
	0	2	7	22	**31**
Knowledge of research conducted in a STEM topic or field	3.2%	3.2%	9.7%	83.9%	
	1	1	3	26	**31**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.2%	3.2%	22.6%	71.0%	
	1	1	7	22	**31**
Knowledge of how scientists and engineers work on real problems in STEM	3.2%	6.5%	9.7%	80.6%	
	1	2	3	25	**31**
Knowledge of what everyday research work is like in STEM	6.5%	3.2%	6.5%	83.9%	
	2	1	2	26	**31**

Approximately three-quarters or more of REAP apprentices (74%-97%) reported at least some gains on all STEM competencies items (Table 67). More than 90% of apprentices reported at least some gains in supporting an explanation with STEM knowledge (97%) and carrying out an experiment and recording data accurately (94%). 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 67. Apprentices Reporting Gains in STEM Competencies (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	12.9%	35.5%	51.6%	
	0	4	11	16	**31**
Creating a hypothesis or explanation that can be tested in an experiment/problem	3.2%	22.6%	29.0%	45.2%	
	1	7	9	14	**31**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	22.6%	29.0%	48.4%	
	0	7	9	15	**31**
Making a model to show how something works	9.7%	9.7%	32.3%	48.4%	
	3	3	10	15	**31**
Designing procedures or steps for an experiment or designing a solution that works	6.5%	12.9%	38.7%	41.9%	
	2	4	12	13	**31**
Identifying the limitations of the methods and tools used for collecting data	6.5%	6.5%	35.5%	51.6%	
	2	2	11	16	**31**
Carrying out an experiment and recording data accurately	3.2%	3.2%	35.5%	58.1%	
	1	1	11	18	**31**
Creating charts or graphs to display data and find patterns	3.2%	6.5%	35.5%	54.8%	
	1	2	11	17	**31**
Considering multiple interpretations of data to decide if something works as intended	3.2%	6.5%	29.0%	61.3%	
	1	2	9	19	**31**
Supporting an explanation with STEM knowledge	3.2%	0.0%	29.0%	67.7%	
	1	0	9	21	**31**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	9.7%	3.2%	54.8%	32.3%	
	3	1	17	10	**31**
Presenting an argument that uses data and/or findings from an experiment or investigation	6.5%	9.7%	41.9%	41.9%	
	2	3	13	13	**31**
Defending an argument based upon findings from an experiment or other data	12.9%	6.5%	41.9%	38.7%	
	4	2	13	12	**31**

Integrating information from technical or STEM texts and other media to support your explanation of an experiment or solution to problem	6.5%	6.5%	29.0%	58.1%	
	2	2	9	18	**31**

Approximately two-thirds or more of REAP apprentices (65%-100%) reported at least some gains in all 21st Century skills items with the exception of creating media products (42%) (Table 68). 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 68. Apprentice Report of Impacts on 21st Century Skills (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
Thinking creatively	0.0%	9.7%	25.8%	64.5%	
	0	3	8	20	**31**
Working creatively with others	3.2%	9.7%	19.4%	67.7%	
	1	3	6	21	**31**
Using my creative ideas to make a product	9.7%	6.5%	29.0%	54.8%	
	3	2	9	17	**31**
Thinking about how systems work and how parts interact with each other	3.2%	3.2%	16.1%	77.4%	
	1	1	5	24	**31**
Evaluating others' evidence, arguments, and beliefs	9.7%	3.2%	29.0%	58.1%	
	3	1	9	18	**31**
Solving problems	0.0%	0.0%	22.6%	77.4%	
	0	0	7	24	**31**
Communicating clearly (written and oral) with others	3.2%	3.2%	22.6%	71.0%	
	1	1	7	22	**31**
Collaborating with others effectively and respectfully in diverse teams	3.2%	3.2%	16.1%	77.4%	
	1	1	5	24	**31**
Interacting effectively in a respectful and professional manner	0.0%	0.0%	19.4%	80.6%	
	0	0	6	25	**31**

	No gain	A little gain	Some gain	Large gain	Response Total
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	6.5%	12.9%	80.6%	
	0	2	4	25	**31**
Analyzing media (news) - understanding points of view in the media	16.1%	19.4%	25.8%	38.7%	
	5	6	8	12	**31**
Creating media products like videos, blogs, social media	48.4%	9.7%	22.6%	19.4%	
	15	3	7	6	**31**
Use technology as a tool to research, organize, evaluate, and communicate information	6.5%	9.7%	25.8%	58.1%	
	2	3	8	18	**31**
Adapting to change when things do not go as planned	3.2%	3.2%	32.3%	61.3%	
	1	1	10	19	**31**
Incorporating feedback into my work effectively	0.0%	6.5%	19.4%	74.2%	
	0	2	6	23	**31**
Setting goals and using time wisely	0.0%	6.5%	12.9%	80.6%	
	0	2	4	25	**31**
Working independently and completing tasks on time	0.0%	0.0%	19.4%	80.6%	
	0	0	6	25	**31**
Taking initiative and doing work without being told to	0.0%	0.0%	22.6%	77.4%	
	0	0	7	24	**31**
Prioritizing, planning, and managing projects to achieve completion	0.0%	0.0%	29.0%	71.0%	
	0	0	9	22	**31**
Producing results - sticking with a task until it is finished	3.2%	0.0%	32.3%	64.5%	
	1	0	10	20	**31**
Leading and guiding others in a team or group	19.4%	3.2%	32.3%	45.2%	
	6	1	10	14	**31**
Being responsible to others - thinking about the larger community	6.5%	9.7%	22.6%	61.3%	
	2	3	7	19	**31**

HSAP

More than 90% (90%-100%) of HSAP apprentices reported at least some gains in all areas of their STEM knowledge as a result of participating in the program (Table 69). The only item with less than 100% of HSAP apprentices reporting at least some gains was in depth knowledge of a STEM topic (94%). 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, or there were not enough data to compare groups.

Table 69. Apprentice Report of Impacts on STEM Knowledge (n=18)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	5.6%	22.2%	72.2%	
	0	1	4	13	**18**
Knowledge of research conducted in a STEM topic or field	0.0%	0.0%	5.6%	94.4%	
	0	0	1	17	**18**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	0.0%	38.9%	61.1%	
	0	0	7	11	**18**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Knowledge of what everyday research work is like in STEM	0.0%	0.0%	11.1%	88.9%	
	0	0	2	16	**18**

More than 60% (61%-100%) of HSAP apprentices reported at least some gains in all STEM competencies (Table 70). All HSAP apprentices indicated at least some gains in creating charts/graphs to display data and find patterns (100%) and supporting an explanation with STEM knowledge (100%). 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, or there were not enough data to compare groups.

Table 70. Apprentice Report of Gains in STEM Competencies (n=18)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	5.6%	22.2%	27.8%	44.4%	
	1	4	5	8	**18**

	No gain	A little gain	Some gain	Large gain	Response Total
Creating a hypothesis or explanation that can be tested in an experiment/problem	11.1%	27.8%	22.2%	38.9%	
	2	5	4	7	**18**
Using my knowledge and creativity to suggest a solution to a problem	11.1%	0.0%	33.3%	55.6%	
	2	0	6	10	**18**
Making a model to show how something works	16.7%	16.7%	33.3%	33.3%	
	3	3	6	6	**18**
Designing procedures or steps for an experiment or designing a solution that works	16.7%	22.2%	16.7%	44.4%	
	3	4	3	8	**18**
Identifying the limitations of the methods and tools used for collecting data	5.6%	0.0%	22.2%	72.2%	
	1	0	4	13	**18**
Carrying out an experiment and recording data accurately	5.6%	16.7%	5.6%	72.2%	
	1	3	1	13	**18**
Creating charts or graphs to display data and find patterns	0.0%	0.0%	27.8%	72.2%	
	0	0	5	13	**18**
Considering multiple interpretations of data to decide if something works as intended	0.0%	11.1%	33.3%	55.6%	
	0	2	6	10	**18**
Supporting an explanation with STEM knowledge	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	11.1%	44.4%	44.4%	
	0	2	8	8	**18**
Presenting an argument that uses data and/or findings from an experiment or investigation	5.6%	11.1%	22.2%	61.1%	
	1	2	4	11	**18**
Defending an argument based upon findings from an experiment or other data	5.6%	16.7%	33.3%	44.4%	
	1	3	6	8	**18**
Integrating information from technical or STEM texts and other media to support your explanation of an experiment or solution to problem	11.1%	11.1%	27.8%	50.0%	
	2	2	5	9	**18**

Apprentices were asked to report on HSAP's impact on their 21st Century skills (Table 71). With the exception of two items, half or more of apprentices (56%-100%) reported at least some gains in all areas of 21st Century skills due to their participation in HSAP. The exceptions were analyzing media (44%) and creating media products (28%). 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 status or individual demographics investigated, or there were not enough data to compare groups.

Table 71. Apprentice Report of Impacts on 21st Century Skills (n=18)

	No gain	A little gain	Some gain	Large gain	Response Total
Thinking creatively	5.6%	11.1%	44.4%	38.9%	
	1	2	8	7	**18**
Working creatively with others	5.6%	16.7%	16.7%	61.1%	
	1	3	3	11	**18**
Using my creative ideas to make a product	27.8%	16.7%	16.7%	38.9%	
	5	3	3	7	**18**
Thinking about how systems work and how parts interact with each other	5.6%	5.6%	16.7%	72.2%	
	1	1	3	13	**18**
Evaluating others' evidence, arguments, and beliefs	5.6%	5.6%	27.8%	61.1%	
	1	1	5	11	**18**
Solving problems	0.0%	16.7%	27.8%	55.6%	
	0	3	5	10	**18**
Communicating clearly (written and oral) with others	0.0%	16.7%	11.1%	72.2%	
	0	3	2	13	**18**
Collaborating with others effectively and respectfully in diverse teams	5.6%	22.2%	16.7%	55.6%	
	1	4	3	10	**18**
Interacting effectively in a respectful and professional manner	0.0%	0.0%	27.8%	72.2%	
	0	0	5	13	**18**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	0.0%	55.6%	44.4%	
	0	0	10	8	**18**
	44.4%	11.1%	22.2%	22.2%	

Analyzing media (news) - understanding points of view in the media	8	2	4	4	**18**
Creating media products like videos, blogs, social media	61.1%	11.1%	5.6%	22.2%	
	11	2	1	4	**18**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	5.6%	22.2%	72.2%	
	0	1	4	13	**18**
Adapting to change when things do not go as planned	5.6%	5.6%	0.0%	88.9%	
	1	1	0	16	**18**
Incorporating feedback into my work effectively	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Setting goals and using time wisely	0.0%	0.0%	38.9%	61.1%	
	0	0	7	11	**18**
Working independently and completing tasks on time	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Taking initiative and doing work without being told to	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Prioritizing, planning, and managing projects to achieve completion	0.0%	0.0%	22.2%	77.8%	
	0	0	4	14	**18**
Producing results - sticking with a task until it is finished	0.0%	0.0%	16.7%	83.3%	
	0	0	3	15	**18**
Leading and guiding others in a team or group	33.3%	16.7%	16.7%	33.3%	
	6	3	3	6	**18**
Being responsible to others - thinking about the larger community	16.7%	0.0%	22.2%	61.1%	
	3	0	4	11	**18**

URAP

Approximately 90%-93% of URAP participants reported at least some gains in each area of STEM knowledge (Table 72). For example, nearly all apprentices reported at least some gain in their knowledge of research conducted in a STEM topic or field (94%) and knowledge of what everyday research work is like in STEM (94%). 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 demographic variables making up U2 classification. However, there was a significant difference by U2 status with U2-identified apprentices reporting greater gains (effect size is large with d = 0.848).[18]

Table 72. Apprentice Report of Impact on STEM Knowledge (n=31)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	9.7%	22.6%	67.7%	
	0	3	7	21	**31**
Knowledge of research conducted in a STEM topic or field	0.0%	6.5%	16.1%	77.4%	
	0	2	5	24	**31**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.2%	6.5%	32.3%	58.1%	
	1	2	10	18	**31**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	9.7%	25.8%	64.5%	
	0	3	8	20	**31**
Knowledge of what everyday research work is like in STEM	0.0%	6.5%	12.9%	80.6%	
	0	2	4	25	**31**

About two-thirds or more of URAP apprentices (65%-90%) reported some gains or large gains in their STEM competencies (Table 73) as a result of participating in URAP. Apprentices were most likely to report gains (some or large) in the following competencies: using knowledge/creativity to suggest a solution to a problem (90%), supporting an explanation with relevant STEM knowledge (90%), and presenting an argument that uses data from an experiment (90%). 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 variables comprising the U2 classification, however there was a significant difference by overall U2 status with U2 apprentices indicating greater gains (effect size is large with d = 1.136).[19]

Table 73. Apprentices Reporting Gains in Their STEM Competencies (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	3.2%	16.1%	38.7%	41.9%	
	1	5	12	13	**31**

[18] Independent Samples t-test for STEM knowledge by U2 status: t(25)=2.12, p=.044.

[19] Independent Samples t-test for STEM competencies by U2 status: t(25)=2.84, p=.009.

Creating a hypothesis or explanation that can be tested in an experiment/problem	3.2%	22.6%	41.9%	32.3%	
	1	7	13	10	**31**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	9.7%	38.7%	51.6%	
	0	3	12	16	**31**
Making a model to show how something works	16.1%	19.4%	38.7%	25.8%	
	5	6	12	8	**31**
Designing procedures or steps for an experiment or designing a solution that works	6.5%	22.6%	25.8%	45.2%	
	2	7	8	14	**31**
Identifying the limitations of the methods and tools used for collecting data	0.0%	16.1%	25.8%	58.1%	
	0	5	8	18	**31**
Carrying out an experiment and recording data accurately	3.2%	9.7%	29.0%	58.1%	
	1	3	9	18	**31**
Creating charts or graphs to display data and find patterns	3.2%	9.7%	38.7%	48.4%	
	1	3	12	15	**31**
Considering multiple interpretations of data to decide if something works as intended	0.0%	12.9%	38.7%	48.4%	
	0	4	12	15	**31**
Supporting an explanation with STEM knowledge	0.0%	9.7%	35.5%	54.8%	
	0	3	11	17	**31**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	22.6%	29.0%	48.4%	
	0	7	9	15	**31**
Presenting an argument that uses data and/or findings from an experiment or investigation	3.2%	6.5%	38.7%	51.6%	
	1	2	12	16	**31**
Defending an argument based upon findings from an experiment or other data	3.2%	19.4%	38.7%	38.7%	
	1	6	12	12	**31**
Integrating information from technical or STEM texts and other media to support your explanation of an experiment or solution to problem	0.0%	25.8%	29.0%	45.2%	
	0	8	9	14	**31**

Approximately two-thirds or more of URAP apprentices (65%-100%) reported at least some gains in all areas of 21st Century skills (Table 74) except for two items. The two exceptions were analyzing media

(26%) and creating media products (16%). All URAP apprentices indicated at least some gains as a result of their apprenticeship in the areas of adapting to change when things do not go as planned (100%) and working independently and complete tasks on time (100%). 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 status, with U2 apprentices identifying greater gains (effect size is large with d = 1.184).[20] Additionally, there were significant differences noted by gender with females reporting greater gains compared to males (effect size is large with d = 0.840).[21]

Table 74. Apprentice Reports of Impacts on 21st Century Skills (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
Thinking creatively	0.0%	25.8%	45.2%	29.0%	
	0	8	14	9	**31**
Working creatively with others	3.2%	16.1%	32.3%	48.4%	
	1	5	10	15	**31**
Using my creative ideas to make a product	9.7%	29.0%	41.9%	19.4%	
	3	9	13	6	**31**
Thinking about how systems work and how parts interact with each other	3.2%	16.1%	32.3%	48.4%	
	1	5	10	15	**31**
Evaluating others' evidence, arguments, and beliefs	3.2%	22.6%	41.9%	32.3%	
	1	7	13	10	**31**
Solving problems	0.0%	9.7%	25.8%	64.5%	
	0	3	8	20	**31**
Communicating clearly (written and oral) with others	0.0%	3.2%	51.6%	45.2%	
	0	1	16	14	**31**
Collaborating with others effectively and respectfully in diverse teams	3.2%	0.0%	45.2%	51.6%	
	1	0	14	16	**31**
	0.0%	3.2%	29.0%	67.7%	

[20] Independent Samples t-test for 21st Century Skills by U2 status: t(25)=2.96, p=.007.

[21] Independent Samples t-test for 21st Century Skills by gender: t(25)=2.10, p=.046.

Interacting effectively in a respectful and professional manner	0	1	9	21	**31**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	9.7%	38.7%	51.6%	
	0	3	12	16	**31**
Analyzing media (news) - understanding points of view in the media	35.5%	38.7%	19.4%	6.5%	
	11	12	6	2	**31**
Creating media products like videos, blogs, social media	64.5%	19.4%	9.7%	6.5%	
	20	6	3	2	**31**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	6.5%	32.3%	61.3%	
	0	2	10	19	**31**
Adapting to change when things do not go as planned	0.0%	0.0%	41.9%	58.1%	
	0	0	13	18	**31**
Incorporating feedback into my work effectively	0.0%	3.2%	25.8%	71.0%	
	0	1	8	22	**31**
Setting goals and using time wisely	0.0%	16.1%	25.8%	58.1%	
	0	5	8	18	**31**
Working independently and completing tasks on time	0.0%	0.0%	35.5%	64.5%	
	0	0	11	20	**31**
Taking initiative and doing work without being told to	0.0%	6.5%	38.7%	54.8%	
	0	2	12	17	**31**
Prioritizing, planning, and managing projects to achieve completion	0.0%	16.1%	25.8%	58.1%	
	0	5	8	18	**31**
Producing results - sticking with a task until it is finished	0.0%	9.7%	29.0%	61.3%	
	0	3	9	19	**31**
Leading and guiding others in a team or group	12.9%	19.4%	29.0%	38.7%	
	4	6	9	12	**31**
Being responsible to others - thinking about the larger community	3.2%	6.5%	35.5%	54.8%	
	1	2	11	17	**31**

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 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 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

Approximately three-quarters or more of CQL apprentices (75%-92%) reported some gains or large gains on all items associated with STEM identity (Table 75). Large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (92%) and sense of accomplishing something in STEM (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 demographics investigated.

Table 75. Apprentice Report of Impacts on STEM Identity (n=47)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	2.1%	12.8%	34.0%	51.1%	
	1	6	16	24	**47**
Interest in pursuing a STEM career	8.5%	17.0%	23.4%	51.1%	
	4	8	11	24	**47**

[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.
[22] Cronbach's alpha reliability for STEM identity composite was 0.840.

Sense of accomplishing something in STEM	2.1%	6.4%	21.3%	70.2%	
	1	3	10	33	**47**
Feeling prepared for more challenging STEM activities	6.4%	4.3%	27.7%	61.7%	
	3	2	13	29	**47**
Confidence to try out new ideas or procedures on my own in a STEM project	4.3%	6.4%	31.9%	57.4%	
	2	3	15	27	**47**
Desire to build relationships with mentors who work in STEM	2.1%	6.4%	14.9%	76.6%	
	1	3	7	36	**47**

SEAP

All SEAP apprentices (100%) reported some gains or large gains on all items associated with STEM Identity (Table 76). 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, or there was not enough data to determine group differences.

Table 76. Apprentice Report of Impacts on STEM Identity (n=11)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Deciding on a path to pursue a STEM career	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Sense of accomplishing something in STEM	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Feeling prepared for more challenging STEM activities	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**
Desire to build relationships with mentors who work in STEM	0.0%	0.0%	27.3%	72.7%	
	0	0	3	8	**11**

STEM Identity and Confidence – University-Based Programs

REAP

More than three-quarters of REAP apprentices (77%-97%) reported at least some gains on all items associated with STEM identity (Table 77). Nearly all reported at least some gains in their sense of accomplishing something in STEM (97%) and desire to build relationships with mentors (97%). 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 demographics investigated.

Table 77. Apprentice Report of Impacts on STEM Identity (n=31)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	6.5%	3.2%	35.5%	54.8%	
	2	1	11	17	**31**
Deciding on a path to pursue a STEM career	3.2%	19.4%	12.9%	64.5%	
	1	6	4	20	**31**
Sense of accomplishing something in STEM	3.2%	0.0%	25.8%	71.0%	
	1	0	8	22	**31**
Feeling prepared for more challenging STEM activities	3.2%	3.2%	29.0%	64.5%	
	1	1	9	20	**31**
Confidence to try out new ideas or procedures on my own in a STEM project	3.2%	3.2%	25.8%	67.7%	
	1	1	8	21	**31**
Desire to build relationships with mentors who work in STEM	0.0%	3.2%	19.4%	77.4%	
	0	1	6	24	**31**

HSAP

More than three-quarters of HSAP apprentices (78%-95%) reported at least some gains on all STEM identity items (Table 78). Nearly all reported at least some gains in feeling prepared for more challenging STEM activities (95%) and confidence to try out new ideas/procedures on their own in a STEM project (95%). 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 demographics, or there was not enough data to determine group differences.

Table 78. Apprentice Report of Impacts on STEM Identity (n=18)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	5.6%	16.7%	22.2%	55.6%	
	1	3	4	10	**18**
Deciding on a path to pursue a STEM career	11.1%	11.1%	22.2%	55.6%	
	2	2	4	10	**18**
Sense of accomplishing something in STEM	0.0%	16.7%	11.1%	72.2%	
	0	3	2	13	**18**
Feeling prepared for more challenging STEM activities	0.0%	5.6%	5.6%	88.9%	
	0	1	1	16	**18**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	5.6%	5.6%	88.9%	
	0	1	1	16	**18**
Desire to build relationships with mentors who work in STEM	0.0%	11.1%	0.0%	88.9%	
	0	2	0	16	**18**

URAP

A large majority of URAP apprentices (81%-94%) reported at least medium gains on all items associated with STEM identity (Table 79). Nearly all indicated at least some gains in the following areas: sense of accomplishing something in STEM (94%), feeling prepared for more challenging STEM activities (94%), and confidence to try out new ideas/procedures on their own in a STEM project (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 individual demographics used to determine U2 classification. However, there were significant differences in overall U2 status with U2 apprentices reporting greater gains (effect size is large with d = 0.916).[22]

[22] Independent Samples t-test for STEM Identity by U2 status: t(25)=2.29, p=.021.

Table 79. Apprentice Report of Impacts on STEM Identity (n=31)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	0.0%	16.1%	22.6%	61.3%	
	0	5	7	19	**31**
Interest in pursuing a STEM career	9.7%	9.7%	19.4%	61.3%	
	3	3	6	19	**31**
Sense of accomplishing something in STEM	0.0%	6.5%	29.0%	64.5%	
	0	2	9	20	**31**
Feeling prepared for more challenging STEM activities	0.0%	6.5%	38.7%	54.8%	
	0	2	12	17	**31**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	6.5%	35.5%	58.1%	
	0	2	11	18	**31**
Desire to build relationships with mentors who work in STEM	0.0%	9.7%	12.9%	77.4%	
	0	3	4	24	**31**

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.

[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

At least two-thirds of CQL mentors (67%-100%) reported using several strategies to help make learning activities relevant to students (Table 80). 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 less frequently were helping students understand how STEM can help them improve their own community (20%), helping students become aware of the role STEM plays in their everyday lives (33%), and asking students to relate real-life events or activities to topics covered in CQL (47%).

Table 80. Mentors Using Strategies to Establish Relevance of Learning Activities (n=15)

	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	100.0%	0.0%	
	15	0	**15**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	15	0	**15**
Selecting readings or activities that relate to students' backgrounds	66.7%	33.3%	
	10	5	**15**
Encouraging students to suggest new readings, activities, or projects	80.0%	20.0%	
	12	3	**15**
Helping students become aware of the role(s) that STEM plays in their everyday lives	33.3%	66.7%	
	5	10	**15**
Helping students understand how STEM can help them improve their own community	20.0%	80.0%	
	3	12	**15**
Asking students to relate real-life events or activities to topics covered in CQL	46.7%	53.3%	
	7	8	**15**

Similarly, most CQL mentors reported using a variety of strategies to support the diverse needs of students as learners (Table 81). Strategies reportedly implemented by approximately three-quarters or more of CQL mentors included directing students to other individuals or programs for additional support as needed (93%) and using a variety of teaching and/or mentoring activities to meet the needs of all students (73%). Considerably fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (20%) and integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (7%).

Table 81. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=15)

	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	60.0%	40.0%	
	9	6	**15**
Interact with students and other personnel the same way regardless of their background	66.7%	33.3%	
	10	5	**15**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	73.3%	26.7%	
	11	4	**15**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	6.7%	93.3%	
	1	14	**15**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	66.7%	33.3%	
	10	5	**15**
Directing students to other individuals or programs for additional support as needed	93.3%	6.7%	
	14	1	**15**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	20.0%	80.0%	
	3	12	**15**

More than half of mentors (53%-93%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 82). A large majority reported having students explain difficult ideas to others (93%) and having students work on collaborative activities or projects as a member of a team (87%).

Table 82. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=15)

	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	80.0%	20.0%	
	12	3	**15**
Having my student(s) explain difficult ideas to others	93.3%	6.7%	
	14	1	**15**
Having my student(s) listen to the ideas of others with an open mind	80.0%	20.0%	
	12	3	**15**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	60.0%	40.0%	
	9	6	**15**
Having my student(s) give and receive constructive feedback with others	80.0%	20.0%	
	12	3	**15**
Having students work on collaborative activities or projects as a member of a team	86.7%	13.3%	
	13	2	**15**
Allowing my student(s) to resolve conflicts and reach agreement within their team	53.3%	46.7%	
	8	7	**15**

Two-thirds or more (67%-100%) of CQL mentors reported using all strategies to support students' engagement in authentic STEM activities (Table 83). All mentors reported allowing students to work independently to improve their self-management abilities (100%) and encouraging students to seek support from other team members (100%).

Table 83. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=15)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	66.7%	33.3%	
	10	5	**15**
Having my student(s) search for and review technical research to support their work	93.3%	6.7%	
	14	1	**15**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	80.0%	20.0%	
	12	3	**15**
Supervising my student(s) while they practice STEM research skills	93.3%	6.7%	
	14	1	**15**
Providing my student(s) with constructive feedback to improve their STEM competencies	93.3%	6.7%	
	14	1	**15**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	15	0	**15**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	93.3%	6.7%	
	14	1	**15**
Encouraging students to seek support from other team members	100.0%	0.0%	
	15	0	**15**

More than half of mentors reported implementing six of the strategies focused on supporting students' STEM educational and career pathways (Table 84). All (100%) responding mentors indicated asking students about their educational and career interests. Nearly all reported discussing STEM career opportunities within the DoD or other government agencies (87%). Fewer than half reported using the strategies of helping students with their resumé, application, personal statement, and/or interview preparations (33%); recommending AEOPs aligned with student goals (40%); discussing economic, political, ethical, and/or social context of a STEM career (40%); and recommending professional organizations in STEM to students (40%).

Table 84. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=15)

	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%	
	15	0	**15**
Recommending extracurricular programs that align with students' goals	53.3%	46.7%	
	8	7	**15**
Recommending Army Educational Outreach Programs that align with students' goals	40.0%	60.0%	
	6	9	**15**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	66.7%	33.3%	
	10	5	**15**
Discussing STEM career opportunities within the DoD or other government agencies	86.7%	13.3%	
	13	2	**15**
Discussing STEM career opportunities in private industry or academia	66.7%	33.3%	
	10	5	**15**
Discussing the economic, political, ethical, and/or social context of a STEM career	40.0%	60.0%	
	6	9	**15**
Recommending student and professional organizations in STEM to my student(s)	40.0%	60.0%	
	6	9	**15**
Helping students build a professional network in a STEM field	53.3%	46.7%	
	8	7	**15**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	33.3%	66.7%	
	5	10	**15**

SEAP

More than half of SEAP mentors (55%-100%) reported using all but one of the strategies to help make learning activities relevant to students (Table 85). For example, all reported becoming familiar with their students' backgrounds and interests (100%) and giving students real-life problems to investigate or solve (100%), and nearly all reported giving students real-life problems to investigate or solve (91%). Slightly more than a third of mentors reported helping students understand how STEM can help them improve their own community (36%).

Table 85. Mentors Using Strategies to Establish Relevance of Learning Activities (n=11)

	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%	
	11	0	**11**
Giving students real-life problems to investigate or solve	90.9%	9.1%	
	10	1	**11**
Selecting readings or activities that relate to students' backgrounds	72.7%	27.3%	
	8	3	**11**
Encouraging students to suggest new readings, activities, or projects	81.8%	18.2%	
	9	2	**11**
Helping students become aware of the role(s) that STEM plays in their everyday lives	63.6%	36.4%	
	7	4	**11**
Helping students understand how STEM can help them improve their own community	36.4%	63.6%	
	4	7	**11**
Asking students to relate real-life events or activities to topics covered in SEAP	54.5%	45.5%	
	6	5	**11**

Similarly, more than half of SEAP mentors (55%-91%) reported using most strategies to support the diverse needs of students as learners (Table 86). For example, nearly all mentors directed students to other individuals or programs for additional support as needed (91%) and identified different learning styles their students had at the beginning of the program (91%). Far fewer mentors reported integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (18%) and highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (18%).

Table 86. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=11)

	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	90.9%	9.1%	
	10	1	**11**
Interact with students and other personnel the same way regardless of their background	72.7%	27.3%	
	8	3	**11**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	72.7%	27.3%	
	8	3	**11**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	18.2%	81.8%	
	2	9	**11**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	54.5%	45.5%	
	6	5	**11**
Directing students to other individuals or programs for additional support as needed	90.9%	9.1%	
	10	1	**11**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	18.2%	81.8%	
	2	9	**11**

Approximately two-thirds or more of SEAP mentors (64%-91%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 87). Nearly all mentors indicated they had students listen to the ideas of others with an open mind (91%).

Table 87. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=11)

	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	63.6%	36.4%	
	7	4	**11**
Having my student(s) explain difficult ideas to others	81.8%	18.2%	
	9	2	**11**
Having my student(s) listen to the ideas of others with an open mind	90.9%	9.1%	
	10	1	**11**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	63.6%	36.4%	
	7	4	**11**
Having my student(s) give and receive constructive feedback with others	81.8%	18.2%	
	9	2	**11**
Having students work on collaborative activities or projects as a member of a team	81.8%	18.2%	
	9	2	**11**
Allowing my student(s) to resolve conflicts and reach agreement within their team	63.6%	36.4%	
	7	4	**11**

SEAP mentors were asked about strategies used to support students' engagement in authentic STEM activities (Table 88). Approximately two-thirds or more (64%-100%) of SEAP mentors reported using all of these strategies, and all mentors (100%) reported using six of the eight strategies listed.

Table 88. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=11)

	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%	
	11	0	**11**
Having my student(s) search for and review technical research to support their work	72.7%	27.3%	
	8	3	**11**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	11	0	**11**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	11	0	**11**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	11	0	**11**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	11	0	**11**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	63.6%	36.4%	
	7	4	**11**
Encouraging students to seek support from other team members	100.0%	0.0%	
	11	0	**11**

Approximately two-thirds or more of SEAP mentors (64%-91%) reported using most strategies focused on supporting students' STEM educational and career pathways (Table 89). Nearly all (91%) responding mentors reported asking students about their educational and career interests. Less than half of SEAP mentors reported using the following four strategies: helping students with their resumé, application, personal statement, and/or interview preparations (9%); discussing the economic, political, ethical, and/or social context of a STEM career (36%); and discussing STEM career opportunities in private industry or academia (46%).

Table 89. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=11)

	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	90.9%	9.1%	
	10	1	**11**
Recommending extracurricular programs that align with students' goals	63.6%	36.4%	
	7	4	**11**
Recommending Army Educational Outreach Programs that align with students' goals	63.6%	36.4%	
	7	4	**11**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	81.8%	18.2%	
	9	2	**11**
Discussing STEM career opportunities within the DoD or other government agencies	72.7%	27.3%	
	8	3	**11**
Discussing STEM career opportunities in private industry or academia	45.5%	54.5%	
	5	6	**11**
Discussing the economic, political, ethical, and/or social context of a STEM career	36.4%	63.6%	
	4	7	**11**
Recommending student and professional organizations in STEM to my student(s)	63.6%	36.4%	
	7	4	**11**
Helping students build a professional network in a STEM field	81.8%	18.2%	
	9	2	**11**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	9.1%	90.9%	
	1	10	**11**

Mentor Strategies and Support – University-Based Programs

REAP

More than three-quarters of REAP mentors (78%-98%) reported using all strategies to help make learning activities relevant to students (Table 90). For example, nearly all reported becoming familiar with their students' backgrounds and interests (98%), selecting readings/activities that relate to students' backgrounds (90%), and helping students become aware of the role STEM plays in their everyday lives (90%).

Table 90. Mentors Using Strategies to Establish Relevance of Learning Activities (n=40)

	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	97.5%	2.5%	
	39	1	**40**
Giving students real-life problems to investigate or solve	87.5%	12.5%	
	35	5	**40**
Selecting readings or activities that relate to students' backgrounds	90.0%	10.0%	
	36	4	**40**
Encouraging students to suggest new readings, activities, or projects	77.5%	22.5%	
	31	9	**40**
Helping students become aware of the role(s) that STEM plays in their everyday lives	90.0%	10.0%	
	36	4	**40**
Helping students understand how STEM can help them improve their own community	80.0%	20.0%	
	32	8	**40**
Asking students to relate real-life events or activities to topics covered in REAP	77.5%	22.5%	
	31	9	**40**

More than half of REAP mentors (60%-95%) reported using all strategies to support the diverse needs of students as learners (Table 91). Ninety percent or more of mentors reported interacting with students and other personnel the same way regardless of their background (90%); providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (90%); and using a variety of teaching and/or mentoring activities to meet the needs of all students (95%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (60%).

Table 91. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=40)

	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	77.5%	22.5%	
	31	9	**40**
Interact with students and other personnel the same way regardless of their background	90.0%	10.0%	
	36	4	**40**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	95.0%	5.0%	
	38	2	**40**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	80.0%	20.0%	
	32	8	**40**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	90.0%	10.0%	
	36	4	**40**
Directing students to other individuals or programs for additional support as needed	82.5%	17.5%	
	33	7	**40**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	60.0%	40.0%	
	24	16	**40**

More than three-quarters of REAP mentors (78%-98%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 92). Nearly all indicated they had students listen to the ideas of others with an open mind (98%).

Table 92. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=40)

	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	82.5%	17.5%	
	33	7	**40**
Having my student(s) explain difficult ideas to others	82.5%	17.5%	
	33	7	**40**
Having my student(s) listen to the ideas of others with an open mind	97.5%	2.5%	
	39	1	**40**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	87.5%	12.5%	
	35	5	**40**
Having my student(s) give and receive constructive feedback with others	95.0%	5.0%	
	38	2	**40**
Having students work on collaborative activities or projects as a member of a team	95.0%	5.0%	
	38	2	**40**
Allowing my student(s) to resolve conflicts and reach agreement within their team	77.5%	22.5%	
	31	9	**40**

When asked about strategies to support students' engagement in authentic STEM activities (Table 93), more than 90% (95% - 100%) of REAP mentors reported using all strategies. All REAP mentors reportedly supervised students while they practiced STEM research skills (100%) and provided students with constructive feedback to improve their STEM competencies (100%).

Table 93. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=40)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	92.5%	7.5%	
	37	3	**40**
Having my student(s) search for and review technical research to support their work	95.0%	5.0%	
	38	2	**40**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	97.5%	2.5%	
	39	1	**40**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	40	0	**40**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	40	0	**40**
Allowing students to work independently to improve their self-management abilities	95.0%	5.0%	
	38	2	**40**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	95.0%	5.0%	
	38	2	**40**
Encouraging students to seek support from other team members	97.5%	2.5%	
	39	1	**40**

More than half of REAP mentors (58%-95%) reported using strategies focused on supporting students' STEM educational and career pathways (Table 94). Nearly all (95%) reported asking students about their educational and career interests. More than 90% also provided guidance about educational pathways that will prepare students for a STEM career (92%). Fewer mentors reported helping students with their resumé, application, personal statement, and/or interview preparations (58%).

Table 94. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=40)

	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	95.0%	5.0%	
	38	2	**40**
Recommending extracurricular programs that align with students' goals	80.0%	20.0%	
	32	8	**40**
Recommending Army Educational Outreach Programs that align with students' goals	65.0%	35.0%	
	26	14	**40**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	92.5%	7.5%	
	37	3	**40**
Discussing STEM career opportunities within the DoD or other government agencies	62.5%	37.5%	
	25	15	**40**
Discussing STEM career opportunities in private industry or academia	85.0%	15.0%	
	34	6	**40**
Discussing the economic, political, ethical, and/or social context of a STEM career	72.5%	27.5%	
	29	11	**40**
Recommending student and professional organizations in STEM to my student(s)	70.0%	30.0%	
	28	12	**40**
Helping students build a professional network in a STEM field	70.0%	30.0%	
	28	12	**40**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	57.5%	42.5%	
	23	17	**40**

HSAP

Half or more of HSAP mentors (50%-86%) reported using all strategies to help make learning activities relevant to students (Table 95). Three-quarters or more of responding mentors reported using each strategy with the exception of helping students understand how STEM can help them improve their own community (50%) and asking students to relate real-life events or activities to topics covered in HSAP (57%).

Table 95. Mentors Using Strategies to Establish Relevance of Learning Activities (n=14)

	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	85.7%	14.3%	
	12	2	**14**
Giving students real-life problems to investigate or solve	78.6%	21.4%	
	11	3	**14**
Selecting readings or activities that relate to students' backgrounds	71.4%	28.6%	
	10	4	**14**
Encouraging students to suggest new readings, activities, or projects	85.7%	14.3%	
	12	2	**14**
Helping students become aware of the role(s) that STEM plays in their everyday lives	78.6%	21.4%	
	11	3	**14**
Helping students understand how STEM can help them improve their own community	50.0%	50.0%	
	7	7	**14**
Asking students to relate real-life events or activities to topics covered in HSAP	57.1%	42.9%	
	8	6	**14**

More than half of mentors (57%-93%) reported using each strategy to support the diverse needs of students as learners (Table 96). The only two items used by less than 80% of mentors were integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (57%) and highlighting under-representation of women and racial/ethnic minority populations in STEM (57%).

Table 96. Mentors Using Strategies to Support the Diverse needs of Students as Learners (n=14)

	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	92.9%	7.1%	
	13	1	**14**
Interact with students and other personnel the same way regardless of their background	85.7%	14.3%	
	12	2	**14**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	92.9%	7.1%	
	13	1	**14**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	57.1%	42.9%	
	8	6	**14**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	92.9%	7.1%	
	13	1	**14**
Directing students to other individuals or programs for additional support as needed	92.9%	7.1%	
	13	1	**14**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	57.1%	42.9%	
	8	6	**14**

More than three-quarters of mentors (79%-100%) indicated they used each strategy to support student development of collaboration and interpersonal skills (Table 97). All mentors reported having students explain difficult ideas to others (100%), having students give/receive constructive feedback with others (100%), and having students work on collaborative activities/projects as a member of a team (100%).

Table 97. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=14)

	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	85.7%	14.3%	
	12	2	**14**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	14	0	**14**
Having my student(s) listen to the ideas of others with an open mind	92.9%	7.1%	
	13	1	**14**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	92.9%	7.1%	
	13	1	**14**
Having my student(s) give and receive constructive feedback with others	100.0%	0.0%	
	14	0	**14**
Having students work on collaborative activities or projects as a member of a team	100.0%	0.0%	
	14	0	**14**
Allowing my student(s) to resolve conflicts and reach agreement within their team	78.6%	21.4%	
	11	3	**14**

More than 90% of responding HSAP mentors (all or all but one mentor) indicated using each strategy to support student engagement in authentic STEM activities (Table 98).

Table 98. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=14)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	92.9%	7.1%	
	13	1	**14**
Having my student(s) search for and review technical research to support their work	85.7%	14.3%	
	12	2	**14**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	92.9%	7.1%	
	13	1	**14**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	14	0	**14**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	14	0	**14**
Allowing students to work independently to improve their self-management abilities	92.9%	7.1%	
	13	1	**14**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	14	0	**14**
Encouraging students to seek support from other team members	100.0%	0.0%	
	4	0	**4**

More than half of HSAP mentors (57%-100%) reported using all strategies focused on supporting students' STEM educational and career pathways (Table 99). All mentors reported providing guidance about educational pathways that will prepare students for STEM careers (100%). The strategy least used by mentors was discussing the economic, political, ethical, and/or social context of a STEM career (57%).

Table 99. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=14)

	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	92.9%	7.1%	
	13	1	**14**
Recommending extracurricular programs that align with students' goals	64.3%	35.7%	
	9	5	**14**
Recommending Army Educational Outreach Programs that align with students' goals	78.6%	21.4%	
	11	3	**14**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	100.0%	0.0%	
	14	0	**14**
Discussing STEM career opportunities within the DoD or other government agencies	64.3%	35.7%	
	9	5	**14**
Discussing STEM career opportunities in private industry or academia	78.6%	21.4%	
	11	3	**14**
Discussing the economic, political, ethical, and/or social context of a STEM career	57.1%	42.9%	
	8	6	**14**
Recommending student and professional organizations in STEM to my student(s)	78.6%	21.4%	
	11	3	**14**
Helping students build a professional network in a STEM field	78.6%	21.4%	
	11	3	**14**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	71.4%	28.6%	
	10	4	**14**

URAP

Approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to help make learning activities relevant to students (Table 100). Strategies reportedly implemented most frequently (nearly all mentors) were becoming familiar with their students' backgrounds and interests (96%), giving students real-life problems to investigate or solve (93%), and selecting readings/activities that relate to students' backgrounds (93%).

Table 100. Mentors Using Strategies to Establish Relevance of Learning Activities (n=28)

	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	96.4%	3.6%	
	27	1	**28**
Giving students real-life problems to investigate or solve	92.9%	7.1%	
	26	2	**28**
Selecting readings or activities that relate to students' backgrounds	92.9%	7.1%	
	26	2	**28**
Encouraging students to suggest new readings, activities, or projects	85.7%	14.3%	
	24	4	**28**
Helping students become aware of the role(s) that STEM plays in their everyday lives	78.6%	21.4%	
	22	6	**28**
Helping students understand how STEM can help them improve their own community	64.3%	35.7%	
	18	10	**28**
Asking students to relate real-life events or activities to topics covered in URAP	75.0%	25.0%	
	21	7	**28**

Similarly, approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to support the diverse needs of students as learners (Table 101). More than 90% of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (93%) and providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (96%). Fewer mentors reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (64%).

Table 101. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=28)

	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	82.1%	17.9%	
	23	5	**28**
Interact with students and other personnel the same way regardless of their background	75.0%	25.0%	
	21	7	**28**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	92.9%	7.1%	
	26	2	**28**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	71.4%	28.6%	
	20	8	**28**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	96.4%	3.6%	
	27	1	**28**
Directing students to other individuals or programs for additional support as needed	85.7%	14.3%	
	24	4	**28**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	64.3%	35.7%	
	18	10	**28**

More than 70% of URAP mentors (71%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 102). All mentors reported having students work on collaborative activities/projects as a member of a team (100%).

Table 102. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=28)

	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	71.4%	28.6%	
	20	8	**28**
Having my student(s) explain difficult ideas to others	92.9%	7.1%	
	26	2	**28**
Having my student(s) listen to the ideas of others with an open mind	92.9%	7.1%	
	26	2	**28**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	89.3%	10.7%	
	25	3	**28**
Having my student(s) give and receive constructive feedback with others	96.4%	3.6%	
	27	1	**28**
Having students work on collaborative activities or projects as a member of a team	100.0%	0.0%	
	28	0	**28**
Allowing my student(s) to resolve conflicts and reach agreement within their team	85.7%	14.3%	
	24	4	**28**

When asked about strategies to support students' engagement in authentic STEM activities (Table 103), more than 90% of URAP mentors (93%-100%) reported using all strategies.

Table 103. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=28)

	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%	
	28	0	**28**
Having my student(s) search for and review technical research to support their work	92.9%	7.1%	
	26	2	**28**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	92.9%	7.1%	
	26	2	**28**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	28	0	**28**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	28	0	**28**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	28	0	**28**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	96.4%	3.6%	
	27	1	**28**
Encouraging students to seek support from other team members	100.0%	0.0%	
	28	0	**28**

More than half of URAP mentors (54%-93%) reported using all strategies focused on supporting students' STEM educational and career pathways (Table 104). Nearly all responding URAP mentors reported asking students about their educational and career goals (93%), providing guidance about educational pathways that will prepare students for a STEM career (93%), and discussing STEM career opportunities in private industry or academia (93%). Far fewer mentors reported recommending AEOPs that align with student goals (54%) and discussing STEM career opportunities within the DoD (57%).

Table 104. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=28)

	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	92.9%	7.1%	
	26	2	**28**
Recommending extracurricular programs that align with students' goals	75.0%	25.0%	
	21	7	**28**
Recommending Army Educational Outreach Programs that align with students' goals	53.6%	46.4%	
	15	13	**28**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	92.9%	7.1%	
	26	2	**28**
Discussing STEM career opportunities within the DoD or other government agencies	57.1%	42.9%	
	16	12	**28**
Discussing STEM career opportunities in private industry or academia	92.9%	7.1%	
	26	2	**28**
Discussing the economic, political, ethical, and/or social context of a STEM career	67.9%	32.1%	
	19	9	**28**
Recommending student and professional organizations in STEM to my student(s)	67.9%	32.1%	
	19	9	**28**
Helping students build a professional network in a STEM field	67.9%	32.1%	
	19	9	**28**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	60.7%	39.3%	
	17	11	**28**

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). More than 80% of CQL apprentices (81%-94%) reported being somewhat or very much satisfied with all of the listed program features except for other administrative tasks such as security clearances and issuance of CAC cards (47%). Features apprentices reported being most satisfied with included: amount of the stipend (94%); teaching/mentoring provided (94%); and applying/registering for the program (92%).

Table 105. Student Satisfaction with CQL Program Features (n=47)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	8.5%	42.6%	48.9%	
	0	0	4	20	23	**47**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	0.0%	21.3%	31.9%	25.5%	21.3%	
	0	10	15	12	10	**47**
Communicating with your host site organizers	0.0%	4.3%	8.5%	29.8%	57.4%	
	0	2	4	14	27	**47**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	10.6%	12.8%	76.6%	
	0	0	5	6	36	**47**
The variety of STEM topics available to you in the Apprenticeship Program	2.1%	2.1%	14.9%	12.8%	68.1%	
	1	1	7	6	32	**47**
Teaching or mentoring provided during Apprenticeship Program activities	2.1%	2.1%	2.1%	14.9%	78.7%	
	1	1	1	7	37	**47**
Amount of stipend (payment)	2.1%	0.0%	4.3%	29.8%	63.8%	
	1	0	2	14	30	**47**
	2.1%	6.4%	10.6%	17.0%	63.8%	

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Timeliness of receiving stipend (payment)	1	3	5	8	30	**47**
Research abstract preparation requirements	4.3%	6.4%	8.5%	27.7%	53.2%	
	2	3	4	13	25	**47**

CQL apprentices were asked about the availability of their mentors during their program (Table 106). All reported that their mentors were available at least half of the time (100%), and more than half (62%) indicated their mentors were always available.

Table 106. Apprentice Reports of Availability of Mentors (n=47)

	Response Percent	Response Total
I did not have a mentor	0%	0
The mentor was never available	0%	0
The mentor was available less than half of the time	2.1 %	1
The mentor was available about half of the time of my project	12.8%	6
The mentor was available more than half of the time	23.4%	11
The mentor was always available	61.7%	29

CQL apprentices were asked about their satisfaction with elements of their research experience (Table 107). Approximately 90% or more indicated being at least somewhat satisfied with all elements. Nearly all were at least somewhat satisfied with their working relationship with their mentor (98%).

Table 107. Apprentice Satisfaction with Their Experience (n=47)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	2.1%	10.6%	87.2%	
	0	0	1	5	41	**47**
My working relationship with the group or team	4.3%	0.0%	2.1%	14.9%	78.7%	
	2	0	1	7	37	**47**
The amount of time I spent doing meaningful research	2.1%	0.0%	8.5%	21.3%	68.1%	
	1	0	4	10	32	**47**
The amount of time I spent with my research mentor	2.1%	0.0%	8.5%	8.5%	80.9%	
	1	0	4	4	38	**47**
The research experience overall	2.1%	0.0%	2.1%	10.6%	85.1%	
	1	0	1	5	40	**47**

An open-ended item on the questionnaire asked apprentices about their overall satisfaction with their CQL experience. All but 1 of the 46 apprentices who responded to the item had something positive to say about their experience. The apprentices who provided detailed comments about their satisfaction cited their mentors, the career information they received, their learning, and the stipend as sources of their satisfaction. For example,

> *"I really enjoyed my experience with CQL…Everyone I worked with in the lab, especially my mentors, were amazing. I had never taken an immunology or microbiology course before this internship, but I will be leaving with so much knowledge of the topics. My mentor took the time to help me learn!"* (CQL Apprentice)

> *"I am very satisfied with my Apprenticeship Program experience. I would highly recommend my colleagues to look into participating in the program to understand what a career in the Army or DoD is like. I certainly gained a better idea of what a career in the Army or DoD is like. I can confidently say that I am considering this career path because of my time in the program."* (CQL Apprentice)

Eight of the apprentice respondents (17%) provided positive comments about their CQL experiences but also offered some caveats. These caveats included lack of opportunities for apprentices to interact with one another, difficulties in finding housing, dissatisfaction with apprentice choice in projects, dissatisfaction with security and CAC card procedures, lack of communication from the program, dissatisfaction with stipend payment procedures, and dissatisfaction with application procedures. For example,

> *"Overall, I had a great experience. I learned a lot about what careers in research are like, and confirmed that it's the type of career I would like to pursue…The application and logistics process of this program could be improved though. I feel like I was given very little information about how I would get started working here: I was basically just given a start date and a room number to show up at. I wish I had more information about work procedures before I started. Also, it was difficult for me to find an affordable place to stay that was close to work and furnished."* (CQL Apprentice)

> *"[My mentors] were both excellent mentors…[but] none of the students nor the mentors in our group received any updates about the apprenticeship aside from the first newsletter which was largely unhelpful. We never received a date for the presentations, or even the link to the abstract submissions. We found out when the presentations were 2 days after they happened from an intern in a different group, and that posters were due the week before…Another issue that was not as impactful but still quite infuriating was that the group handling the issuing of stipends changed every month requiring more paperwork, only notifying us only 1 or 2 days before the deadline of the paperwork. I was unable to get information from my bank in time and thus had to*

have one of the deposits put in a family member's account and have them wire transfer it to me." (CQL Apprentice)

"Satisfied overall with the experiences gained with the mentor, however was not given adequate time beforehand to read previous literature by mentor, as I was not told who it would be until two weeks before I started. Security process and getting a CAC and a full computer account was a nightmare." (CQL Apprentice)

Only 1 apprentices had nothing positive to say about his CQL experience. This apprentice indicated that his mentor was rarely available, saying,

"My mentor wasn't really available during the internship and when he was, he was very vague and confusing in expressing his instructions." (CQL Apprentice)

An open-ended questionnaire item asked apprentices to list three benefits of CQL. The 47 apprentices who responded cited a variety of benefits. The most frequently mentioned (30 apprentices or 64%) were the real-world and hands-on lab experiences they gained. Another 43%-45% of these apprentices (20 or 21) cited specific STEM skills they had gained, the career information they received, and the opportunities to network as benefits of CQL. Over a third (18, or 38%) cited their STEM learning as a benefit, and nearly a quarter (11, or 23%) mentioned the value of the DoD information they received. Other benefits, none mentioned by more than seven respondents (15%), included developing communication skills, developing workplace skills, the mentoring they received, increases in their motivation for graduate school and/or research, the value of CQL in resumé building, and the opportunity to develop workplace skills.

Focus group participants were also asked to comment upon the benefits of CQL. These apprentices also cited the value of real-world, hands on lab experience as a key benefit of CQL, and appreciated the opportunity to participate in research they viewed as meaningful. Apprentices added that they valued the unique access to high-tech equipment and cutting-edge research that CQL gave them, indicated that it improved their confidence, and helped them develop problem solving skills Apprentices said, for example,

"This [CQL research] matters. We are actually changing people's lives. We are like, 'Even if we are a tiny little cog in a really big machine, we are still helping.' That's really important to me." (CQL Apprentice)

"I feel more confident going into a project where I have to do my own thing and figure stuff out now." (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)

"[A benefit to CQL] is building up the skills I've learned in school." (CQL Apprentice)

Apprentices were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The two most frequently suggested improvements among the 45 apprentices who responded (each suggested by 17 apprentices, or 38%) were to provide more opportunities for apprentices to connect with one another and to provide better communication from the program. Another 16 apprentices (36%) suggested less paperwork and/or more streamlined in-processing, including issuance of CAC cards. Improvements to stipends were mentioned by over a quarter of respondents (12, or 27%). Some apprentices found the changes in organizations processing their stipends troubling, and also suggested more frequent payment of or larger stipends. Ten apprentices (22%) commented upon the abstract requirements, suggesting earlier or clearer communication of requirements. Other improvements, suggested by five or six apprentices (11%-13%) included providing apprentices with a choice of projects, providing assistance with locating housing, providing an orientation to apprentices before their start date, and providing a wider variety of or more in-person (rather than video) presentations.

Apprentices participating in focus groups were also asked for their opinions about how the CQL program could be improved. Their responses primarily mirrored the comments above, including requests for better communication and orientation and more information about abstracts, although one participant suggested ensuring that mentors are more available, noting that he saw his mentor only twice during the program.

CQL mentors were also asked about their satisfaction with program features (Table 108). More than half of mentors (53%-87%) reported being at least somewhat satisfied with all program features except for the following two items that large proportions of mentors had not experienced: communicating with RIT (53% had not experienced) and support for instruction/mentorship during program activities (40% had not experienced). Areas of greatest satisfaction (somewhat or very much) were amount of stipends for apprentices (87%); timeliness or stipend payment (73%); and application/registration process (73%).

Table 108. Mentor Satisfaction with CQL Program Features (n=15)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	13.3%	6.7%	6.7%	46.7%	26.7%	
	2	1	1	7	4	**15**
Other administrative tasks (in-processing, network access, etc.)	26.7%	6.7%	13.3%	46.7%	6.7%	
	4	1	2	7	1	**15**
Communicating with Rochester Institute of Technology (RIT)	53.3%	6.7%	13.3%	13.3%	13.3%	
	8	1	2	2	2	**15**
Communicating with CQL organizers	20.0%	6.7%	6.7%	33.3%	33.3%	
	3	1	1	5	5	**15**
Support for instruction or mentorship during program activities	40.0%	6.7%	13.3%	20.0%	20.0%	
	6	1	2	3	3	**15**
Amount of stipends for apprentices (payment)	13.3%	0.0%	0.0%	33.3%	53.3%	
	2	0	0	5	8	**15**
Timeliness of stipend payment to apprentices	20.0%	0.0%	6.7%	26.7%	46.7%	
	3	0	1	4	7	**15**
Research abstract preparation requirements	20.0%	6.7%	6.7%	40.0%	26.7%	
	3	1	1	6	4	**15**
Research presentation process	13.3%	13.3%	20.0%	33.3%	20.0%	
	2	2	3	5	3	**15**

Mentors were also asked to respond to open-ended items asking for their opinions about the program. When asked about their satisfaction with CQL, 10 of the 11 respondents had something positive to say. Mentors who provided details about their satisfaction cited the quality of the students in the program, the help they received with research, and the career information apprentices received. Mentors said, for example,

> *"I had an excellent student. He was very self motivated and successfully completed tasks that he didn't know how to accomplish at the beginning of the program. He worked quite independently and did very impressive work."* (CQL Mentor)

"[The CQL] program provides excellent exposure to STEM professional environments; opportunities to attempt scientific investigations and all that is entailed, [including] exercising the steps of the scientific method, formulating relevant research questions, acumen in gaining familiarity with prior work, deciding an appropriate experimental design, interpreting results, and envisioning future research. Applications to real-world problems were also important topics." (CQL Mentor)

Another open-ended item asked mentors to identify the three most important strengths of CQL. Fifteen mentors identified at least one strength of the program. The most frequently mentioned strength, mentioned by 10 respondents (67%), was the research and hands-on experience apprentices received. Other strengths, mentioned by three or four mentors (20%-26%) included the career information apprentices received, the opportunity to network, and the value of CQL in developing the future workforce.

Mentors participating in focus groups echoed these themes. These mentors emphasized the insight apprentices gain about their career goals, their experience in real-world scientific research, the value of the lab work the apprentices perform, and the opportunity to develop the lab's future workforce. Mentors said, for example,

"The CQL program provides unparalleled opportunity in research. It provides direct experience for the students to get their hands dirty in the laboratory or with a computer if they're working on virtual research, where they wouldn't have that experience in the classroom." (CQL Mentor)

"Really getting the hands on to reinforce classroom concepts, it advances their learning and helps us as well. We're training the next generation of scientists." (CQL Mentor)

One of the mentors who participated in a focus group had been a CQL apprentice and credited his career as an Army S&E to the program and emphasized the value of the CQL apprentices to his current work. He said,

"I just want to thank everybody that's involved because, first of all, having been a participant in CQL and the SMART program myself, I wouldn't be here without the AEOP and everyone behind it. Thank you. Now today as a researcher, I couldn't do my job without the CQL program, specifically. It's the easiest and best way that I can get the best talent to work with me here at the lab." (CQL Mentor)

Mentors were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The 13 mentors who responded made a variety of suggestions. The most frequently mentioned suggestion (mentioned by six mentors, or 46%) was to provide better communication with the program. Five mentors suggested having less paperwork and/or streamlining apprentice onboarding procedures as an improvement. Two mentors (15%) suggested providing mentor orientation or preparation. No other suggestion was made by more than one mentor.

Mentors participating in focus groups also offered a variety of suggestion for program improvement. These mentors suggested providing institutional support for apprentices and incentives for mentors, holding meet and greets with potential apprentices before selections are made, and improving AEOP marketing materials. For example, mentors said,

> *"There needs to be a concerted effort by command to get behind this program, and for PIs to take on the students. There needs to be an incentive offered."* (CQL Mentor)
>
> *"Most of the marketing that I see is a little bit stuffy, in a way. It's always folks in safety glasses and lab coats with test tubes, which is so far from the research that we actually do here."* (CQL Mentor)

CQL apprentices were asked to report on their input into the design of their projects (Table 109). Only one apprentice (2%) reported independently designing their entire project, however 47% indicated they had some input or choice in project design. Approximately 43% of apprentices reported being assigned a project by their mentors.

Table 109. Apprentice Input on Design of Their Project (n=47)

	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	42.5%	20
I worked with my mentor to design a project	12.8%	6
I had a choice among various projects suggested by my mentor	21.3%	10
I worked with my mentor and members of a research team to design a project	12.8%	6
I designed the entire project on my own	2.1%	1
I worked on various projects for other mentors	8.5%	4

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 (64%). Few (13%) worked in isolation with their research mentor, and approximately 23% of apprentices worked collaboratively in a group on the same project.

Table 110. Apprentice Participation in a Research Group (n=47)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	12.8%	6
I worked with others in a shared laboratory or other space, but we worked on different projects	31.9%	15
I worked alone on my project and I met with others regularly for general reporting or discussion	17.0%	8
I worked alone on a project that was closely connected with projects of others in my group	14.9%	7
I worked with a group who all worked on the same project	23.4%	11

SEAP

Apprentices were asked how satisfied they were with a number of features of the SEAP program (Table 111). More than 80% of SEAP apprentices (82%-100%) reported being somewhat or very much satisfied with all of the listed program features except for other administrative tasks such as security clearances and issuance of CAC cards (27%). All apprentices reported being at least somewhat satisfied with the physical location of their apprenticeship activities (100%).

Table 111. Student Satisfaction with SEAP Program Features (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	18.2%	27.3%	54.5%	
	0	0	2	3	6	**11**
Other administrative tasks (security clearances, issuing CAC cards, etc.)	0.0%	18.2%	54.5%	9.1%	18.2%	
	0	2	6	1	2	**11**
Communicating with your host site organizers	0.0%	0.0%	9.1%	18.2%	72.7%	
	0	0	1	2	8	**11**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	0.0%	18.2%	81.8%	
	0	0	0	2	9	**11**
The variety of STEM topics available to you in the Apprenticeship Program	0.0%	0.0%	9.1%	18.2%	72.7%	
	0	0	1	2	8	**11**
Teaching or mentoring provided during Apprenticeship Program activities	9.1%	0.0%	0.0%	9.1%	81.8%	
	1	0	0	1	9	**11**
Amount of stipends (payment)	0.0%	0.0%	9.1%	27.3%	63.6%	

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
	0	0	1	3	7	**11**
Timeliness of payment of stipends (payment)	0.0%	18.2%	0.0%	18.2%	63.6%	
	0	2	0	2	7	**11**
Research abstract preparation requirements	0.0%	9.1%	9.1%	0.0%	81.8%	
	0	1	1	0	9	**11**

Apprentices were also asked about the availability of their mentors during SEAP (Table 112). All apprentices reported that their mentors were available at least half of the time (100%), and 82% indicated their mentors were always available.

Table 112. Apprentice Reports of Availability of Mentors (n=11)

	Response Percent	Response Total
I did not have a mentor	0%	0
The mentor was never available	0%	0
The mentor was available less than half of the time	0%	0
The mentor was available about half of the time of my project	18.18%	2
The mentor was available more than half of the time	0%	0
The mentor was always available	81.82%	9

SEAP apprentices were asked about their satisfaction with various elements of their research experience (Table 113). More than 90% of SEAP apprentices reported being at least somewhat satisfied with each experience. All reported being at least somewhat satisfied with the research experience overall (100%) and the amount of time they spent doing meaningful research (100%).

Table 113. Apprentice Satisfaction with Their Experience (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	9.1%	9.1%	81.8%	
	0	0	1	1	9	**11**
My working relationship with the group or team	9.1%	0.0%	0.0%	9.1%	81.8%	
	1	0	0	1	9	**11**
The amount of time I spent doing meaningful research	0.0%	0.0%	0.0%	27.3%	72.7%	
	0	0	0	3	8	**11**
The amount of time I spent with my research mentor	0.0%	0.0%	9.1%	18.2%	72.7%	
	0	0	1	2	8	**11**
The research experience overall	0.0%	0.0%	0.0%	18.2%	81.8%	
	0	0	0	2	9	**11**

SEAP apprentices were asked to comment on their overall satisfaction with their SEAP experiences in an open-ended questionnaire item. All but one of the 11 apprentices who provided a response made positive comments, focusing on their opportunities to experience real-life hands-on research, their mentors, and the learning they experienced. Apprentices said, for example,

> *"I had an amazing experience. My mentor was always understanding and so caring. She contributed so much to the new information I have learned in terms of both core STEM knowledge and troubleshooting when an experiment does not go as expected. This was a very valuable unique experience."* (SEAP Apprentice)

> *"I really enjoyed my [SEAP] experience this summer. I loved being able to see what it's like to work in a real laboratory and outside of a classroom. It was cool also see how the things I learned in my biomed classes actually connected to the real world. I got to grow so much this summer as a student and a scientist. This apprenticeship really helped me on my path on becoming a biomedical engineer and I hope to come back next year!"* (SEAP Apprentice)

Two of the apprentices responded with positive comments, but offered caveats as well. These caveats focused on a desire for more hands-on content and a comment about lack of guidance and orientation early in their apprenticeships. One apprentices said,

> *"My overall satisfaction with my Apprenticeship Program was generally positive…I felt like my time here could have been more hands on, given that I mostly worked with a computer software where I created an organized database…One aspect of this program that I would change would*

be the initial introduction to the institute. Although, people were willing to help and guide individuals around this was only offered if an individual were to ask around. If there was no previous knowledge of the building or if someone did not have a friend to guide them around, a person would most likely be lost." (SEAP Apprentice)

The one apprentice who did not make any positive comments cited dissatisfaction with communication regarding the stipend processing, saying,

"I wasn't paid according to the initial schedule because the people in charge of that kept changing. I understand that sometimes these changes are necessary but I would like these to be communicated better, rather than just receiving an email out of nowhere and questioning its legitimacy." (SEAP Apprentice)

In another open-ended questionnaire item, SEAP apprentices were asked to name three benefits of SEAP. The 11 apprentices who responded cited a variety of benefits. The most frequently cited benefits were gaining STEM skills and/or research experience (mentioned by eight apprentices), the real-world research experience they gained (six apprentices), the opportunities to network (five apprentices), and career information and exposure (five apprentices). Other benefits, mentioned two or three times, included confirmation of interests for college programs and teamwork.

Apprentices participating in focus groups also cited a number of benefits of participating in SEAP. These apprentices focused on their exposure to real-world research in an authentic workplace, gaining STEM skills and knowledge, gaining career information, the opportunity to work independently, and making friends. For example,

"I like how it's like a real workplace. You get to learn more about the jobs that real people have." (SEAP Apprentice)

"We're actually taking our knowledge and applying it to the real world and using it to be inventive and to investigate problems that haven't been solved yet." (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)

"I didn't realize how much just being in an environment where these interesting topics are being talked about all the time would do for my knowledge...Listening to the conversations, you pick up so much more than you think you do. Just being in this environment, I've learned so much without even realizing that I'm learning it." (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 ten apprentices who responded offered a variety of suggestions. The most frequently mentioned improvement (mentioned by seven apprentices) was providing guidance or orientation for new apprentices orientation and/or improving in-processing procedures. Six apprentices suggested improving communication, and five suggested providing more opportunities for apprentices to interact. Two apprentices suggested improvements to the stipend payment system, citing confusing rules and the change in the organization processing the payments. Suggestions mentioned by just one apprentice included providing a choice of research topic, providing assistance with housing, and providing information about the SMART scholarship.

SEAP apprentices participating in focus groups echoed some of these suggestions for improvements, and added suggestions for earlier contact with mentors, better site preparation (e.g., ensuring that apprentices have access to computers), and bringing SEAP alumni in to make presentations on topics such as applying to college. Apprentices in focus groups at one site were particularly concerned about their lack of opportunity to connect with other apprentices. As two apprentices said,

> *"I think it's important to network with people your age, as well, just to see where they are. I know it's a great experience to be around adults, but you can also learn a lot from your peers and see what they're doing."* (SEAP Apprentice)

> *"I feel disconnected. I don't know what they're all working on. It'll be really cool to have something where we are able to see what everyone is doing."* (SEAP Apprentice)

SEAP mentors were also asked about their satisfaction with the program components they experienced (Table 114). More than half of mentors (55%-73%) reported being at least somewhat satisfied with all features except for the following three: communicating with SEAP organizers (82% did not experience), other administrative tasks (18% did not experience and 27% were not at all satisfied), and research abstract preparation requirements (27% did not experience). Approximately three-quarters of SEAP mentors were at least somewhat satisfied with the application/registration process (73%).

Table 114. Mentor Satisfaction with SEAP Program Features (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	27.3%	0.0%	0.0%	63.6%	9.1%	
	3	0	0	7	1	**11**
Other administrative tasks (in-processing, network access, etc.)	18.2%	27.3%	18.2%	18.2%	18.2%	
	2	3	2	2	2	**11**
Communicating with SEAP organizers	81.8%	0.0%	0.0%	9.1%	9.1%	
	9	0	0	1	1	**11**
Support for instruction or mentorship during program activities	18.2%	0.0%	18.2%	18.2%	45.5%	
	2	0	2	2	5	**11**
Amount of stipends (payment)	27.3%	0.0%	18.2%	27.3%	27.3%	
	3	0	2	3	3	**11**
Timeliness of payment (stipends)	27.3%	0.0%	9.1%	0.0%	63.6%	
	3	0	1	0	7	**11**
Research presentation process	36.4%	0.0%	0.0%	0.0%	63.6%	
	4	0	0	0	7	**11**
Research abstract preparation requirements	27.3%	0.0%	27.3%	27.3%	18.2%	
	3	0	3	3	2	**11**

Mentors were also asked to respond to an open-ended questionnaire item asking them to comment on their overall satisfaction with SEAP. Of the five mentors responded to this item, two made positive comments. The other three mentors commented only upon aspects of SEAP with which they were dissatisfied, including the website and the in-processing and CAC card procurement procedures. In contrast, all mentors participating in focus groups made positive comments about SEAP. For example,

> *"I think it's almost unmatched program for the opportunity to work in a lab, and to really get lab exposure if they're interested in a career in science"* (SEAP Mentor)

In another open-ended questionnaire item, mentors were asked to identify the three most important strengths of SEAP. Nine mentors provided responses and emphasized the value of apprentices' exposure to hands-on real-world research, the value of the mentorship experience, the exposure to DoD research, the career information apprentices received, the value of networking with STEM professionals, and the program structure. Mentors also commented that having assistance in their labs, apprentices' opportunities to work in teams, and communication with the program are strengths of SEAP.

Mentors participating in focus groups echoed these themes, and added that apprentices gain unique access to high-tech lab equipment, are exposed to a broad variety of research, and gain information about the Army. These mentors also commented upon the benefits they experience as mentors, noting that they appreciate the assistance in their labs and generally enjoy acting as mentors. For example,

> *"At the end of the summer [the apprentices] give presentations on what they're done in their individual labs. In addition to the students seeing in great detail what goes in the particular lab they're located at, they get to also get a sampling from their peers, of what the others are doing in the other laboratories."* (SEAP Mentor)

> *''It's just fun to be able to mentor and teach people things. It can be time consuming, but we do it because we enjoy it. Also, I should mention that my students, a couple of them, have done really good projects that I've been able to use after they leave. If they're trained well enough then you can get some definite benefit back from them."* (SEAP Mentor)

Mentors were also asked in a questionnaire item to suggest three ways in which SEAP could be improved for future participants. The eight mentors who responded provided a wide range of improvements. The most frequently suggested improvement (mentioned by four mentors) was to reduce the amount of paperwork and/or improving in-processing procedures. Three mentors suggested providing seminars or training for apprentices throughout the summer and providing more clear learning objectives and/or expectations for apprentices' presentations. Other improvements, mentioned by one or two mentors included:

- Providing ways for mentors and apprentices to connect before apprentices' start date
- Increasing advertising for the program in schools
- Avoiding changing administrative organizations mid-way through the summer
- Ensuring that apprentices have internet access on site
- Eliminating the presentation requirement

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

- Providing ways for mentors and apprentices to connect before apprentices' start date
- Improving apprentice selection procedures to avoid nepotism
- Providing expectations and a program overview for mentors
- Providing mentors for mentors
- Providing feedback for mentors about the quality of their mentoring
- Providing more information about presentation requirements and/or providing examples of presentations

Mentors said, for example,

> *"I feel like getting to know your intern [before the start of the apprenticeship] and having them know you would be nice, because then they're a little bit more comfortable, and it doesn't take a whole month for them to come out of their shell and start talking to you."* (SEAP Mentor)

> *"For new mentors, have a list of expectations of the mentors. I'm also flying blind. I'm like, 'What would I have liked to have known if I were doing this as a high school student?' I'm trying to provide her with that information. I would love [information about] this is what we expect from our mentors, and this is what we expect or this is what we anticipate our interns learning by the end of the first summer*" (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 apprentice selection. Mentors noted that outreach programs to local schools could be productive in broadening the application base. Mentors also noted that many apprentices are relatives of those working in the lab and suggested that there might be ways that selection procedures could be revised in order to avoid this bias in selection.

SEAP apprentices were asked to report on their input into the design of their projects (Table 115). No apprentices reported independently designing their entire project. However, 45% indicated they had some input or choice in project design. Approximately 36% of apprentices reported being assigned a project by their mentors.

Table 115. Apprentice Input on Design of Their Project (n=11)

	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	36.36%	4
I worked with my mentor to design a project	18.18%	2
I had a choice among various projects suggested by my mentor	27.27%	3
I worked with my mentor and members of a research team to design a project	0%	0
I designed the entire project on my own	0%	0
I worked on various projects for other mentors	18.18%	2

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 (64%). Few (9%) worked in isolation with their research mentor, and 27% of apprentices worked collaboratively in a group on the same project.

Table 116. Apprentice Participation in a Research Group (n=11)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	9.09%	1
I worked with others in a shared laboratory or other space, but we worked on different projects	36.36%	4
I worked alone on my project and I met with others regularly for general reporting or discussion	0%	0
I worked alone on a project that was closely connected with projects of others in my group	27.27%	3
I worked with a group who all worked on the same project	27.27%	3

Program Features and Satisfaction – University-Based Programs

REAP

Apprentices were asked how satisfied they were with a number of features of the SEAP program (Table 117). Approximately two-thirds or more of REAP apprentices (61%-94%) reported being somewhat or very much satisfied with all of the listed program features. Aspects of the program apprentices reported being most satisfied with included: applying/registering for the program (94%) and the amount of the stipend (90%).

Table 117. Apprentice Satisfaction with REAP Program Features (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	3.2%	0.0%	3.2%	32.3%	61.3%	
	1	0	1	10	19	**31**
Other administrative tasks (in-processing, network access, etc.)	12.9%	0.0%	16.1%	29.0%	41.9%	
	4	0	5	9	13	**31**
Communicating with your host site organizers	6.5%	0.0%	6.5%	32.3%	54.8%	
	2	0	2	10	17	**31**
The physical location(s) of Apprenticeship Program activities	3.2%	3.2%	16.1%	12.9%	64.5%	
	1	1	5	4	20	**31**
The variety of STEM topics available to you in the Apprenticeship Program	3.2%	3.2%	32.3%	16.1%	45.2%	
	1	1	10	5	14	**31**
Teaching or mentoring provided during Apprenticeship Program activities	3.2%	0.0%	9.7%	19.4%	67.7%	
	1	0	3	6	21	**31**
Amount of stipends (payment)	3.2%	0.0%	6.5%	38.7%	51.6%	
	1	0	2	12	16	**31**
Timeliness of payment of stipends	12.9%	9.7%	9.7%	22.6%	45.2%	
	4	3	3	7	14	**31**
Research abstract preparation requirements	6.5%	3.2%	19.4%	41.9%	29.0%	
	2	1	6	13	9	**31**

Apprentices were also asked about the availability of their mentors during REAP (Table 118). All apprentices reported that their mentors were available at least half of the time (100%), and approximately two-thirds (65%) indicated their mentors were always available.

Table 118. Apprentice Reports of Availability of Mentors (n=31)

Choice	Response Percent	Response Total
I did not have a mentor	0%	0
The mentor was never available	0%	0
The mentor was available less than half of the time	12.90%	4
The mentor was available about half of the time of my project	0%	0
The mentor was available more than half of the time	22.58%	7
The mentor was always available	64.52%	20

More than 80% of REAP apprentices (83%-100%) reported being at least somewhat satisfied with all elements related to their research experience (Table 119). All REAP apprentices indicated being at least somewhat satisfied with the amount of time they spend doing meaningful research and nearly all felt similarly about their overall research experience (97%).

Table 119. Apprentice Satisfaction with Their Experience (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	9.7%	12.9%	77.4%	
	0	0	3	4	24	**31**
My working relationship with the group or team	3.2%	0.0%	6.5%	22.6%	67.7%	
	1	0	2	7	21	**31**
The amount of time I spent doing meaningful research	0.0%	0.0%	0.0%	25.8%	74.2%	
	0	0	0	8	23	**31**
The amount of time I spent with my research mentor	0.0%	0.0%	16.1%	19.4%	64.5%	
	0	0	5	6	20	**31**
The research experience overall	0.0%	0.0%	3.2%	16.1%	80.6%	
	0	0	1	5	25	**31**

REAP apprentices were asked to comment on their overall satisfaction with their REAP experience in an open-ended item on the questionnaire. All of the 31 apprentices who responded to this question made positive comments. The apprentices who elaborated upon their satisfaction mentioned the hands-on research experience, their STEM learning in various fields, the career information they received, their mentors, and the opportunity to make friends as sources of satisfaction. Apprentices said, for example,

> "*I have enjoyed my experience in the AEOP REAP program. Getting to work with a variety of researchers in a more sophisticated educational environment has been invaluable. From getting first-hand experience in cell culture to listening in on visiting speaker's lectures, I have gained an enormous amount of knowledge on careers and fields in STEM research. My mentor also made sure there was always an opportunity for me to learn and practice laboratory skills as well as talked to me about my future plans and gave me valuable advice.*" (REAP Apprentice)

> *"[REAP] was the best educational experience of my life. I loved working with my professor and she was very intelligent. I am excited to continue to do research when I go to college. I feel that through my research I have made a scientific contribution to humanity at a young age. I hope to find more opportunities like this as I continue with my education."* (REAP Apprentice)

> *"The [REAP] apprenticeship program was an exciting and educational experience. It allowed me to experience what it was actually like to work in a STEM related career."* (REAP Apprentice)

> *"I absolutely loved my experience with REAP, and I am very glad that I was given this opportunity. My mentor and other researchers in the lab were always very helpful and friendly, which made the research environment better. We had a group meeting every week in which we presented our progress from the previous week, which gave everyone a chance to listen to different research and ask questions. Overall, throughout the summer I learned a lot about STEM, specifically in the chemistry field, and subtopics that I had never heard about before. My experience was amazing and I hope to be able to continue my research in the future."* (REAP Apprentice)

Two apprentices made positive comments, but included some caveats. These caveats included a comment about the timeliness of the stipend payment (at the close of the program the apprentice had not received the stipend payment) and a comment indicating that the apprentice did not always find his work interesting.

Apprentices were also asked in an open-ended questionnaire item to list three benefits of participating in REAP. The 31 apprentices who responded cited a variety of benefits. The most frequently mentioned benefit was the research experience and STEM skills apprentices gained (mentioned by 19, or 61% of apprentices). About a third (10, or 32%) cited the career information they gained, and just over a quarter (8, or 26%) mentioned their STEM learning, the teamwork they experienced, and the opportunity to present and/or write about their research findings as program benefits. Other benefits, mentioned by five or six apprentices (16%-19%), included specific STEM skills such as programming. the opportunity to network, improving their communication skills, and the opportunity to work independently as benefits of participating in REAP.

REAP apprentices participating in phone interviews were also asked to name ways they believed REAP benefited them. These apprentices also emphasized the value of the research experience, their STEM learning, career information, and specific STEM skills they acquired. These apprentices added that the college experience and information they gained and increases in their confidence were also benefits. Apprentices said, for example,

> *"I feel like a real-life researcher because I'm actually on field researching on things, reading, writing, taking notes, making suggestions, making side-notes, typing, and making graphs."* (REAP Apprentice)
>
> *"When I went in [to REAP], I had literally no idea about anything [like] material science, electrical engineering....Now, I think I'm going out more knowledgeable, more experienced."* REAP Apprentice)
>
> *"[In REAP], I got to experience how college life works more or less and I learned about electronics and a little bit of physics."* REAP Apprentice)
>
> *"[The REAP mentors are] very helpful towards me and the other students that worked in our lab…it's an opportunity for me to get actual career and research experience within universities."* REAP Apprentice)

REAP apprentices were also asked in an open-ended questionnaire item to list three ways that the REAP program could be improved. The 29 apprentices who responded suggested a wide variety of potential program improvements. The most frequently mentioned improvements focused on communication (mentioned by 12, or 41% of apprentices) and included suggestions for better program communication with mentors, faster replies, more frequent communication, information about symposiums and conferences, and providing more program information in advance of the start of the apprenticeship. Eight apprentices (27%) suggested providing more choice in projects, and just under a quarter (seven, or 33%) suggested both improvements to the stipend (e.g., a larger stipend, faster payment, or more frequent payment) and improvements to mentoring (e.g., providing more mentors, more contact with the mentor, more instruction on content such as stoichiometry, and help with presentations). Six apprentices (21%) suggested providing ways for apprentices to connect with each other and other mentors. Other suggestions, mentioned by four or fewer apprentices (14% or less) included providing better materials, more hands on content, making the program residential, providing assistance with transportation, and providing more DoD information and/or speakers.

Apprentices participating in phone interviews were also asked about potential program improvements. These apprentices suggested improvements such as improved organization and use of time, providing more materials or tools, and ensuring that mentors spend an equal amount of time with all apprentices.

REAP mentors were asked about their satisfaction with the program components they experienced (Table 120). More than half (55%-73%) reported being at least somewhat satisfied with the various features asked about. Very few mentors (one or two) reporting being dissatisfied with any program feature, however up to a third of mentors had not experienced some of the features such as the research abstract preparation requirements (18% had not experienced), application/registration process (25% had not experienced), and communication with RIT (33% had not experienced).

Table 120. Mentor Satisfaction with REAP Program Features (n=40)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	25.0%	2.5%	2.5%	20.0%	50.0%	
	10	1	1	8	20	**40**
Other administrative tasks (in-processing, network access, etc.)	15.0%	2.5%	10.0%	30.0%	42.5%	
	6	1	4	12	17	**40**
Communicating with Rochester Institute of Technology (RIT)	32.5%	2.5%	10.0%	22.5%	32.5%	
	13	1	4	9	13	**40**
Communicating with program organizers	15.0%	2.5%	10.0%	17.5%	55.0%	
	6	1	4	7	22	**40**
Support for instruction or mentorship during program activities	17.5%	5.0%	5.0%	27.5%	45.0%	
	7	2	2	11	18	**40**
Amount of stipends for apprentices (payment)	7.5%	7.5%	10.0%	30.0%	45.0%	
	3	3	4	12	18	**40**
Timeliness of stipend payment to apprentices	15.0%	10.0%	17.5%	22.5%	35.0%	
	6	4	7	9	14	**40**
Research abstract preparation requirements	20.0%	0.0%	10.0%	30.0%	40.0%	
	8	0	4	12	16	**40**
Research presentation process	17.5%	0.0%	17.5%	22.5%	42.5%	
	7	0	7	9	17	**40**

Mentors were also asked to respond to open-ended items asking for their opinions about the program. All of the 22 mentors who responded to an item asking them about their overall satisfaction with REAP had something positive to say. Mentors' comments focused on the value of the college and career information apprentices received, the apprentice stipends, apprentices' enthusiasm and increases in confidence during the program, and the benefits they experienced from mentoring. Mentors said, for example,

> *"This was the first time I had the opportunity to work with 2 REAP students. I think the program is inspiring and both of my students did really well. Giving students that are from an underserved communities the opportunity to experience research on a university campus is an amazing gift to them that will influence their future. The stipend also makes a huge difference and offers the students learning experiences instead of spending their time on paid summer jobs that might not advance them in their future pursuits. I am looking forward to inviting more REAP students to my lab in the future."* (REAP Mentor)

> "*[REAP] is one of the most meaningful activities I participate in during the year.. It is amazing to see the transformation of these students, who are wonderful and talented to begin with, throughout the summer. They gain confidence, build both technical and communication skills and become team members within their labs. This year, all of our 3 students participated in projects that made new discoveries or invented products/computer programs that have a real world application. It is so empowering to them to get to talk about their role in this work. The project is so beneficial to our faculty too. Thank you for allowing my campus participate!*" (REAP Mentor)

Four mentors made positive comments about REAP but also offered caveats. These caveats focused on the funding provided to apprentices and mentors and some problems mentors experienced with the application process and information on the website. These mentors said, for example,

> "*The program has great intentions. But the amount allocated is barely enough to train a student on a certain procedure and not enough for them to do a research project. It's okay, but could use more support and time."* (REAP Mentor)

> *"Overall, I felt that the summer went very well…[REAP apprentices] successfully completed useful research projects which they appeared to enjoy. We set one of the two students in our lab up with a professor at our university to work with for their high school final project as a follow up research experience. We talked to the other student about returning next summer to continue research with us. We also advised them a lot about the college process and encouraged them to reach out for letters of recommendation and advice throughout their career. One of the students was clearly experiencing financial troubles in their family which was impacting their life and making their academic success more difficult. Had their stipend been paid earlier and had the mentors been aware of this issue, they would have had an easier time over the summer. In particular, we could have made an effort to connect them to frequent academic events at our university which would*

have provided them with multiple free lunches per week while also expanding their perspective on academic research." (REAP Mentor)

Mentors were asked in an open-ended questionnaire item to identify the three most important strengths of REAP. The 39 mentors who responded most frequently cited the exposure to STEM research and opportunity for hands-on laboratory experiences (mentioned by 22, or 56% of mentors). Nine mentors (23%) specifically cited REAP's focus on engaging apprentices underserved or underrepresented in STEM fields. Eight mentors (21%) mentioned each of the following as program strengths: the career information apprentices receive, apprentices' acquisition of specific STEM skills, the stipend, and the program's administration. Other strengths mentioned by six or fewer mentors (15% or less) included apprentices' STEM learning, apprentices' increases in interest in or motivation for STEM, college exposure, the mentor/apprentice relationship, and the quality of students enrolled as REAP apprentices.

REAP mentors participating in phone interviews were asked to comment on the strengths of the program. These mentors reiterated the strengths noted above. Mentors said, for example,

> *"Regardless of whether they actually go on to pursue a career in STEM, it's given them chance to explore it, it's given them a chance to be in a college atmosphere. That's particularly important for those who are first-gen and whose parents don't necessarily know that experience."* (REAP Mentor)

> *"[In REAP], students are exposed to the methods of doing some little research…It gradually shows them how to do some hands-on experiment and how to write reports."* (REAP Mentor)

> *"[REAP apprentices are] doing something productive; that can be really transformative. Throughout the process they'll learn a lot, when they are getting results, they truly feel like they're scientists and might envision themselves in that role...It's particularly good for students who have background typically underrepresented in STEM...It's encouraging more diverse STEM population in general."* (REAP Mentor)

During the phone interviews, REAP mentors were asked to identify benefits they experienced from participating in the program. Mentors provided various responses, including the satisfaction of mentoring and observing apprentices' learning and growth, the experience in teaching and planning curriculum, and the assistance and perspective that apprentices can provide in the mentors' research. Mentors said, for example,

> *"When my students give their presentation, and I see the way they do it, it gives me big sense of pride that at least these students, I've been able to impact knowledge. It's a good feeling. There's no question about it."* (REAP Mentor)

> *"For myself, a benefit is getting a hand from them. Of course, it takes time to train them...but it's also good for me to have experience of guiding and teaching. At the same time, once they get*

trained, they can also give me a hand through labor. By discussing with them, I also get idea of things that I didn't think of." (REAP Mentor)

The 35 mentors who provided a response to a questionnaire item that 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 (11 mentors or 31%) focused on communication, including suggestions that the program provide mentors with more information or guidelines, that communication be faster, or that communication be improved in general. Another 10 mentors (29%) suggested providing more DoD information and/or career information by, for example, providing more DoD speakers or webinars. Other suggestions, mentioned by seven or eight mentors (20%-23%) included extending the length of the program, providing more funding to the host institution (e.g., for materials), improving the apprentice stipend (e.g., a larger stipend or earlier payment of the stipend), and accepting more apprentices into the program. Other improvements, mentioned by five or fewer mentors (14% or less) included conducting more outreach for the program, providing field trips, providing opportunities for apprentices to present their research and/or travel grants for this purpose, providing assistance for apprentices' transportation or parking, and providing more opportunities for apprentices to interact with each other and other researchers.

REAP apprentices were asked to report on their input into the design of their projects (Table 121). Two apprentices (6%) reported independently designing their entire project, while 45% indicated they had some input or choice in project design. Approximately 35% of apprentices reported being assigned a project by their mentors.

Table 121. Apprentice Input on Design of Their Project (n=31)

Choice	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	35.48%	11
I worked with my mentor to design a project	6.45%	2
I had a choice among various projects suggested by my mentor	22.58%	7
I worked with my mentor and members of a research team to design a project	16.14%	5
I designed the entire project on my own	6.45%	2
I worked on various projects for other mentors	12.90%	4

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=31)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	9.68%	3
I worked with others in a shared laboratory or other space, but we worked on different projects	25.81%	8
I worked alone on my project and I met with others regularly for general reporting or discussion	12.90%	4
I worked alone on a project that was closely connected with projects of others in my group	16.13%	5
I worked with a group who all worked on the same project	35.48%	11

HSAP

Apprentices were asked how satisfied they were with a number of features of the HSAP program (Table 123). Two-thirds or more of HSAP apprentices (67%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of stipend payment (56%). Features apprentices reported being most satisfied with included applying or registering for the program (100%) and the physical location of their program activities (94%).

Table 123. Apprentice Satisfaction with HSAP Program Features (n=18)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	0.0%	38.9%	61.1%	
	0	0	0	7	11	**18**
Other administrative tasks (in-processing, network access, etc.)	11.1%	5.6%	5.6%	22.2%	55.6%	
	2	1	1	4	10	**18**
Communicating with your host site organizers	11.1%	0.0%	11.1%	5.6%	72.2%	
	2	0	2	1	13	**18**
The physical location(s) of Apprenticeship Program activities	5.6%	0.0%	0.0%	11.1%	83.3%	
	1	0	0	2	15	**18**
The variety of STEM topics available to you in the Apprenticeship Program	5.6%	0.0%	27.8%	16.7%	50.0%	
	1	0	5	3	9	**18**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	11.1%	11.1%	77.8%	
	0	0	2	2	14	**18**
Amount of stipends (payment)	5.6%	0.0%	5.6%	22.2%	66.7%	

	1	0	1	4	12	**18**
Timeliness of payment of stipend	11.1%	11.1%	22.2%	5.6%	50.0%	
	2	2	4	1	9	**18**
Research abstract preparation requirements	0.0%	0.0%	16.7%	38.9%	44.4%	
	0	0	3	7	8	**18**

Apprentices were also asked about the availability of their mentors during HSAP (Table 124). Nearly all apprentices reported that their mentors were available at least half of the time (94%), and more than half (61%) indicated their mentors were always available.

Table 124. Apprentice Reports of Availability of Mentors (n=18)

Choice	Response Percent	Response Total
I did not have a mentor	5.56%	1
The mentor was never available	0%	0
The mentor was available less than half of the time	5.56%	1
The mentor was available about half of the time of my project	16.66%	3
The mentor was available more than half of the time	11.11%	2
The mentor was always available	61.11%	11

A large majority (89%-100%) of HSAP apprentices reported being at least somewhat satisfied with various elements of their research experience (Table 125). Two aspects with which all apprentices were somewhat or very much satisfied were their working relationship with their mentor (100%) and the overall research experience (100%).

Table 125. Apprentice Satisfaction with Their Experience (n=18)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	0.0%	22.2%	77.8%	
	0	0	0	4	14	**18**
My working relationship with the group or team	0.0%	0.0%	5.6%	16.7%	77.8%	
	0	0	1	3	14	**18**
The amount of time I spent doing meaningful research	0.0%	0.0%	5.6%	27.8%	66.7%	
	0	0	1	5	12	**18**
The amount of time I spent with my research mentor	0.0%	0.0%	11.1%	11.1%	77.8%	
	0	0	2	2	14	**18**
The research experience overall	0.0%	0.0%	0.0%	16.7%	83.3%	
	0	0	0	3	15	**18**

The questionnaire included an open-ended item asking apprentices to comment on their satisfaction with their HSAP experiences. All 18 apprentices who provided a response had something positive to say. Comments focused on the value of the learning they experienced, their research exposure and experience, the college and career information they received, and their relationships with their mentors. For example,

> *"I thoroughly enjoyed this experience. I knew I wanted to go in to scientific research before this but I wasn't sure. Now I'm positive that I want to go into research. My mentor was excellent and extremely helpful. Everyone in the lab was easy to work with. It was overall excellent and I have no complaints."* (HSAP Apprentice)

> *"Working on this program was an excellent experience. It provided me a lot of knowledge and meaningful experience, giving me the opportunity to do and learn things…[The] mentoring was also excellent. My mentor was outstanding and had a lot of experience and knowledge, besides being very dedicated to our work and to this program. Honestly, this program was just excellent."* (HSAP Apprentice)

Two of the apprentices had positive comments but also offered some caveats. These apprentices mentioned having issues with transportation, the schedule, and organization. They said,

> *"I overall greatly enjoyed my experience at my local university. Although transportation sometimes was a worry to get to the university, I found I was able to maintain a great relationship*

with my mentor which allowed for the project to be continued. I definitely believe that a calendar of what's to be done can be made to ensure the project is going smoothly to finish on time and some communication more frequently. Overall, I enjoyed the 8 weeks I had working in the lab." (HSAP Apprentice)

"Though the program was unorganized, it was a wonderful opportunity to gain real-world experience in a true STEM work environment, and allowed me to learn about from industry professionals in the field. There were a lot of unorganized and sudden changes and confusion in the project and direction of research, however, the program was an amazing experience and opportunity to be able to work with a lab and attribute to STEM research, and helped me cement my want and direction in working on STEM and, more specifically, computer science research in the future." (HSAP Apprentice)

In another open-ended item, apprentices were asked to list three benefits of HSAP. The 18 apprentices who responded cited a variety of benefits, however the most frequently mentioned benefits were the research exposure and laboratory experience (mentioned by 13, or 72%) and the STEM skills apprentices gained during HSAP (mentioned by 11, or 61%). Another 10 apprentices (56%) cited the opportunity to develop 21st Century or workplace skills such as the ability to work independently, critical thinking, time management, collaboration, and communication as benefits of their HSAP participation. Seven apprentices (39%) cited career or college major information, six (33%) mentioned STEM learning, and five (28%) opportunities to networking. Other responses, mentioned by one or two apprentices, included DoD or Army information and the opportunity to include HSAP on their resumés.

Apprentices participating in interviews echoed these themes and also commented on specific STEM skills they had gained, the opportunity to present their research, and their exposure to the collaborative and interdisciplinary nature of research. Apprentices said, for example,

"I've been learning a lot of both physics and computer science through the program. I've met a lot of other students who are equally as interested in this stuff and they're able to teach me a lot as well as my mentor." (HSAP Apprentice)

"I could definitely explain all the concepts associated with my project to anyone who asked me about it, which is a leap from when I started in June. My mentor did a really good job of explaining these new concepts to me and building my knowledge in that way, which was something I appreciate." (HSAP Apprentice)

"[A benefit of HSAP] is how you're able to work with other teams who may have different backgrounds such as engineering combined with scientific backgrounds and then how that helps you foster across disciplinary project that will ultimately help advance both fields." (HSAP Apprentice)

"I got skill sets out of the program. I learned how to do different things regarding the lab. I learned how to package and culture cells. I'd never learned how to do that before. I learned how to set up lab equipment and learned how to really learn the background of it so I can handle it properly." (HSAP Apprentice)

HSAP apprentices were also asked, in an open-ended questionnaire item, to indicate three ways that the program could be improved. The 16 apprentices who responded provided a wide variety of suggestions, however the most frequently mentioned suggestions had to do with communication from the program and information about the program (mentioned in 16 comments), including communication generally, providing clearer objectives and/or communication with mentors about guidelines, defining the start and end date of the apprenticeship, and providing clearer instructions or clearer descriptions of research topics. Four apprentices (25%) mentioned providing more networking opportunities (e.g., with mentors and alumni), four also suggested providing a longer program or opportunities for apprentices to extend their research experience by, for example, writing a paper. Three apprentices suggested improvements to the stipend (e.g., timeliness, larger stipend). One or two apprentices mentioned other improvements such as having more teamwork, more choices of topics or projects, more choices of location, earlier assignment of the project, and more active teaching.

Apprentices participating in interviews were also asked to suggest program improvements. Apprentices who made suggestions also focused on program logistics, including better communication before the start of the apprenticeship, providing examples of projects before the start of the apprenticeship, providing an online symposium for apprentices to present their research, allowing apprentices to work for more hours, and providing time off. For example,

"We could have an online symposium where students that are HSAP students from every university could go online and then click on maybe an abstract of their research so then we get to see what everyone else is doing and how we are contributing towards the DoD as a whole." (HSAP Apprentice)

"I definitely think that it would be very helpful if the PI would reach out a little bit more before the start of the program to start thinking about a project, so that when the student comes in, they could start working right away…it took me almost a week and a half to figure out what project I'd even be working with. In the summer, when the whole program lasts about 8 to 10 weeks, that takes up a good amount of time." (HSAP Apprentice)

"It would definitely be useful for students if the program…showed examples of abstracts…or more examples of projects that students could do, so that students could have a more reasonable approach to deciding what project they could work on. As I started working on them, I realized I

was completely overly ambitious...I think [it would have helped if I read a few other abstracts [before HSAP].” (HSAP Apprentice)

More than 80% of HSAP mentors (86%-93%) reported being at least somewhat satisfied with all program features except two (Table 126). While more than half of mentors indicated being somewhat or very much satisfied with both communication with RIT (50%) and timeliness of stipend payment to apprentices (71%), there were large numbers of mentors who reported having not experienced either (43% and 14% respectively).

Table 126. Mentor Satisfaction with HSAP Program Features (n=14)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	0.0%	7.1%	35.7%	57.1%	
	0	0	1	5	8	**14**
Other administrative tasks (in-processing, network access, etc.)	7.1%	0.0%	7.1%	35.7%	50.0%	
	1	0	1	5	7	**14**
Communicating with Rochester Institute of Technology (RIT)	42.9%	0.0%	7.1%	28.6%	21.4%	
	6	0	1	4	3	**14**
Communicating with program organizers	0.0%	0.0%	7.1%	35.7%	57.1%	
	0	0	1	5	8	**14**
Support for instruction or mentorship during program activities	0.0%	0.0%	14.3%	35.7%	50.0%	
	0	0	2	5	7	**14**
Amount of stipends for apprentices (payment)	0.0%	7.1%	0.0%	21.4%	71.4%	
	0	1	0	3	10	**14**
Timeliness of stipend payment to apprentices	14.3%	7.1%	7.1%	14.3%	57.1%	
	2	1	1	2	8	**14**
Research abstract preparation requirements	7.1%	0.0%	0.0%	21.4%	71.4%	
	1	0	0	3	10	**14**
Research presentation process	7.1%	0.0%	7.1%	21.4%	64.3%	
	1	0	1	3	9	**14**

The six mentors who responded to an open-ended questionnaire item asking about their overall satisfaction with the program all responded positively, focusing their comments on the high quality of their HSAP apprentices. They said, for example,

> *"The quality of HSAP applicants was very high, and the student we accepted was excellent and far exceeded our expectations. We were very happy with the experience and would participate again."* (HSAP Mentor)

> *"Very satisfied with the opportunity to work with motivated students, and what we were able to achieve together."* (HSAP Mentor)

Mentors were asked to list three program strengths in another open-ended questionnaire item. The 14 mentors who responded to this item identified a number of strengths. The most frequently mentioned strength was the hands-on research experience apprentices receive (mentioned by 12, or 86%). Six mentors (43%) mentioned the value of the career information apprentices receive, five (36%) commented on the value of paying apprentices stipends, four (29%) cited as networking as a program strength, and another four cited the program administration as a strength. Strengths cited by one or two mentors included the quality of the apprentices; the mentoring aspect of the program; apprentices' confidence; and their leadership, critical thinking, and problem solving skills.

Mentors participating in interviews echoed the above themes, emphasizing apprentices' exposure to research, and the opportunity for apprentices to explore their interests. HSAP mentors also commented on their sense of satisfaction with mentoring, ways that the apprentices benefited their own work and the lab environment, and the impact on HSAP on building a community of researchers. For example,

> *"As a Mentor, I find [mentoring an HSAP student] useful for my personal development, professional development."* (HSAP Mentor)

> *"Placing a high school student among undergraduate, graduate students and PhD students, an atmosphere is created which makes everybody do better in my lab. That's what I noticed...The high school student himself is a catalyzer and makes the undergraduates and the graduate students work much better."* (HSAP Mentor)

> *"For me, I enjoy it when you see the smile when the students learn a new thing. There's these wow moments and light bulb moments...It makes a community of…HSAP and URAP. This community, obviously, this network will grow. I'm part of that network too…I will benefit from that network. Down the line, it's a mutual educational benefit."* (HSAP Mentor)

When mentors were asked in a questionnaire item about their suggestions for program improvement, their comments focused on program logistics. Among the 13 mentors who provided suggestions, the most frequently mentioned were related to funding, including faster or smoother stipend payment, providing funding for mentors, and providing funding for more apprentices or increasing stipends (six mentors, or 46%). The next most frequently suggested improvements were to accept more apprentices (five mentors, or 38%), and provide apprentices with opportunities to present their research (three mentors, or 23%). Other suggestions, mentioned by one or two mentors, included providing clearer guidelines, better communication with the program, trips to seminars or DoD facilities, having a longer program, and providing more networking opportunities. Mentors who participated in interviews suggested improvements similar to those cited above.

HSAP apprentices were asked to report on their input into the design of their projects (Table 127). One apprentice (6%) reported independently designing their entire project, and 33% indicated they had some input or choice in project design. Approximately 56% of apprentices reported being assigned a project by their mentors.

Table 127. Apprentice Input on Design of Their Project (n=18)

Choice	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	55.56%	10
I worked with my mentor to design a project	11.11%	2
I had a choice among various projects suggested by my mentor	5.56%	1
I worked with my mentor and members of a research team to design a project	16.66%	3
I designed the entire project on my own	5.56%	1
I worked on various projects for other mentors	5.56%	1

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 (61%). None worked in isolation with their research mentor, and approximately 39% of apprentices worked collaboratively in a group on the same project.

Table 128. Apprentice Participation in a Research Group (n=18)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	0%	0
I worked with others in a shared laboratory or other space, but we work on different projects	22.22%	4
I worked alone on my project and I met with others regularly for general reporting or discussion	5.56%	1
I worked alone on a project that was closely connected with projects of others in my group	33.33%	6
I work with a group who all worked on the same project	38.89%	7

URAP

Apprentices were asked how satisfied they were with a number of features of the URAP program (Table 129). About three-quarters or more of URAP apprentices (74%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of payment (58% somewhat or very much satisfied, 16% not at all satisfied). Features apprentices reported being most satisfied with included the physical location of their program (100%), application/registration for the program (97%), and the teaching or mentoring provided (97%).

Table 129. Apprentice Satisfaction with URAP Program Features (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	3.2%	16.1%	80.6%	
	0	0	1	5	25	**31**
Other administrative tasks (in-processing, network access, etc.)	16.1%	0.0%	9.7%	19.4%	54.8%	
	5	0	3	6	17	**31**
Communicating with your host site organizers	9.7%	0.0%	6.5%	3.2%	80.6%	
	3	0	2	1	25	**31**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	0.0%	19.4%	80.6%	
	0	0	0	6	25	**31**
The variety of STEM topics available to you in the Apprenticeship Program	6.5%	0.0%	6.5%	12.9%	74.2%	
	2	0	2	4	23	**31**
	0.0%	0.0%	3.2%	6.5%	90.3%	

Teaching or mentoring provided during Apprenticeship Program activities	0	0	1	2	28	**31**
Amount of stipend (payment)	9.7%	0.0%	6.5%	22.6%	61.3%	
	3	0	2	7	19	**31**
Timeliness of payment (stipend)	6.5%	16.1%	19.4%	9.7%	48.4%	
	2	5	6	3	15	**31**
Research abstract preparation requirements	3.2%	0.0%	6.5%	29.0%	61.3%	
	1	0	2	9	19	**31**

Apprentices were also asked about the availability of their mentors during URAP (Table 130). All apprentices reported that their mentors were available at least half of the time (100%), and more than three-quarters (84%) indicated their mentors were always available.

Table 130. Apprentice Reports of Availability of Mentors (n=31)

Choice	Response Percent	Response Total
I did not have a mentor	0%	0
The mentor was never available	0%	0
The mentor was available less than half of the time	0%	0
The mentor was available about half of the time of my project	3.2%	1
The mentor was available more than half of the time	12.9%	4
The mentor was always available	83.9%	26

URAP apprentices were asked about their satisfaction with various elements of their research experience (Table 131). More than 90% of URAP apprentices (94%-100%) indicated they were at least somewhat satisfied with all aspects. All apprentices reported being somewhat or very much satisfied with the amount of time spent with their research mentor (100%) and the overall research experience (100%).

Table 131. Apprentice Satisfaction with Their Experience (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	6.5%	3.2%	90.3%	
	0	0	2	1	28	**31**
My working relationship with the group or team	6.5%	0.0%	0.0%	9.7%	83.9%	
	2	0	0	3	26	**31**
The amount of time I spent doing meaningful research	0.0%	3.2%	0.0%	25.8%	71.0%	
	0	1	0	8	22	**31**
The amount of time I spent with my research mentor	0.0%	0.0%	0.0%	12.9%	87.1%	
	0	0	0	4	27	**31**
The research experience overall	0.0%	0.0%	0.0%	19.4%	80.6%	
	0	0	0	6	25	**31**

Apprentices were asked to respond to open-ended questionnaire items asking them about their experiences in URAP. When apprentices were asked about their overall satisfaction with URAP, all 31 who provided responses made positive comments about their URAP experiences. Apprentices who provided details about their satisfaction cited the value of the research experience, their mentors, the graduate school and career information they received, the stipend, increases in their motivation and interest in STEM, and increased confidence. Apprentices made the following comments, for example:

> *"This summer I gained a new perspective and appreciation for the research process. I was able to work in a completely new field and learn about my strengths and weaknesses in research. In being able to expand my understanding of the many ways researchers make an impact on biotechnology, I was able to start refining my research interests. Overall, this summer was extremely impactful in allowing me to realize that with time and dedication I can conduct scientific research."* (URAP Apprentice)

> *"The apprenticeship program allowed me to explore another field of interest. I was able to gain new cross-disciplinary skills in a high-throughput, but supportive environment. I'm taking away a new appreciation for the research process and insights about how to question/dive deeper into research. I hope to improve upon my approach to research and academics at my home institution. This summer was truly phenomenal."* (URAP Apprentice)

> *"I am extremely satisfied with my program experience. The financial support was quite generous and very much appreciated. I am grateful for the opportunity not only to work within a*

professional STEM environment, but also as a part of a team. This program element, I believe, highlights the reality of any work within STEM." (URAP Apprentice)

Six apprentices made positive comments about the program but also offered some caveats. These caveats were focused on payment of the stipend, the organization of and communication from the program, dissatisfaction with the repetitive nature of assigned work, and issues with finding housing. These apprentices said, for example,

> *"Overall, I was satisfied with my experience…my grad student had allowed me to choose a mini project to work on from the main project, so I would be able to work on my own and just check in with him at the end of the day or whenever I needed it. If there was one thing that I was dissatisfied with, is that the college had difficulty getting me paid."* (URAP Apprentice)

> *"I was a great resumé builder, but it seemed a little disorganized overall. Both my mentors and myself did not know a project was required of me before beginning the program. I'm not sure if that was on AEOP's end or ours though!"* (URAP Apprentice)

> *"My apprenticeship program gave me a unique experience in research which has given me more merit and experience when applying for future research positions. I am very pleased with my stipend but I would rather have had housing included in the internship even if that means that the stipend was reduced (I had to commute about an hour both ways 5 days a week)."* (URAP Apprentice)

Apprentices were asked in an open-ended questionnaire item to list three benefits of URAP. The 31 apprentices who responded mentioned a variety of benefits. The most frequently cited benefit, mentioned by 17 apprentices (54%), was the research experience and skills they gained. Another 14 (45%) mentioned the benefit of real-world laboratory workplace experience, and 13 (42%) cited the career information they received as a benefit of participating in URAP. Twelve apprentices (39%) cited the mentoring they received as a benefit, and 10 (32%) cited their STEM learning generally. Benefits mentioned by six or fewer apprentices (less than 20%) included the value of networking, gaining problem solving and critical thinking skills, the opportunity to work independently, the opportunity to improve communication skills, and exposure to DoD STEM research.

URAP 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 their laboratory experience, the mentoring they received, and the gains in their critical thinking and problem solving skills. These apprentices also noted the value of the preparation for graduate school the program provided, and their access to resources and opportunity to develop workplace skills. Apprentices said, for example,

> *"I'm definitely getting a lot more experience with presentations. I've had to continuously make slideshows, and working with the graduate students, I think that really gives me an insight into*

what it's like to be a graduate student and that's something I'm interested in [for] the future." (URAP Apprentice)

"[A benefit of URAP is that I had exposure to] a lot of quite important resources such as seminars, workshops, practice presentations to help build our professional skills, but also a lot of soft skills that you may not learn in industry. For example, how to make a nice presentation or communication on the professional level with your peers and your colleagues." (URAP Apprentice)

[A benefit of URAP] is taking ownership of things and doing more than what's expected...I learned how to think differently about things. In terms of when we would design an experiment with my graduate student or we would analyze the results, I learned by shadowing them and hearing them think out loud, I feel like my way of thinking about things and solving problems also changed." URAP Apprentice)

"It did change my perspective towards the engineering field. I like it more. It did, I guess trigger me to think more about my career plans in the future in terms of doing a PhD for example. It affected my career plans, and it also gave me a lot of new experiences in research and science." (URAP Apprentice)

Apprentices were also asked in an open-ended question to list three ways in which URAP could be improved. The 28 apprentices who responded offered a variety of suggestions for improvement. The most frequently mentioned improvements were related to communication with the program (mentioned by 13 apprentices, or 46%), and included suggestions for clearer or more concise communication from the program, or more frequent communication. Ten apprentices (36%) suggested improvements to the stipend, including more frequent payment of the stipend, a larger stipend, or better communication about the stipend. Eight apprentices (21%) suggested providing apprentices with more information specifically about the DoD or STEM careers within the DoD. Five apprentices (18%) suggested improvements regarding mentors, including suggestions for apprentices to have more contact with or more guidance from mentors, that the program providing better information to mentors, and that the program provide earlier contact with mentors. Other improvements, mentioned by five or fewer apprentices (18% or less) included providing more AEOP information, providing more career information generally, providing assistance with housing, and improving the choice of projects or providing information about available projects at the point of application.

Apprentices participating in interviews were also asked for their ideas about how URAP could be improved. These apprentices' comments echoed the questionnaire responses, with apprentices suggesting that the program provide more information about AEOP and DoD STEM research and career opportunities and assistance with housing. Apprentices also mentioned providing more marketing of URAP and offering flexible start dates for the program.

Nearly two-thirds or more of the responding URAP mentors (61%-89%) reported being at least somewhat satisfied with all program components they experienced (Table 132) except for communicating with RIT (25% somewhat or very much satisfied, 71% had not experienced). Program features mentors were most satisfied with (somewhat or very much) were the stipends (89%) and application or registration process (82%).

Table 132. Mentor Satisfaction with URAP Program Features (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	14.3%	0.0%	3.6%	25.0%	57.1%	
	4	0	1	7	16	**28**
Other administrative tasks (in-processing, network access, etc.)	17.9%	0.0%	7.1%	28.6%	46.4%	
	5	0	2	8	13	**28**
Communicating with Rochester Institute of Technology (RIT)	71.4%	0.0%	3.6%	7.1%	17.9%	
	20	0	1	2	5	**28**
Communicating with program organizers	25.0%	0.0%	3.6%	17.9%	53.6%	
	7	0	1	5	15	**28**
Support for instruction or mentorship during program activities	35.7%	0.0%	3.6%	28.6%	32.1%	
	10	0	1	8	9	**28**
Amount of stipends for apprentices (payment)	7.1%	0.0%	3.6%	21.4%	67.9%	
	2	0	1	6	19	**28**
Timeliness of stipend payment to apprentices	17.9%	3.6%	7.1%	17.9%	53.6%	
	5	1	2	5	15	**28**
Research abstract preparation requirements	14.3%	0.0%	14.3%	17.9%	53.6%	
	4	0	4	5	15	**28**
Research presentation process	21.4%	0.0%	10.7%	17.9%	50.0%	
	6	0	3	5	14	**28**

Like apprentices, URAP mentors were asked to reflect on their overall satisfaction with URAP in an open-ended questionnaire item. All 11 mentors who responded made positive comments about their satisfaction with URAP. Mentors expressed satisfaction with the quality of their apprentices, the mentoring experience generally, the career information apprentices receive, the organization of the program, and the presentation experience apprentices gain. Mentors said, for example, *"I enjoyed the mentorship aspect [of URAP], and would participate again."* (URAP Mentor)

"Overall, I am an amazed at the organization of this program. It helped two students change the course of their lives. They are indebted for the experience." (URAP Mentor)

Two mentors made positive comments about the program but also offered caveats to their overall satisfaction. These caveats included comments regarding providing better communication about and earlier apprentice acceptance. One of these mentors said, for example,

"AEOP is a very effective program. The single best thing it can do to help apprentices is to give them timely and clear-cut information about the apprenticeship start date. Incidentally, it will also help AEOP to recruit better apprentices, because more competitive applicants will often get early-decision offers from other sources, and they will often choose to take these rather than contend with the uncertainties of the AEOP apprenticeship timeline." (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 27 mentors who responded was apprentices' exposure to and experience in in URAP (mentioned by 19 mentors, or 70%). Nearly half of responding mentors (12, or 44%) mentioned the apprentice stipends as a strength of the program. Seven mentors (26%) mentioned the quality of the apprentices the program recruits and communication with the program and/or program administration as strengths. Other strengths, mentioned by four or five mentors (15%-19%) included the opportunity for apprentices to network, to work collaboratively or in teams, to gain career information, and to develop specific STEM skills and/or have access to laboratory equipment.

Mentors participating in interviews were asked about the value of URAP for apprentices. Mentors cited the value of exposure to real world research, the value of URAP as a resumé builder, the opportunity for apprentices to gain college and career information, the opportunity to prepare for graduate level research, and the opportunity to apply classroom learning and develop problem solving skills. For example, mentors said the following:

"[URAP] helps the undergraduate students to connect to the graduate-level research. Oftentimes, there is a disconnect between what they learn in their undergraduate courses. They're usually surprised about how those kind of things that they learn in class apply to the research topic at the graduate level." (URAP Mentor)

"[URAP] helps them to see whether research is for them. Is it a good option for them or not, whether they're going to like it? They're getting exposed to…graduate students, how they're working." (URAP Mentor)

"Some of our students are first-generation to college and they don't have this kind of information and role model to see this happening. In my experience, this kind of relationship will shape the

vision of your own career and of yourself -- of what you think you can aspire to, be suitable for, and ultimately try to achieve." (URAP Mentor)

Mentors also noted that URAP had benefits for them personally. Mentors cited the satisfaction they gain from mentoring, the assistance in the lab, the value of URAP in recruiting graduate students, and the broadened perspectives on research that URAP apprentices can provide as benefits. For example,

> *"For me, [serving as a URAP mentor] has meant giving opportunities to these students, whom I care about, and showing them research - what it should be, and how the Army fits into the picture of basic research."* (URAP Mentor)
>
> *"[URAP is] a good way of recruiting [an apprentice] as a graduate student later on. Another option is to keep them as an undergrad if they're coming from my institution."* (URAP Mentor)
>
> *"It's allowed me to answer different recent research questions that I might like to answer but don't really have the time to, that are related to but not a direct part of my thesis…they supported me in my main thesis work in terms of general, getting the lab experience to do different, sort of the routine things that I'm doing without help...They're helping me do a lot of the foundation work to support these projects."* (URAP Mentor)

The questionnaire also asked mentors to note three ways in which URAP could be improved for future participants. The 27 mentors who responded offered a wide variety of suggestions. The most frequently mentioned suggestions, mentioned by six mentors (22%) each were to increase the number of apprentices in the program; to provide ways for apprentices to disseminate their research such as a virtual symposium, a post-program event, or an abstract book; and improvements to the apprentice stipend, including providing a larger stipend, faster processing, or more frequent payment. Improvements mentioned by five mentors (19%) included providing a longer program and clearer information about applications, guidelines, and goals. Suggestions mentioned by four mentors each (15%) included providing mentors with more training or information, providing apprentices with financial support to attend conferences, and providing more DoD information.

Mentors participating in interviews were also asked to share their ideas about ways that URAP could be improved. These mentors suggested extending the program past the summer months, providing additional funding for administrative functions, allowing labs to host more than one URAP apprentice, and providing ways for apprentices to connect (e.g., networking events, poster symposium).

URAP apprentices were asked to report on their input into the design of their projects (Table 133). Two apprentices (7%) reported independently designing their entire project, and 39% indicated they had some input or choice in project design. A little more than half (55%) of apprentices reported being assigned a project by their mentors.

Table 133. Apprentice Input on Design of Their Project (n=31)

Choice	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	54.8%	17
I worked with my mentor to design a project	16.1%	5
I had a choice among various projects suggested by my mentor	12.9%	4
I worked with my mentor and members of a research team to design a project	9.7%	3
I designed the entire project on my own	6.5%	2

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 (56%). Few (7%) worked in isolation with their research mentor, and approximately 39% of apprentices worked collaboratively in a group on the same project.

Table 134. Apprentice Participation in a Research Group (n=31)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	6.5%	2
I worked with others in a shared laboratory or other space, but we work on different projects	19.3%	6
I worked alone on my project and I met with others regularly for general reporting or discussion	25.8%	8
I worked alone on a project that was closely connected with projects of others in my group	9.7%	3
I work with a group who all worked on the same project	38.7%	12

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 quarter or more of apprentices, included someone who works with the DoD (43%), a family member (27%), and someone who works at the school/university they attend (25%).

Table 135. How Apprentices Learned About AEOP (n=44)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	15.9%	7
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	9.1%	4
Past participant of program	18.2%	8
Friend	22.7%	10
Family Member	27.3%	12
Someone who works at the school or university I attend	25.0%	11
Someone who works with the program	15.9%	7
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	43.2%	19

Community group or program	0%	0
Choose Not to Report	0%	0

CQL mentors were also asked how they learned about AEOP (Table 136). Nearly half reported learning about AEOP through a colleague (41%) and workplace communications (41%).

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

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	17.6%	3
AEOP on Facebook, Twitter, Pinterest, or other social media	0.0%	0
A STEM conference or STEM education conference	0.0%	0
An email or newsletter from school, university, or a professional organization	0.0%	0
Past CQL participant	11.8%	2
A student	0.0%	0
A colleague	41.2%	7
My supervisor or superior	17.6%	3
A CQL site host or director	5.9%	1
Workplace communications	41.2%	7
Someone who works with the Department of Defense (Army, Navy, Air Force)	0.0%	0
Other, (specify):	11.8%	2

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in CQL. (Table 137). Motivators that were most frequently selected for participating in CQL were 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 (96%), desire to learn something new or interesting (89%), learning in ways that are not possible in school (86%), and desire to expand laboratory or research skills (84%).

Table 137. Factors Motivating Apprentices to Participate in CQL (n=44)

	Response Percent	Response Total
Teacher or professor encouragement	25.0%	11
An academic requirement or school grade	9.1%	4
Desire to learn something new or interesting	88.6%	39
The mentor(s)	61.4%	27
Building college application or résumé	47.7%	21
Networking opportunities	68.2%	30
Interest in science, technology, engineering, or mathematics (STEM)	95.5%	42
Interest in STEM careers with the Army	54.5%	24
Having fun	50.0%	22
Earning stipends or awards for doing STEM	34.1%	15
Opportunity to do something with friends	11.4%	5
Opportunity to use advanced laboratory technology	75.0%	33
Desire to expand laboratory or research skills	84.1%	37
Learning in ways that are not possible in school	86.4%	38
Serving the community or country	70.5%	31
Exploring a unique work environment	65.9%	29
Figuring out education or career goals	54.5%	24
Seeing how school learning applies to real life	56.8%	25
Recommendations of past participants	15.9%	7
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 real-world, hands-on research experience as motivators for participating. Some apprentices also indicated other motivators indicating, for example, that they were motivated to apply because the laboratory is close to their homes or that they had been invited to participate by their mentors.

Mentors were asked how apprentices were recruited for CQL (Table 138). Mentors most frequently reported that apprentices were recruited through university faculty outside of their workplace (27%). Twenty percent of mentors reported a variety of methods including AEOP website applications (20%), colleagues in their workplace (20%), and K-12 teachers outside their workplace (20%). Another 20% reported not knowing how apprentices were recruited for CQL.

Table 138. Mentor Reports of Recruitment Strategies (n=15)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	20.0%	3
Personal acquaintance(s) (friend, family, neighbor, etc.)	6.7%	1
Colleague(s) in my workplace	20.0%	3
K-12 school teacher(s) outside of my workplace	20.0%	3
University faculty outside of my workplace	26.7%	4
Informational materials sent to K-12 schools or Universities outside of my workplace	0%	0
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	13.3%	2
Communication(s) generated by a university or faculty (newsletter, email blast, website)	6.7%	1
STEM or STEM Education conference(s) or event(s)	0%	0
Organization(s) that serve underserved or underrepresented populations	6.7%	1
The student contacted me (the mentor) about the program	6.7%	1
I do not know how student(s) were recruited for CQL	20.0%	3
Other	20.0%	3

SEAP

SEAP apprentices reported a variety of sources of information about AEOP (Table 139). The most frequently selected sources of information, selected by approximately two-thirds or more of apprentices, included a family member (75%) and someone who works for the DoD (63%).

Table 139. How Participants Learned About AEOP (n=8)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	25.0%	2
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	12.5%	1
Past participant of program	37.5%	3
Friend	12.5%	1
Family Member	75.0%	6

Someone who works at the school or university I attend	37.5%	3
Someone who works with the program	12.5%	1
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	62.5%	5
Community group or program	0%	0
Choose Not to Report	0%	0

SEAP mentors were also asked how they learned about AEOP (Table 140). More than a third reported learning about AEOP through workplace communications (46%) and through a past participant (36%).

Table 140. How Mentors Learned About AEOP (n=11)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	18.2%	2
AEOP on Facebook, Twitter, Instagram, or other social media	0.0%	0
A STEM conference or STEM education conference	0.0%	0
An email or newsletter from school, university, or a professional organization	9.1%	1
Past participant	36.4%	4
A student	9.1%	1
A colleague	18.2%	2
My supervisor or superior	9.1%	1
An AEOP site host or director	0.0%	0
Workplace communications	45.5%	5
Someone who works with the Department of Defense (Army, Navy, Air Force)	0.0%	0
Other	0.0%	0

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in SEAP. (Table 141). Motivators most frequently selected for participating in SEAP were 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 (100%), opportunity to use advanced laboratory technology (100%), desire to expand laboratory or research skills (88%), and figuring out education or career goals (88%).

Table 141. Factors Motivating Apprentices to Participate in SEAP (n=8)

	Response Percent	Response Total
Interest in science, technology, engineering, or mathematics (STEM)	100.0%	8
Opportunity to use advanced laboratory technology	100.0%	8
Desire to expand laboratory or research skills	87.5%	7
Figuring out education or career goals	87.5%	7
The mentor(s)	75.0%	6
Building college application or résumé	75.0%	6
Interest in STEM careers with the Army	75.0%	6
Learning in ways that are not possible in school	75.0%	6
Seeing how school learning applies to real life	75.0%	6
Desire to learn something new or interesting	62.5%	5
Serving the community or country	62.5%	5
Exploring a unique work environment	62.5%	5
Having fun	50.0%	4
Earning stipends or awards for doing STEM	50.0%	4
Recommendations of past participants	50.0%	4
Teacher or professor encouragement	37.5%	3
Networking opportunities	25.0%	2
Opportunity to do something with friends	25.0%	2
An academic requirement or school grade	0.0%	0
Choose Not to Report	0.0%	0

Apprentices participating in focus groups were asked about their reasons for participating in SEAP. These apprentices noted the opportunity to gain research experience, the value of the program in preparing them for college, the career information available to them through SEAP, and the unique resources and research topics available.

SEAP mentors were asked how apprentices were recruited for SEAP (Table 142). Mentors most frequently reported that apprentices were recruited through colleagues in their workplace (64%). Slightly more than a quarter of mentors (27%) indicated that apprentices were recruited through AEOP website applications.

Table 142. Mentor Reports of Strategies Used to Recruit Apprentices (n = 11)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	27.3%	3
Personal acquaintance(s) (friend, family, neighbor, etc.)	9.1%	1
Colleague(s) in my workplace	63.6%	7
K-12 school teacher(s) outside of my workplace	0.0%	0
University faculty outside of my workplace	0.0%	0
Informational materials sent to K-12 schools or Universities outside of my workplace	0.0%	0
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	0.0%	0
Communication(s) generated by a university or faculty (newsletter, email blast, website)	0.0%	0
STEM or STEM Education conference(s) or event(s)	9.1%	1
Organization(s) that serve underserved or underrepresented populations	0.0%	0
The student contacted me (the mentor) about the program	9.1%	1
I do not know how student(s) were recruited for SEAP	18.2%	2
Other	9.1%	1

How Participants Found out About AEOP – University-Based Programs

REAP

REAP apprentices reported a variety of sources from which they learned about AEOP (Table 143). The most frequently selected sources of information about AEOP, selected by more than a quarter of apprentices, were someone who works at the school they attend (39%), a school/university newsletter, email, or website (29%), and someone who works with the program (25%).

Table 143. How Apprentices Learned about AEOP (n=28)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	21.4%	6
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	28.6%	8
Past participant of program	21.4%	6
Friend	7.1%	2
Family Member	7.1%	2
Someone who works at the school or university I attend	39.3%	11
Someone who works with the program	25.0%	7
Someone who works with the Department of Defense	3.6%	1
Community group or program	3.6%	1
Choose Not to Report	3.6%	1

Mentors were also asked how they learned about AEOP (Table 144). More than a quarter of mentors reported they learned about AEOP from a colleague (33%), a supervisor or superior (33%), or from the AEOP website (28%). Slightly less than a quarter (23%) of REAP mentors indicated that they had learned about AEOP through an AEOP site director or host.

Table 144. How Mentors Learned about AEOP (n=40)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	27.5%	11
AEOP on Facebook, Twitter, Pinterest, or other social media	7.5%	3
A STEM conference or STEM education conference	5.0%	2
An email or newsletter from school, university, or a professional organization	12.5%	5
Past REAP participant	15.0%	6
A student	2.5%	1
A colleague	32.5%	13
My supervisor or superior	32.5%	13
A REAP site host or director	22.5%	9
Workplace communications	7.5%	3
Someone who works with the Department of Defense (Army, Navy, Air Force)	5.0%	2
Other	2.5%	1

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in REAP. (Table 145). Motivators most frequently reported for participating in REAP were related to apprentices' educational interests and learning. More than two-thirds of apprentices indicated that they were motivated to participate in REAP by their desire to learn something new or interesting (89%), interest in STEM (86%), and learning in ways that are not possible in school (71%).

Table 145. Factors Motivating Apprentices to Participate in REAP (n=28)

Choice	Response Percent	Response Total
Teacher or professor encouragement	35.7%	10
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	89.3%	25
The mentor(s)	35.7%	10
Building college application or résumé	60.7%	17
Networking opportunities	46.4%	13
Interest in science, technology, engineering, or mathematics (STEM)	85.7%	24
Interest in STEM careers with the Army	46.4%	13
Having fun	57.1%	16
Earning stipends or awards for doing STEM	28.6%	8
Opportunity to do something with friends	17.9%	5
Opportunity to use advanced laboratory technology	64.3%	18
Desire to expand laboratory or research skills	67.9%	19
Learning in ways that are not possible in school	71.4%	20
Serving the community or country	46.4%	13
Exploring a unique work environment	57.1%	16
Figuring out education or career goals	60.7%	17
Seeing how school learning applies to real life	64.3%	18
Recommendations of past participants	10.7%	3
Choose Not to Report	7.1%	2

The REAP apprentices who participated in interviews also cited their desire for learning outside of school and research experience as motivators for their participation. These apprentices added that the opportunity to gain career information and college experience motivated them to participate.

Mentors were asked how apprentices were recruited for REAP (Table 146). Mentors most frequently reported that apprentices were recruited through AEOP applications (53%), followed by colleague(s) in their workplace (35%), and K-12 school teacher(s) outside of their workplace (33%). A quarter (25%) of mentors reported not knowing how their apprentices had been recruited for REAP.

Table 146. Mentor Reports of Recruitment Strategies (n=40)

Choice	Response Percent	Response Total
Applications from AEOP (REAP)	52.5%	21
Personal acquaintance(s) (friend, family, neighbor, etc.)	12.5%	5
Colleague(s) in my workplace	35.0%	14
K-12 school teacher(s) outside of my workplace	32.5%	13
University faculty outside of my workplace	5.0%	2
Informational materials sent to K-12 schools or Universities outside of my workplace	27.5%	11
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	15.0%	6
Communication(s) generated by a university or faculty (newsletter, email blast, website)	12.5%	5
STEM or STEM Education conference(s) or event(s)	17.5%	7
Organization(s) that serve underserved or underrepresented populations	22.5%	9
The student contacted me (the mentor) about the program	12.5%	5
I do not know how student(s) were recruited for REAP	25.0%	10
Other	2.5%	1

HSAP

HSAP apprentices reported a variety of sources of information about AEOP (Table 147). The most frequently selected sources of information about AEOP were someone who works at their school/university (61%), followed by the AEOP website (28%), and school/university newsletter, email, or website (22%).

Table 147. How Apprentices Learned About AEOP (n=18)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	27.8%	5
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	22.2%	4
Past participant of program	5.6%	1
Friend	0%	0
Family Member	16.7%	3
Someone who works at the school or university I attend	61.1%	11
Someone who works with the program	16.7%	3
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	5.6%	1
Community group or program	5.6%	1
Choose Not to Report	0%	0

Mentors were also asked how they learned about AEOP (Table 148). More than a third reported learning about AEOP through the AEOP website (43%), their supervisor or superior (36%), or someone who works with the DoD (36%).

Table 148. How Mentors Learned About AEOP (n=14)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	42.9%	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	14.3%	2
Past participant	21.4%	3
A student	0%	0
A colleague	0%	0
My supervisor or superior	35.7%	5
An AEOP site host or director	7.1%	1
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	35.7%	5
Other, (specify):	0%	0

The apprentice questionnaire included a question to explore what factors motivated apprentices to participate in HSAP. (Table 149). Motivators most frequently selected for participating in HSAP were related to apprentices' educational interests and learning. More than 80% of apprentices indicated that they were motivated to participate in HSAP by their desire to learn something new/interesting (94%), interest in STEM (89%), the opportunity to use advanced laboratory technology (83%), and the desire to expand laboratory or research skills (83%).

Table 149. Factors Motivating Apprentice Participation in HSAP (n=18)

Choice	Response Percent	Response Total
Teacher or professor encouragement	44.4%	8
An academic requirement or school grade	5.6%	1
Desire to learn something new or interesting	94.4%	17
The mentor(s)	55.6%	10
Building college application or résumé	66.7%	12
Networking opportunities	50.0%	9
Interest in science, technology, engineering, or mathematics (STEM)	88.9%	16
Interest in STEM careers with the Army	38.9%	7
Having fun	66.7%	12
Earning stipends or awards for doing STEM	55.6%	10
Opportunity to do something with friends	5.6%	1
Opportunity to use advanced laboratory technology	83.3%	15
Desire to expand laboratory or research skills	83.3%	15
Learning in ways that are not possible in school	77.8%	14
Serving the community or country	61.1%	11
Exploring a unique work environment	77.8%	14
Figuring out education or career goals	50.0%	9
Seeing how school learning applies to real life	55.6%	10
Recommendations of past participants	16.7%	3
Choose Not to Report	0%	0

Apprentices participating in interviews reported learning about HSAP primarily either from their schools or from a contact at the lab where they apprenticed. These apprentices cited the learning and hands-on research opportunities, career information and exploration, and opportunity to build their resumés as motivators for participating in HSAP. Apprentices said, for example,

> *"Before starting on [the] college application process and truly deciding what I want to do as a major, I wanted some hands-on experience in a lab setting, doing research, specifically, with chemical engineering and seeing how that would play out. My main motivation behind joining this program was getting that experience in the lab, also learning new skills that would be helpful to me in a university setting and potentially doing research in the future."* (HSAP Apprentice)

> *"I chose to participate in this program because I felt that it would give me a broader knowledge base as to how research is conducted, how the skills I have learned in the classroom apply in the real world."* (HSAP Apprentice)

Mentors were asked how apprentices were recruited for HSAP (Table 150). Mentors most frequently reported that apprentices were recruited through RIT or AEOP applications (71%). More than a quarter of mentors also reported the following recruitment methods: personal acquaintances (29%), colleague in their workplace (29%), informational materials sent to K-12 schools or universities outside their workplace (29%), communications generated by a K-12 teacher (29%), and student contacting the mentor (29%).

Table 150. Mentor Reports of Recruitment Strategies (n=14)

Choice	Response Percent	Response Total
Applications from the Rochester Institute of Technology (RIT) or the AEOP	71.4%	10
Personal acquaintance(s) (friend, family, neighbor, etc.)	28.6%	4
Colleague(s) in my workplace	28.6%	4
K-12 school teacher(s) outside of my workplace	21.4%	3
University faculty outside of my workplace	7.1%	1
Informational materials sent to K-12 schools or Universities outside of my workplace	28.6%	4
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	28.6%	4
Communication(s) generated by a university or faculty (newsletter, email blast, website)	21.4%	3
STEM or STEM Education conference(s) or event(s)	7.1%	1
Organization(s) that serve underserved or underrepresented populations	7.1%	1

The student contacted me (the mentor) about the program	28.6%	4
I do not know how student(s) were recruited for REAP	21.4%	3
Other	0%	0

URAP

URAP apprentices reported a variety of sources of information about AEOP (Table 151). The most frequently selected sources of information about AEOP were someone who works at the school they attend (60%), followed by school communications (newsletter, email, or website) (40%), and someone who works with the program (17%).

Table 151. How Apprentices Learned About AEOP (n=30)*

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	13.3%	4
AEOP on Facebook, Twitter, Instagram, or other social media	3.3%	1
School or university newsletter, email, or website	40.0%	12
Past participant of program	3.3%	1
Friend	3.3%	1
Family Member	10.0%	3
Someone who works at the school or university I attend	60.0%	18
Someone who works with the program	16.7%	5
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	3.3%	1
Community group or program	0%	0
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

Mentors were also asked how they learned about AEOP (Table 152). A quarter or more of mentors reported learning about AEOP through the AEOP website (32%), their supervisor or superior (32%), or someone who works with the DoD (25%).

Table 152. How Mentors Learned About AEOP (n=28)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	32.1%	9
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	3.6%	1
An email or newsletter from school, university, or a professional organization	21.4%	6
Past participant	14.3%	4
A student	7.1%	2
A colleague	17.9%	5
My supervisor or superior	32.1%	9
An AEOP site host or director	7.1%	2
Workplace communications	3.6%	1
Someone who works with the Department of Defense (Army, Navy, Air Force)	25.0%	7
Other, (specify):	7.1%	2

The apprentice questionnaire included an item to explore what factors motivated apprentices to participate in URAP (Table 153). Motivators most frequently selected for participating in URAP were 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 (90%), desire to learn something new or interesting (90%), desire to expand laboratory/research skills (83%), and learning in ways that are not possible in school (73%).

Table 153. Factors Motivating Apprentice Participation in URAP (n=30)

Choice	Response Percent	Response Total
Teacher or professor encouragement	36.7%	11
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	90.0%	27
The mentor(s)	43.3%	13
Building college application or résumé	70.0%	21
Networking opportunities	43.3%	13
Interest in science, technology, engineering, or mathematics (STEM)	90.0%	27
Interest in STEM careers with the Army	23.3%	7
Having fun	33.3%	10

Earning stipends or awards for doing STEM	40.0%	12
Opportunity to do something with friends	6.7%	2
Opportunity to use advanced laboratory technology	70.0%	21
Desire to expand laboratory or research skills	83.3%	25
Learning in ways that are not possible in school	73.3%	22
Serving the community or country	23.3%	7
Exploring a unique work environment	43.3%	13
Figuring out education or career goals	63.3%	19
Seeing how school learning applies to real life	53.3%	16
Recommendations of past participants	6.7%	2
Choose Not to Report	0%	0

Apprentices participating in interviews were also asked about why they chose to participate in URAP. These apprentices' responses focused primarily on the value of the research experience. Apprentices also noted the value of the graduate school and career information available to them through URAP.

Mentors were asked how apprentices were recruited for URAP (Table 154). Mentors most frequently reported that apprentices were recruited through RIT or AEOP applications (39%), followed by communications from a university (36%), and colleague(s) in their workplace (32%).

Table 154. Mentor Reports of Recruitment Strategies (n=28)

Choice	Response Percent	Response Total
Applications from the Rochester Institute of Technology (RIT) or the AEOP	39.3%	11
Personal acquaintance(s) (friend, family, neighbor, etc.)	10.7%	3
Colleague(s) in my workplace	32.1%	9
K-12 school teacher(s) outside of my workplace	7.1%	2
University faculty outside of my workplace	21.4%	6
Informational materials sent to K-12 schools or Universities outside of my workplace	10.7%	3
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	7.1%	2
Communication(s) generated by a university or faculty (newsletter, email blast, website)	35.7%	10
STEM or STEM Education conference(s) or event(s)	3.6%	1

Organization(s) that serve underserved or underrepresented populations	14.3%	4
The student contacted me (the mentor) about the program	28.6%	8
I do not know how student(s) were recruited for REAP	28.6%	8
Other	0%	0

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, apprentices 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

CQL apprentices were asked to report on their previous participation in AEOPs (Table 155). While more than half (55%) indicated they had never participated in any AEOPs, smaller proportions reported having participated in the following programs: GEMS (23%), CQL (11%), Camp Invention (4%), and eCM (2%). Few responding CQL participants (6%) reported participating in other STEM programs.

Table 155. Previous Participation in AEOP Programs (n=47)

Choice	Response Percent	Response Total
Camp Invention	4.3%	2
eCYBERMISSION	2.1%	1
Junior Solar Sprint (JSS)	0.0%	0
Gains in the Education of Mathematics and Science (GEMS)	23.4%	11
UNITE	0.0%	0
Junior Science & Humanities Symposium (JSHS)	0.0%	0
Science & Engineering Apprenticeship Program (SEAP)	4.3%	2
Research & Engineering Apprenticeship Program (REAP)	0.0%	0
High School Apprenticeship Program (HSAP)	0.0%	0
College Qualified Leaders (CQL)	10.6%	5
Undergraduate Research Apprenticeship Program (URAP)	0.0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.0%	0
I've never participated in any AEOP programs	55.3%	26
Other STEM Program	6.4%	3

CQL apprentices were asked how interested they were in participating in AEOPs in the future (Table 156). More than three-quarters of apprentices were at least somewhat interested in participating in CQL again (85%), and approximately half or more of apprentices reported being at least somewhat interested in the SMART Scholarship (70%) and NDSEG Fellowship (47%). More than a third of apprentices had never heard of the NDSEG Fellowship (34%), GEMS-NPM (40%), and URAP (40%).

Table 156. Student Interest in Future AEOP Programs (n=47)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	0.0%	6.4%	8.5%	23.4%	61.7%	
	0	3	4	11	29	**47**
Undergraduate Research Apprenticeship Program (URAP)	40.4%	14.9%	14.9%	8.5%	21.3%	
	19	7	7	4	10	**47**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	8.5%	14.9%	6.4%	23.4%	46.8%	
	4	7	3	11	22	**47**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	34.0%	10.6%	8.5%	14.9%	31.9%	
	16	5	4	7	15	**47**
GEMS Near Peer Mentor Program	40.4%	19.1%	10.6%	8.5%	21.3%	
	19	9	5	4	10	**47**

Mentors were asked which of the AEOPs they explicitly discussed with their apprentices during CQL. Table 157 displays results and shows more than half discussed CQL (87%) and SMART (53%). Fewer than a quarter discussed any other specific program directly with apprentices, but 27% reported discussing AEOP in general.

Table 157. Mentors Explicitly Discussing AEOPs with Apprentices (n=15)

	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)	86.7%	13.3%	
	13	2	**15**
GEMS Near Peer Mentor Program	6.7%	93.3%	
	1	14	**15**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	15	**15**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	53.3%	46.7%	
	8	7	**15**

National Defense Science & Engineering Graduate (NDSEG) Fellowship	20.0%	80.0%	
	3	12	**15**
I discussed AEOP with my student(s) but did not discuss any specific program	26.7%	73.3%	
	4	11	**15**

SEAP

SEAP apprentices were asked to report on their previous participation in AEOPs (Table 158). While half (50%) indicated they had not previously participated in any AEOPs, smaller proportions reported having participated in the following AEOPs: GEMS (38%), SEAP (25%), and JSS (13%). More than a third of SEAP participants reported participating in other STEM programs (38%) that were not part of AEOP.

Table 158. Previous Participation in AEOP Programs (n=8)*

Choice	Response Percent	Response Total
Camp Invention	0%	0
eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	12.5%	1
Gains in the Education of Mathematics and Science (GEMS)	37.5%	3
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	25.0%	2
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	50.0%	4
Other STEM Program	37.5%	3

*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). Approximately three-quarters or more of apprentices were at least somewhat interested in participating in each program. Less than 20% of apprentices indicated that they had never heard of the AEOPs listed (9%-18%).

Table 159. Student Interest in Future AEOP Programs (n=11)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	9.1%	0.0%	0.0%	9.1%	81.8%	
	1	0	0	1	9	**11**
College - Undergraduate Research Apprenticeship Program (URAP)	18.2%	0.0%	0.0%	18.2%	63.6%	
	2	0	0	2	7	**11**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	0.0%	0.0%	9.1%	9.1%	81.8%	
	0	0	1	1	9	**11**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	18.2%	0.0%	9.1%	18.2%	54.5%	
	2	0	1	2	6	**11**
High School and College - GEMS Near Peer Mentor Program	18.2%	0.0%	9.1%	18.2%	54.5%	
	2	0	1	2	6	**11**

Mentors were asked which of the AEOP programs they explicitly discussed with their apprentices during SEAP. Table 160 displays results and shows the only programs reportedly discussed were SMART (55%) and CQL (36%). While most programs were not discussed directly, 36% of mentors reported talking about AEOP in general with their apprentices.

Table 160. Mentors Explicitly Discussing AEOPs with Apprentices (n=11)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
High School Apprenticeship Program (HSAP)	0.0%	100.0%	
	0	11	**11**
College Qualified Leaders (CQL)	36.4%	63.6%	
	4	7	**11**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	11	**11**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	11	**11**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	54.5%	45.5%	
	6	5	**11**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	11	**11**
I discussed AEOP with my student(s) but did not discuss any specific program	36.4%	63.6%	
	4	7	**11**

Previous Program Participation & Future Interest – University-Based Programs

REAP

REAP apprentices were asked to report on their previous participation in AEOPs (Table 161). While 54% indicated they had never participated in any AEOPs in the past, smaller proportions reported having participated in the following AEOPs: REAP (14%), UNITE (11%), and GEMS (4%). Twenty-eight percent of responding REAP participants reported participating in other STEM programs.

Table 161. Apprentice Participation in AEOP Programs (n=28)*

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)	3.6%	1
UNITE	10.7%	3
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	14.3%	4
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	53.6%	15
Other STEM Program	28.6%	8

*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). More than half of apprentices reported being at least somewhat interested in participating in URAP (61%) and SMART (58%). More than half of apprentices reported not having heard of CQL, NDSEG, and GEMS (52%-58%).

Table 162. Apprentice Interest in Future AEOP Programs (n=31)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	58.1%	0.0%	3.2%	12.9%	25.8%	
	18	0	1	4	8	**31**
Undergraduate Research Apprenticeship Program (URAP)	35.5%	0.0%	3.2%	19.4%	41.9%	
	11	0	1	6	13	**31**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	35.5%	3.2%	3.2%	9.7%	48.4%	
	11	1	1	3	15	**31**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	51.6%	6.5%	3.2%	6.5%	32.3%	
	16	2	1	2	10	**31**
GEMS Near Peer Mentor Program	58.1%	6.5%	6.5%	6.5%	22.6%	
	18	2	2	2	7	**31**

Mentors were asked which of the AEOP programs they explicitly discussed with their apprentices during REAP. Table 163 shows a third or less of mentors discussed any of the specific AEOPs with their apprentices. However, nearly three-quarters (73%) reported discussing AEOPs in general.

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
High School Apprenticeship Program (HSAP)	25.0%	75.0%	
	10	30	**40**
Junior Science and Humanities Symposium (JSHS)	22.5%	77.5%	
	9	31	**40**
College Qualified Leaders (CQL)	15.0%	85.0%	
	6	34	**40**
GEMS Near Peer Mentor Program	15.0%	85.0%	
	6	34	**40**
	32.5%	67.5%	

Undergraduate Research Apprenticeship Program (URAP)	13	27	**40**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	27.5%	72.5%	
	11	29	**40**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	20.0%	80.0%	
	8	32	**40**
I discussed AEOP with my student(s) but did not discuss any specific program	72.5%	27.5%	
	29	11	**40**

HSAP

HSAP apprentices were asked to report on their previous participation in AEOPs (Table 164). Seventy percent indicated they had never participated in any AEOPs in the past, and only one apprentice reported having participated in JSHS (5%). One quarter of responding HSAP participants reported participating in other STEM programs (25%).

Table 164. Previous Participation in AEOP Programs (n=20)*

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)	5.0%	1
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	70.0%	14
Other STEM Program	25.0%	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). With the exception of CQL (39%), half or more of apprentices reported being at least somewhat interested in all other AEOPs (50- 83%). At the same time, more than a third of HSAP apprentices indicated they had never heard of all programs (39%-61%) except URAP.

Table 165. Apprentice Interest in Future AEOP Programs (n=18)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	61.1%	0.0%	0.0%	16.7%	22.2%	
	11	0	0	3	4	**18**
College - Undergraduate Research Apprenticeship Program (URAP)	0.0%	0.0%	16.7%	11.1%	72.2%	
	0	0	3	2	13	**18**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	38.9%	0.0%	0.0%	0.0%	61.1%	
	7	0	0	0	11	**18**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	44.4%	0.0%	5.6%	0.0%	50.0%	
	8	0	1	0	9	**18**
High School and College - GEMS Near Peer Mentor Program	38.9%	5.6%	0.0%	16.7%	38.9%	
	7	1	0	3	7	**18**

Mentors were asked which of the AEOP programs they explicitly discussed with their apprentices during HSAP (Table 166). More than three-quarters of mentors reportedly discussed HSAP (93%) and URAP (79%) with their apprentices. Slightly more than a third also discussed SMART (36%) and NDSEG (36%). Additionally, more than a third (36%) discussed AEOPs in general with apprentices.

Table 166. Mentors Explicitly Discussing AEOPs with Apprentices (n=14)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
High School Apprenticeship Program (HSAP)	92.9%	7.1%	
	13	1	**14**
Junior Science and Humanities Symposium (JSHS)	7.1%	92.9%	
	1	13	**14**
College Qualified Leaders (CQL)	7.1%	92.9%	
	1	13	**14**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	14	**14**
Undergraduate Research Apprenticeship Program (URAP)	78.6%	21.4%	
	11	3	**14**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	35.7%	64.3%	
	5	9	**14**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	35.7%	64.3%	
	5	9	**14**
I discussed AEOP with my student(s) but did not discuss any specific program	35.7%	64.3%	
	5	9	**14**

URAP

Apprentices were asked to report on their previous participation in AEOPs (Table 167). Eighty percent of URAP apprentices reported not having participated in any AEOP previously, and only one indicated participating in Camp Invention (3%) and URAP (3%). Approximately 13% of apprentices reported participating in other STEM programs.

Table 167. Previous Participation in AEOP Programs (n=30)*

Choice	Response Percent	Response Total
Camp Invention	3.3%	1
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)	3.3%	1
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	80.0%	24
Other STEM Program	13.3%	4

*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 (81%), SMART (45%), and NDSEG (45%). Large proportions of apprentices indicated they had not heard of CQL (77%), GEMS-NPM (71%), NDSEG (42%), and SMART (36%).

Table 168. Apprentice Interest in Future AEOP Programs (n=31)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College - College Qualified Leaders (CQL)	77.4%	3.2%	6.5%	3.2%	9.7%	
	24	1	2	1	3	**31**
College - Undergraduate Research Apprenticeship Program (URAP)	0.0%	3.2%	16.1%	12.9%	67.7%	
	0	1	5	4	21	**31**
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	35.5%	3.2%	16.1%	12.9%	32.3%	
	11	1	5	4	10	**31**
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	41.9%	6.5%	6.5%	12.9%	32.3%	
	13	2	2	4	10	**31**
High School and College - GEMS Near Peer Mentor Program	71.0%	0.0%	12.9%	6.5%	9.7%	
	22	0	4	2	3	**31**

Mentors were asked which of the AEOPs they explicitly discussed with their apprentices during URAP (Table 169). A majority of mentors (79%) reported speaking to apprentices about SMART, and 43% discussed NDSEG. Large proportions of mentors reported not discussing the other AEOPs with their apprentices (71%-93%).

Table 169. Mentors Explicitly Discussing AEOPs with Apprentices (n=28)

	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)	10.7%	89.3%	
	3	25	**28**
GEMS Near Peer Mentor Program	7.1%	92.9%	
	2	26	**28**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	78.6%	21.4%	
	22	6	**28**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	42.9%	57.1%	
	12	16	**28**
I discussed AEOP with my student(s) but did not discuss any specific program	28.6%	71.4%	
	8	20	**28**

Awareness of STEM Careers & DoD STEM Careers & Research – Overall

A goal of all 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 (94%) reported learning about at least one STEM job/career and that most (75%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (87%) reported learning about at least one DoD STEM job/career, although slightly fewer (72%) reported learning about three or more Army or DoD STEM jobs during CQL.

Table 170. Number of STEM Jobs/Careers Apprentices Learned About During CQL (n=47)

	Response Percent	Response Total
None	6.4%	3
1	0%	0
2	19.1%	9
3	21.3%	10
4	6.4%	3
5 or more	46.8%	22

Table 171. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During CQL (n=47)

	Response Percent	Response Total
None	12.8%	6
1	4.3%	2
2	10.5%	5
3	21.3%	10
4	8.5%	4
5 or more	42.6%	20

Apprentices participating in focus groups indicated that being on-site at Army labs was influential in their awareness and understanding of Army and DoD STEM careers. For some, the experience had a positive influence on their career aspirations. As one apprentice said,

> *"[Before CQL], I didn't particularly have any aspirations to work with the Army directly. After being here, I definitely could see it in the future."* (CQL Apprentice)

Apprentices cited primarily learning about careers from their mentors and lab experiences, and from emails they received about job openings at labs rather than from information they received through the CQL program. Mentors' comments in focus group also highlighted the value of the career information apprentices gain from being on site at an Army lab. One mentor conceptualized his role as mentor as extending beyond the boundaries of the CQL apprenticeship itself, noting,

> *"Being a mentor doesn't stop when they give the presentation. You certainly work on to put them in touch with people who can advance their careers."* (CQL Mentor)

CQL apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements (Table 172). For example, all agreed or strongly agreed (100%) that DoD researchers advance science and engineering fields. Additionally, 98% agreed or strongly agreed that DoD researchers solve real-world problems and that DoD research is valuable to society.

Table 172. Student Opinions about DoD Researchers and Research (n=47)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	0.0%	21.3%	78.7%	
	0	0	0	10	37	**47**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	6.4%	31.9%	61.7%	
	0	0	3	15	29	**47**
DoD researchers solve real-world problems	0.0%	0.0%	2.1%	14.9%	83.0%	
	0	0	1	7	39	**47**
DoD research is valuable to society	0.0%	2.1%	0.0%	23.4%	74.5%	
	0	1	0	11	35	**47**

SEAP

Tables 173 and 174 show that all SEAP apprentices (100%) reported learning about at least one STEM job/career, and that most (73%) reported learning about 3 or more general STEM careers. Similarly, a large majority of apprentices (91%) reported learning about at least one DoD STEM job/career, and slightly more than half (55%) reported learning about three or more Army or DoD STEM jobs or careers during SEAP.

Table 173. Number of STEM Jobs/Careers Apprentices Learned About During SEAP (n=11)

	Response Percent	Response Total
None	0%	0
1	18.18%	2
2	9.09%	1
3	18.18%	2
4	9.09%	1
5 or more	45.45%	5

Table 174. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During SEAP (n=35)

	Response Percent	Response Total
None	9.09%	1
1	18.18%	2
2	18.18%	2
3	0.00%	0
4	9.09%	1
5 or more	45.45%	5

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 exposure to DoD professionals at the sites where they worked. In particular, apprentices cited their mentors and informal conversations as sources of information rather than information they received from the program.

SEAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than nearly 90% agreeing to all statements (Table 175). For example, all agreed or strongly agreed that DoD researchers solve real-world problems (100%), and that DoD research is valuable to society (100%).

Table 175. Student Opinions about DoD Researchers and Research (n=11)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	9.1%	9.1%	81.8%	
	0	0	1	1	9	**11**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	9.1%	18.2%	72.7%	
	0	0	1	2	8	**11**
DoD researchers solve real-world problems	0.0%	0.0%	0.0%	9.1%	90.9%	
	0	0	0	1	10	**11**
DoD research is valuable to society	0.0%	0.0%	0.0%	9.1%	90.9%	
	0	0	0	1	10	**11**

Awareness of STEM Careers & DoD STEM Careers & Research – University-Based Programs

REAP

Tables 176 and 177 show that nearly all REAP apprentices (94%) reported learning about at least one STEM job/career, and that approximately two-thirds (68%) reported learning about three or more general STEM careers. However, much smaller proportions of apprentices (45%) reported learning about at least one DoD STEM job/career, and even fewer (19%) reported learning about three or more Army or DoD STEM jobs during REAP.

Table 176. Number of STEM Jobs/Careers Apprentices Learned About During REAP (n=31)

Choice	Response Percent	Response Total
None	6.45%	2
1	3.23%	1
2	22.58%	7
3	32.26%	10
4	6.45%	2
5 or more	29.03%	9

Table 177. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During REAP (n=31)

Choice	Response Percent	Response Total
None	54.85%	17
1	12.90%	4
2	12.90%	4
3	6.45%	2
4	6.45%	2
5 or more	6.45%	2

Most REAP apprentices participating in phone interviews indicated that they had not learned about STEM careers in the DoD during their apprenticeships. Those that indicated they had learned about careers cited their mentors or professors as sources of information.

REAP apprentices' opinions about DoD researchers and research were very positively with more than 80% agreeing to all statements (Table 178). For example, 94% agreed or strongly agreed that DoD researchers solve real-world problems.

Table 178. Apprentice Opinions about DoD Researchers and Research (n=31)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	16.1%	41.9%	41.9%	
	0	0	5	13	13	**31**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	12.9%	41.9%	45.2%	
	0	0	4	13	14	**31**
DoD researchers solve real-world problems	0.0%	0.0%	6.5%	41.9%	51.6%	
	0	0	2	13	16	**31**
DoD research is valuable to society	0.0%	0.0%	12.9%	38.7%	48.4%	
	0	0	4	12	15	**31**

HSAP

Tables 179 and 180 show that all HSAP apprentices (100%) reported learning about at least one STEM job/career, and only a third (33%) reported learning about three or more general STEM careers. Considerably fewer apprentices (50%) reported learning about at least one DoD STEM job/career, and very few (11%) reported learning about three or more Army or DoD STEM jobs during HSAP.

Table 179. Number of STEM Jobs/Careers Apprentices Learned About During HSAP (n=18)

Choice	Response Percent	Response Total
None	0%	0
1	0%	0
2	66.67%	12
3	0%	0
4	11.11%	2
5 or more	22.22%	4

Table 180. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During HSAP (n=18)

Choice	Response Percent	Response Total
None	50.00%	9
1	16.67%	3
2	22.22%	4
3	0%	0
4	0%	0
5 or more	11.11%	2

About half of HSAP apprentices participating in phone interviews reported learning about careers during their apprenticeships, and three cited learning specifically about Army or DoD STEM careers through their mentors, webinars, and meeting with other researchers. One apprentice described how his mentor drew connections between his research and DoD STEM work. He said,

> *"My mentor mentioned that there's potential applications for this [research] in the Air Force where it could be applied to fighter jets in order to help with the turning of fighter jets and managing speed around curves, things like that. That brought up the idea of this category of research for potential defense applications or applications within the Army."* (HSAP Apprentice)

HSAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with 90% or more agreeing to all statements (Table 181).

Table 181. Apprentice Opinions about DoD Researchers and Research (n=18)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	5.6%	27.8%	66.7%	
	0	0	1	5	12	**18**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	5.6%	27.8%	66.7%	
	0	0	1	5	12	**18**
DoD researchers solve real-world problems	0.0%	0.0%	5.6%	22.2%	72.2%	
	0	0	1	4	13	**18**
DoD research is valuable to society	0.0%	0.0%	5.6%	16.7%	77.8%	
	0	0	1	3	14	**18**

URAP

Tables 182 and 183 show that a large majority of URAP apprentices (84%) reported learning about at least one STEM job/career, and slightly more than half (55%) reported learning about three or more general STEM careers. Considerably fewer apprentices (45%) reported learning about at least one DoD STEM job/career, and even less (10%) reported learning about three or more Army or DoD STEM jobs during URAP.

Table 182. Number of STEM Jobs/Careers Learned About During URAP (n=31)

Choice	Response Percent	Response Total
None	16.1%	5
1	16.1%	5
2	12.9%	4
3	12.9%	4
4	3.2%	1
5 or more	38.8%	12

Table 183. Number of DoD STEM Jobs/Careers Learned About During URAP (n=31)

Choice	Response Percent	Response Total
None	54.8%	17
1	22.6%	7
2	12.9%	4
3	3.2%	1
4	0.0%	0
5 or more	6.5%	2

Most URAP apprentices participating in phone interviews had not learned about STEM careers within the DoD during their apprenticeships. The three apprentices who reported some learning about careers cited various sources of information. One apprentice noted that he had learned about DoD job opportunities from graduate students in his lab who were looking for jobs, another noted discussing career opportunities with her mentor, and the third indicated that he had worked with veterans as part of his apprenticeship and had learned about the DoD from this experience.

URAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements (Table 184). For example, 97% agreed or strongly agreed that DoD researchers solve real-world problems, and that DoD researchers develop new, cutting edge technologies.

Table 184. Apprentice Opinions about DoD Researchers and Research (n=31)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	6.5%	25.8%	67.7%	
	0	0	2	8	21	**31**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	3.2%	25.8%	71.0%	
	0	0	1	8	22	**31**
DoD researchers solve real-world problems	0.0%	0.0%	3.2%	29.0%	67.7%	
	0	0	1	9	21	**31**
DoD research is valuable to society	0.0%	0.0%	6.5%	22.6%	71.0%	
	0	0	2	7	22	**31**

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 across programs reported increased likelihood that they would engage in various activities.

Interest & Future Engagement in STEM – Level and Setting Comparisons

Apprentices were asked to indicate their likelihood of engaging with STEM activities outside of school as a result of participating in 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 apprentices' intended 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 by program level, with high school apprentices reporting greater likelihood compared to university level apprentices (effect size is small with d = 0.405).[27]

CQL

More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL except watching/reading non-fiction STEM (43%) (Table 185). Activities for which more than three-quarters of CQL apprentices reported increased likelihood of engagement were working on a STEM project in a university or professional setting (85%), talking with friends/family about STEM (77%), and mentoring/teaching other students about STEM (77%). 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 likelihood of future STEM engagement by overall U2 classification or specific variables investigated.

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[26] Cronbach's alpha reliability for Future STEM engagement was 0.920.

[27] Independent Samples t-test for Future STEM engagement by program level: $t(136)=2.36$, $p=0.020$.

Table 185. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=47)

	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%	57.4%	23.4%	19.1%	
	0	0	27	11	9	**47**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	42.6%	36.2%	21.3%	
	0	0	20	17	10	**47**
Work on solving mathematical or scientific puzzles	0.0%	4.3%	38.3%	31.9%	25.5%	
	0	2	18	15	12	**47**
Use a computer to design or program something	0.0%	0.0%	48.9%	23.4%	27.7%	
	0	0	23	11	13	**47**
Talk with friends or family about STEM	0.0%	0.0%	23.4%	51.1%	25.5%	
	0	0	11	24	12	**47**
Mentor or teach other students about STEM	0.0%	0.0%	23.4%	48.9%	27.7%	
	0	0	11	23	13	**47**
Help with a community service project related to STEM	0.0%	0.0%	40.4%	31.9%	27.7%	
	0	0	19	15	13	**47**
Participate in a STEM camp, club, or competition	0.0%	0.0%	42.6%	34.0%	23.4%	
	0	0	20	16	11	**47**
Take an elective (not required) STEM class	0.0%	0.0%	40.4%	27.7%	31.9%	
	0	0	19	13	15	**47**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	14.9%	42.6%	42.6%	
	0	0	7	20	20	**47**

The questionnaire also included an item to gauge apprentices' educational aspirations (Table 186). When asked how much formal education CQL apprentices wanted to complete after participating in the program, nearly all (98%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's (26%) or terminal degree (55%) in their field.

Table 186. Apprentice Education Aspirations After CQL (n=47)

Choice	Response Percent	Response Total
Go to a trade or vocational school	2.1%	1
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	8.5%	4
Get more education after college	8.5%	4
Get a master's degree	25.5%	12
Get a Ph.D.	40.4%	19
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	10.7%	5
Get a combined M.D. / Ph.D.	4.3%	2
Get another professional degree (law, business, etc.)	0%	0

SEAP

Approximately three-quarters 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). Activities for which all (100%) SEAP apprentices reported greater likelihood of engagement were talking with friends/family about STEM, taking an elective STEM class, and working on a STEM project in a university or professional setting. 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, or there was not enough data to make group comparisons.

Table 187. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=11)

	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%	9.1%	45.5%	45.5%	
	0	0	1	5	5	11
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	18.2%	27.3%	54.5%	
	0	0	2	3	6	11
Work on solving mathematical or scientific puzzles	0.0%	0.0%	9.1%	27.3%	63.6%	
	0	0	1	3	7	11
Use a computer to design or program something	0.0%	0.0%	18.2%	45.5%	36.4%	
	0	0	2	5	4	11
Talk with friends or family about STEM	0.0%	0.0%	0.0%	36.4%	63.6%	
	0	0	0	4	7	11
Mentor or teach other students about STEM	0.0%	0.0%	18.2%	18.2%	63.6%	
	0	0	2	2	7	11
Help with a community service project related to STEM	0.0%	0.0%	27.3%	18.2%	54.5%	
	0	0	3	2	6	11
Participate in a STEM camp, club, or competition	0.0%	0.0%	18.2%	27.3%	54.5%	
	0	0	2	3	6	11
Take an elective (not required) STEM class	0.0%	0.0%	0.0%	36.4%	63.6%	
	0	0	0	4	7	11
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	0.0%	45.5%	54.5%	
	0	0	0	5	6	11

When asked about how much formal education they wanted to earn after participating in the program, all (100%) responding SEAP apprentices reported wanting to at least earn a Bachelor’s degree and many reported a desire to earn a master’s degree (18%) or terminal degree (64%) in their field (Table 188).

Table 188. Apprentice Education Aspirations After SEAP (n=11)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0%	0
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	9.09%	1
Get more education after college	9.09%	1
Get a master's degree	18.18%	2
Get a Ph.D.	36.36%	4
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	0%	0
Get a combined M.D. / Ph.D.	27.27%	3
Get another professional degree (law, business, etc.)	0%	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). Items for which more than 85% of REAP apprentices expressed increased likelihood of engagement were talking with friends/family about STEM (90%) and working on a STEM project in a university or professional setting (87%). 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 189. Change in Likelihood Apprentice Will Engage in STEM Activities Outside of School (n=31)

	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%	3.2%	45.2%	29.0%	22.6%	
	0	1	14	9	7	**31**
Tinker (play) with a mechanical or electrical device	3.2%	6.5%	32.3%	35.5%	22.6%	
	1	2	10	11	7	**31**
Work on solving mathematical or scientific puzzles	0.0%	3.2%	29.0%	48.4%	19.4%	
	0	1	9	15	6	**31**
Use a computer to design or program something	0.0%	3.2%	32.3%	41.9%	22.6%	
	0	1	10	13	7	**31**
Talk with friends or family about STEM	0.0%	0.0%	9.7%	51.6%	38.7%	
	0	0	3	16	12	**31**
Mentor or teach other students about STEM	0.0%	6.5%	12.9%	41.9%	38.7%	
	0	2	4	13	12	**31**
Help with a community service project related to STEM	0.0%	0.0%	19.4%	41.9%	38.7%	
	0	0	6	13	12	**31**
Participate in a STEM camp, club, or competition	0.0%	0.0%	19.4%	32.3%	48.4%	
	0	0	6	10	15	**31**
Take an elective (not required) STEM class	3.2%	0.0%	19.4%	19.4%	58.1%	
	1	0	6	6	18	**31**
Work on a STEM project or experiment in a university or professional setting	0.0%	3.2%	9.7%	29.0%	58.1%	
	0	1	3	9	18	**31**

When asked about how much formal education REAP apprentices wanted to earn after participating in their program, nearly all (97%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (19%) or terminal degree (71%) in their field (Table 190).

Table 190. Apprentice Education Aspirations After REAP (n=31)

Choice	Response Percent	Response Total
Go to a trade or vocational school	3.23%	1
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	3.23%	1
Get more education after college	3.23%	1
Get a master's degree	19.35%	6
Get a Ph.D.	29.03%	9
Get a medical-related (M.D.), veterinary (D.V.M), or dental degree (D.D.S)	25.81%	8
Get a combined M.D. / Ph.D.	12.90%	4
Get another professional degree (law, business, etc.)	3.23%	1

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). Activities for which more than three-quarters of HSAP apprentices indicated an increased likelihood of engagement were using a computer to design/program something (83%), talking with friends/family about STEM (78%), taking a STEM elective (78%), and working on a STEM project in a university/professional setting (78%). 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, or there was not enough data to make group comparisons.

Table 191. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=18)

	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%	33.3%	33.3%	33.3%	
	0	0	6	6	6	**18**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	38.9%	22.2%	38.9%	
	0	0	7	4	7	**18**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	44.4%	16.7%	38.9%	
	0	0	8	3	7	**18**
Use a computer to design or program something	0.0%	0.0%	16.7%	44.4%	38.9%	
	0	0	3	8	7	**18**
Talk with friends or family about STEM	0.0%	0.0%	22.2%	22.2%	55.6%	
	0	0	4	4	10	**18**
Mentor or teach other students about STEM	0.0%	0.0%	33.3%	16.7%	50.0%	
	0	0	6	3	9	**18**
Help with a community service project related to STEM	0.0%	0.0%	27.8%	22.2%	50.0%	
	0	0	5	4	9	**18**
Participate in a STEM camp, club, or competition	0.0%	0.0%	27.8%	33.3%	38.9%	
	0	0	5	6	7	**18**
Take an elective (not required) STEM class	0.0%	0.0%	22.2%	22.2%	55.6%	
	0	0	4	4	10	**18**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	22.2%	5.6%	72.2%	
	0	0	4	1	13	**18**

When asked about how much formal education REAP apprentices wanted to earn after participating in their program, all (100%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (22%) or terminal degree (61%) in their field (Table 192).

Table 192. Apprentice Education Aspirations After HSAP (n=18)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0%	0
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	5.56%	1
Get more education after college	11.11%	2
Get a master's degree	22.22%	4
Get a Ph.D.	50.00%	9
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	5.56%	1
Get a combined M.D. / Ph.D.	5.56%	1
Get another professional degree (law, business, etc.)	0%	0

URAP

More than half of URAP apprentices reported more likelihood of engaging with all activities they were asked (Table 193) except for tinkering with mechanical/electrical devices (48%) and working on solving math/science puzzles (48%). Activities for which more than three-quarters of URAP apprentices reported increased likelihood of engagement were talking with friends/family about STEM (81%) and working on a STEM project in a university/professional setting (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 specific variables used to make up the U2 variable. However, there were differences by overall U2 status with U2 apprentices reporting greater likelihood of future engagement (effect size is large with d = 0.916).[23]

[23] Independent Samples t-test for Future STEM engagement by U2 status: t(25)=2.70, p=.021.

Table 193. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=31)

	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%	35.5%	38.7%	25.8%	
	0	0	11	12	8	**31**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	51.6%	29.0%	19.4%	
	0	0	16	9	6	**31**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	51.6%	29.0%	19.4%	
	0	0	16	9	6	**31**
Use a computer to design or program something	0.0%	0.0%	32.3%	25.8%	41.9%	
	0	0	10	8	13	**31**
Talk with friends or family about STEM	0.0%	0.0%	19.4%	38.7%	41.9%	
	0	0	6	12	13	**31**
Mentor or teach other students about STEM	0.0%	0.0%	29.0%	41.9%	29.0%	
	0	0	9	13	9	**31**
Help with a community service project related to STEM	0.0%	0.0%	35.5%	38.7%	25.8%	
	0	0	11	12	8	**31**
Participate in a STEM camp, club, or competition	0.0%	0.0%	41.9%	32.3%	25.8%	
	0	0	13	10	8	**31**
Take an elective (not required) STEM class	0.0%	0.0%	32.3%	35.5%	32.3%	
	0	0	10	11	10	**31**
Work on a STEM project or experiment in a university or professional setting	0.0%	3.2%	16.1%	25.8%	54.8%	
	0	1	5	8	17	**31**

When asked about how much formal education REAP apprentices wanted to earn after participating in their program, all (100%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (26%) or terminal degree (58%) in their field (Table 190).

Table 194. Apprentice Education Aspirations After URAP (n=31)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0%	0
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	6.5%	2
Get more education after college	9.7%	3
Get a master's degree	25.8%	8
Get a Ph.D.	41.9%	13
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	16.1%	5
Get a combined M.D. / Ph.D.	0.0%	0
Get another professional degree (law, business, etc.)	0.0%	0

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 (77%) and apprentices' mentors (77%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. More than a third of CQL apprentices reported they had not experienced AEOP resources such as the AEOP brochure (36%), the ARO website (61%), and AEOP on social media (70%).

Table 195. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=47)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	29.8%	17.0%	27.7%	19.1%	6.4%	
	14	8	13	9	3	**47**
AEOP on Facebook, Twitter or other social media	70.2%	14.9%	10.6%	2.1%	2.1%	
	33	7	5	1	1	**47**
Army Research Office (ARO) website	61.7%	17.0%	14.9%	6.4%	0.0%	
	29	8	7	3	0	**47**
AEOP brochure	36.2%	17.0%	38.3%	6.4%	2.1%	
	17	8	18	3	1	**47**
My Apprenticeship Program mentor	10.6%	2.1%	10.6%	29.8%	46.8%	
	5	1	5	14	22	**47**
Presentations or information shared in the Apprenticeship Program	23.4%	2.1%	36.2%	23.4%	14.9%	
	11	1	17	11	7	**47**
Participation in CQL	10.6%	0.0%	12.8%	34.0%	42.6%	
	5	0	6	16	20	**47**

Mentors were also asked how useful these resources were for exposing apprentices to DoD STEM careers (Table 196). Similar to apprentices, mentors were most likely to rate participation in CQL (80%) and CQL program administrator (33%) as at least somewhat useful resources. All other resources were not experienced by more than half of responding CQL mentors.

Table 196. Usefulness of Resources on Exposing Students to DoD STEM Careers (n=15)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	53.3%	0.0%	33.3%	13.3%	0.0%	
	8	0	5	2	0	**15**
AEOP on Facebook, Twitter or other social media	80.0%	20.0%	0.0%	0.0%	0.0%	
	12	3	0	0	0	**15**
AEOP brochure	80.0%	13.3%	6.7%	0.0%	0.0%	
	12	2	1	0	0	**15**
It Starts Here! Magazine	86.7%	13.3%	0.0%	0.0%	0.0%	
	13	2	0	0	0	**15**
CQL Program Administrator or site coordinator	33.3%	6.7%	26.7%	20.0%	13.3%	
	5	1	4	3	2	**15**
Invited speaker or "career" events	53.3%	6.7%	20.0%	20.0%	0.0%	
	8	1	3	3	0	**15**
Participation in CQL	13.3%	0.0%	6.7%	33.3%	46.7%	
	2	0	1	5	7	**15**

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 (77%) and their program mentors (64%). More than half of responding apprentices had not experienced AEOP resources such as AEOP on social media (77%) and the AEOP brochure (51%).

Table 197. Impact of Resources on Student Awareness of AEOPs (n=47)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	25.5%	2.1%	34.0%	25.5%	12.8%	
	12	1	16	12	6	**47**
AEOP on Facebook, Twitter or other social media	76.6%	14.9%	4.3%	2.1%	2.1%	
	36	7	2	1	1	**47**
AEOP brochure	51.1%	14.9%	25.5%	8.5%	0.0%	
	24	7	12	4	0	**47**
My Apprenticeship Mentor	10.6%	8.5%	17.0%	21.3%	42.6%	
	5	4	8	10	20	**47**
Presentations or information shared through the Apprenticeship Program	23.4%	12.8%	27.7%	19.1%	17.0%	
	11	6	13	9	8	**47**
Participation in CQL	8.5%	0.0%	14.9%	29.8%	46.8%	
	4	0	7	14	22	**47**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOPs (Table 198). Participation in CQL was most commonly reported (73%) as somewhat or very much useful for this purpose followed by CQL program administrator or site coordinator (60%). Most mentors reported that they did not experience materials provided by AEOP such as social media (73%) and the AEOP brochure (73%) as resources for exposing apprentices to AEOPs.

Table 198. Usefulness of Resources on Exposing Students to AEOPs (n=15)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	40.0%	6.7%	26.7%	20.0%	6.7%	
	6	1	4	3	1	**15**
AEOP on Facebook, Twitter, Pinterest or other social media	73.3%	20.0%	6.7%	0.0%	0.0%	
	11	3	1	0	0	**15**
AEOP brochure	73.3%	6.7%	6.7%	13.3%	0.0%	
	11	1	1	2	0	**15**
CQL Program administrator or site coordinator	13.3%	13.3%	13.3%	20.0%	40.0%	
	2	2	2	3	6	**15**
Invited speakers or "career" events	46.7%	6.7%	20.0%	26.7%	0.0%	
	7	1	3	4	0	**15**
Participation in CQL	13.3%	6.7%	6.7%	13.3%	60.0%	
	2	1	1	2	9	**15**

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 (91%) and apprentices' mentors (82%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. Many apprentices reported that they had not experienced AEOP resources such as AEOP on social media (46%), the ARO website (36%), and the AEOP brochure (36%).

Table 199. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	18.2%	9.1%	18.2%	9.1%	45.5%	
	2	1	2	1	5	**11**
AEOP on Facebook, Twitter or other social media	45.5%	18.2%	0.0%	18.2%	18.2%	
	5	2	0	2	2	**11**
Army Research Office (ARO) website	36.4%	9.1%	9.1%	18.2%	27.3%	
	4	1	1	2	3	**11**
AEOP brochure	36.4%	9.1%	18.2%	9.1%	27.3%	
	4	1	2	1	3	**11**
My Apprenticeship Program mentor	0.0%	0.0%	18.2%	0.0%	81.8%	
	0	0	2	0	9	**11**
Presentations or information shared in the Apprenticeship Program	9.1%	9.1%	18.2%	18.2%	45.5%	
	1	1	2	2	5	**11**
Participation in SEAP	0.0%	0.0%	9.1%	9.1%	81.8%	
	0	0	1	1	9	**11**

Mentors were also asked how useful these resources were for exposing apprentices to DoD STEM careers (Table 200). Similar to apprentices, mentors were most likely to rate participation in SEAP as useful, with 82% selecting this as a somewhat or very much useful resource. More than half of SEAP mentors reported having not experienced all other resources for this purpose.

Table 200. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	63.6%	9.1%	9.1%	0.0%	18.2%	
	7	1	1	0	2	**11**
AEOP on Facebook, Twitter, Pinterest or other social media	81.8%	9.1%	0.0%	9.1%	0.0%	
	9	1	0	1	0	**11**
AEOP printed materials	81.8%	9.1%	0.0%	9.1%	0.0%	
	9	1	0	1	0	**11**
AEOP Program administrator or site coordinator	63.6%	9.1%	18.2%	9.1%	0.0%	
	7	1	2	1	0	**11**
Invited speakers or "career" events	54.5%	0.0%	27.3%	18.2%	0.0%	
	6	0	3	2	0	**11**
Participation in SEAP	9.1%	0.0%	9.1%	36.4%	45.5%	
	1	0	1	4	5	**11**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 201). Approximately two-thirds or more (73%-91%) indicated all resources except two were at least somewhat useful for this purpose. The two resources not noted as useful were AEOP on social media and the AEOP brochure; more than a third of apprentices (36%) had not experienced either resource.

Table 201. Impact of Resources on Student Awareness of AEOPs (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	9.1%	18.2%	27.3%	45.5%	
	0	1	2	3	5	**11**
AEOP on Facebook, Twitter or other social media	36.4%	27.3%	0.0%	18.2%	18.2%	
	4	3	0	2	2	**11**
AEOP brochure	36.4%	18.2%	0.0%	18.2%	27.3%	
	4	2	0	2	3	**11**
My Apprenticeship Mentor	0.0%	0.0%	9.1%	9.1%	81.8%	

	0	0	1	1	9	**11**
Presentations or information shared through the Apprenticeship Program	9.1%	18.2%	0.0%	27.3%	45.5%	
	1	2	0	3	5	**11**
Participation in SEAP	0.0%	0.0%	9.1%	9.1%	81.8%	
	0	0	1	1	9	**11**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOPs (Table 202). More than a third of SEAP mentors reported that participation in SEAP (91%) and SEAP program administrators (36%) were at least somewhat useful resources. All other resources were not experienced my more than half of SEAP mentors.

Table 202. Usefulness of Resources for Exposing Students to AEOPs (n=11)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	54.5%	0.0%	27.3%	0.0%	18.2%	
	6	0	3	0	2	**11**
AEOP on Facebook, Twitter or other social media	81.8%	9.1%	0.0%	9.1%	0.0%	
	9	1	0	1	0	**11**
AEOP brochure	63.6%	0.0%	18.2%	18.2%	0.0%	
	7	0	2	2	0	**11**
SEAP Program Administrator or Site Coordinator	36.4%	0.0%	27.3%	18.2%	18.2%	
	4	0	3	2	2	**11**
Invited speakers or "career" events	81.8%	0.0%	0.0%	18.2%	0.0%	
	9	0	0	2	0	**11**
Participation in SEAP	0.0%	0.0%	9.1%	36.4%	54.5%	
	0	0	1	4	6	**11**

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 the following resources as being somewhat or very much impactful on their awareness of DoD STEM careers: participation in REAP (61%), program mentors (58%), and the AEOP website (52%). However, more than a third of apprentices indicated they had not experienced all other resources.

Table 203. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	3.2%	9.7%	35.5%	35.5%	16.1%	
	1	3	11	11	5	**31**
AEOP on Facebook, Twitter or other social media	54.8%	12.9%	19.4%	6.5%	6.5%	
	17	4	6	2	2	**31**
Army Research Office (ARO) website	54.8%	9.7%	16.1%	12.9%	6.5%	
	17	3	5	4	2	**31**
AEOP printed materials	38.7%	9.7%	16.1%	25.8%	9.7%	
	12	3	5	8	3	**31**
My Apprenticeship Program mentor	6.5%	16.1%	19.4%	25.8%	32.3%	
	2	5	6	8	10	**31**
Presentations or information shared in the Apprenticeship Program	35.5%	9.7%	22.6%	9.7%	22.6%	
	11	3	7	3	7	**31**
Participation in REAP	3.2%	12.9%	22.6%	19.4%	41.9%	
	1	4	7	6	13	**31**

Approximately half or more of mentors reported the following resources as at least somewhat useful for exposing students to DoD STEM careers (Table 204): participation in REAP (65%), AEOP administrator/site coordinator (55%), AEOP website (50%), and AEOP printed materials (48%). However, half or more reported not experiencing AEOP on social media (53%) and invited speakers (50%).

Table 204. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=40)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	32.5%	5.0%	12.5%	20.0%	30.0%	
	13	2	5	8	12	**40**
AEOP on Facebook, Twitter, Pinterest or other social media	52.5%	7.5%	5.0%	20.0%	15.0%	
	21	3	2	8	6	**40**
AEOP printed materials	40.0%	5.0%	7.5%	15.0%	32.5%	
	16	2	3	6	13	**40**
AEOP Program administrator or site coordinator	35.0%	5.0%	5.0%	20.0%	35.0%	
	14	2	2	8	14	**40**
Invited speakers or "career" events	50.0%	10.0%	10.0%	15.0%	15.0%	
	20	4	4	6	6	**40**
Participation in REAP	17.5%	5.0%	12.5%	17.5%	47.5%	
	7	2	5	7	19	**40**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 205). The two resources that stood out as being particularly impactful (somewhat or very much) on apprentices were participation in REAP (74%) and the AEOP website (74%). More than a third of apprentices had not experienced AEOP on social media (58%), the AEOP brochure (42%), and presentations shared through the program (36%).

Table 205. Impact of Resources on Apprentice Awareness of AEOPs (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	6.5%	0.0%	19.4%	32.3%	41.9%	
	2	0	6	10	13	**31**
AEOP on Facebook, Twitter, Pinterest or other social media	58.1%	12.9%	16.1%	6.5%	6.5%	
	18	4	5	2	2	**31**
AEOP brochure	41.9%	6.5%	22.6%	12.9%	16.1%	
	13	2	7	4	5	**31**
My Apprenticeship Mentor	12.9%	12.9%	29.0%	19.4%	25.8%	
	4	4	9	6	8	**31**
Presentations or information shared through the Apprenticeship Program	35.5%	0.0%	16.1%	25.8%	22.6%	
	11	0	5	8	7	**31**
Participation in the REAP	6.5%	0.0%	19.4%	16.1%	58.1%	
	2	0	6	5	18	**31**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOPs (Table 206). Participation in REAP was most commonly reported (75%) as somewhat or very much useful for this purpose. Half or more of mentors also indicated that REAP program administrator (58%) and the AEOP website (55%) were at least somewhat useful. More than a third of mentors reported not experiencing AEOP on social media (53%), invited speakers (50%), and AEOP printed materials (38%).

Table 206. Usefulness of Resources for Exposing Students to AEOPs (n=40)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	30.0%	0.0%	15.0%	12.5%	42.5%	
	12	0	6	5	17	**40**
AEOP on Facebook, Twitter, Pinterest or other social media	52.5%	7.5%	12.5%	12.5%	15.0%	
	21	3	5	5	6	**40**
AEOP printed materials	37.5%	5.0%	15.0%	15.0%	27.5%	
	15	2	6	6	11	**40**
	27.5%	7.5%	7.5%	20.0%	37.5%	

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
AEOP Program administrator or site coordinator	11	3	3	8	15	**40**
Invited speakers or "career" events	50.0%	7.5%	10.0%	15.0%	17.5%	
	20	3	4	6	7	**40**
Participation in REAP	15.0%	2.5%	7.5%	25.0%	50.0%	
	6	1	3	10	20	**40**

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 (61%) was the only resource reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers by a majority of respondents. Most apprentices reported that they had not experienced AEOP on social media (56%).

Table 207. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=18)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	22.2%	22.2%	11.1%	16.7%	27.8%	
	4	4	2	3	5	**18**
AEOP on Facebook, Twitter, Pinterest or other social media	55.6%	11.1%	11.1%	11.1%	11.1%	
	10	2	2	2	2	**18**
Army Research Office (ARO) website	44.4%	11.1%	5.6%	11.1%	27.8%	
	8	2	1	2	5	**18**
AEOP brochure	38.9%	11.1%	16.7%	16.7%	16.7%	
	7	2	3	3	3	**18**
My Apprenticeship Program mentor	22.2%	11.1%	22.2%	27.8%	16.7%	
	4	2	4	5	3	**18**
Presentations or information shared in the Apprenticeship Program	22.2%	16.7%	22.2%	16.7%	22.2%	
	4	3	4	3	4	**18**
Participation in HSAP	5.6%	5.6%	27.8%	27.8%	33.3%	
	1	1	5	5	6	**18**

Table 208 shows that half or more of HSAP mentors indicated that participation in HSAP (64%) and the AEOP website (50%) were at least somewhat useful for exposing apprentices to DoD STEM careers. Most mentors had not experienced invited speakers (79%), AEOP on social media (71%), AEOP printed materials (57%), and AEOP program administrators (57%) as resources for exposing students to DoD STEM careers.

Table 208. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=14)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	28.6%	0.0%	21.4%	14.3%	35.7%	
	4	0	3	2	5	**14**
AEOP on Facebook, Twitter, Pinterest or other social media	71.4%	0.0%	7.1%	14.3%	7.1%	
	10	0	1	2	1	**14**
AEOP printed materials	57.1%	7.1%	7.1%	28.6%	0.0%	
	8	1	1	4	0	**14**
AEOP Program administrator or site coordinator	57.1%	0.0%	7.1%	21.4%	14.3%	
	8	0	1	3	2	**14**
Invited speakers or "career" events	78.6%	0.0%	7.1%	0.0%	14.3%	
	11	0	1	0	2	**14**
Participation in HSAP	14.3%	7.1%	14.3%	28.6%	35.7%	
	2	1	2	4	5	**14**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 209). Half or more HSAP apprentices reported all resources except two were at least somewhat useful for this purpose: AEOP on social media (56% had not experienced) and the AEOP brochure (39% had not experienced).

Table 209. Impact of Resources on Apprentice Awareness of AEOPs (n=18)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	27.8%	0.0%	11.1%	16.7%	44.4%	
	5	0	2	3	8	**18**
AEOP on Facebook, Twitter, Pinterest or other social media	55.6%	11.1%	0.0%	11.1%	22.2%	
	10	2	0	2	4	**18**
AEOP brochure	38.9%	11.1%	5.6%	22.2%	22.2%	
	7	2	1	4	4	**18**
My Apprenticeship Mentor	16.7%	11.1%	16.7%	22.2%	33.3%	
	3	2	3	4	6	**18**
Presentations or information shared through the Apprenticeship Program	16.7%	5.6%	27.8%	22.2%	27.8%	
	3	1	5	4	5	**18**
Participation in the HSAP	0.0%	5.6%	22.2%	27.8%	44.4%	
	0	1	4	5	8	**18**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOPs (Table 210). More than half indicated the following resources were at least somewhat useful for this purpose: the AEOP website (79%), HSAP participation (79%), and AEOP program administrator/ coordinator (57%). More than a third reported not experiencing the other resources for this purpose.

Table 210. Useful Resources for Exposing Apprentices to AEOPs (n=14)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	21.4%	0.0%	0.0%	42.9%	35.7%	
	3	0	0	6	5	**14**
AEOP on Facebook, Twitter, Pinterest or other social media	64.3%	7.1%	7.1%	21.4%	0.0%	
	9	1	1	3	0	**14**
AEOP printed materials	42.9%	14.3%	7.1%	35.7%	0.0%	
	6	2	1	5	0	**14**
AEOP Program administrator or site coordinator	42.9%	0.0%	0.0%	21.4%	35.7%	
	6	0	0	3	5	**14**

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Invited speakers or "career" events	64.3%	21.4%	0.0%	0.0%	14.3%	
	9	3	0	0	2	**14**
Participation in HSAP	14.3%	0.0%	7.1%	28.6%	50.0%	
	2	0	1	4	7	**14**

URAP

Apprentice reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 211. When asked about resources that impacted their awareness of DoD STEM careers, apprentices most frequently chose "did not experience" for each resource. The resources most frequently cited as at least somewhat impactful were participation in URAP (43%), the AEOP website (39%), and mentors (37%).

Table 211. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	35.5%	6.5%	19.4%	22.6%	16.1%	
	11	2	6	7	5	**31**
AEOP on Facebook, Twitter or other social media	67.7%	6.5%	12.9%	6.5%	6.5%	
	21	2	4	2	2	**31**
Army Research Office (ARO) website	61.3%	3.2%	9.7%	12.9%	12.9%	
	19	1	3	4	4	**31**
AEOP printed materials	51.6%	9.7%	9.7%	9.7%	19.4%	
	16	3	3	3	6	**31**
My Apprenticeship Program mentor	35.5%	19.4%	9.7%	9.7%	25.8%	
	11	6	3	3	8	**31**
Presentations or information shared in the Apprenticeship Program	41.9%	19.4%	9.7%	9.7%	19.4%	
	13	6	3	3	6	**31**
Participation in URAP	29.0%	6.5%	22.6%	19.4%	22.6%	
	9	2	7	6	7	**31**

Mentors were also asked how useful resources were for exposing apprentices to DoD STEM careers (Table 212). They were most likely to rate participation in URAP (79%) and the AEOP website (61%) as at least somewhat useful. However, between 50% and 75% of mentors also reported having not experienced all other resources for this purpose.

Table 212. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	35.7%	0.0%	3.6%	21.4%	39.3%	
	10	0	1	6	11	**28**
AEOP on Facebook, Twitter, Pinterest or other social media	75.0%	3.6%	7.1%	7.1%	7.1%	
	21	1	2	2	2	**28**
AEOP printed materials	60.7%	7.1%	7.1%	7.1%	17.9%	
	17	2	2	2	5	**28**
AEOP Program administrator or site coordinator	50.0%	3.6%	3.6%	14.3%	28.6%	
	14	1	1	4	8	**28**
Invited speakers or "career" events	71.4%	3.6%	3.6%	3.6%	17.9%	
	20	1	1	1	5	**28**
Participation in URAP	17.9%	0.0%	3.6%	17.9%	60.7%	
	5	0	1	5	17	**28**

Apprentices were asked which resources impacted their awareness of the various AEOPs (Table 213). More than half of URAP apprentices reported participation in URAP (61%), the AEOP website (61%), and their URAP mentor (55%) as being at least somewhat useful. All other resources were not experienced by large proportions of apprentices.

Table 213. Impact of Resources on Apprentice Awareness of AEOPs (n=31)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	25.8%	0.0%	12.9%	29.0%	32.3%	
	8	0	4	9	10	**31**
AEOP on Facebook, Twitter, Pinterest or other social media	64.5%	16.1%	6.5%	6.5%	6.5%	
	20	5	2	2	2	**31**
AEOP brochure	51.6%	3.2%	16.1%	9.7%	19.4%	
	16	1	5	3	6	**31**
My Apprenticeship Mentor	9.7%	12.9%	22.6%	9.7%	45.2%	
	3	4	7	3	14	**31**
Presentations or information shared through the Apprenticeship Program	35.5%	6.5%	16.1%	22.6%	19.4%	
	11	2	5	7	6	**31**
Participation in URAP	12.9%	6.5%	19.4%	32.3%	29.0%	
	4	2	6	10	9	**31**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOPs (Table 214). Participation in URAP was most commonly reported (89%) as somewhat or very much useful for this purpose. Half or more of mentors also indicated the AEOP website (68%) and AEOP program administrator/site coordinator (50%) were at least somewhat useful for this purpose. Most mentors reported that they did not experience AEOP social media (75%), invited speakers (71%), and AEOP printed materials (61%) as a resource for exposing apprentices to AEOPs.

Table 214. Usefulness of Resources for Exposing Apprentices to AEOPs (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	25.0%	0.0%	7.1%	32.1%	35.7%	
	7	0	2	9	10	**28**
AEOP on Facebook, Twitter, Pinterest or other social media	75.0%	3.6%	7.1%	7.1%	7.1%	
	21	1	2	2	2	**28**
AEOP printed materials	60.7%	7.1%	3.6%	14.3%	14.3%	
	17	2	1	4	4	**28**

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
AEOP Program administrator or site coordinator	42.9%	3.6%	3.6%	7.1%	42.9%	
	12	1	1	2	12	**28**
Invited speakers or "career" events	71.4%	3.6%	3.6%	3.6%	17.9%	
	20	1	1	1	5	**28**
Participation in URAP	7.1%	0.0%	3.6%	21.4%	67.9%	
	2	0	1	6	19	**28**

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 across programs 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 60% or more of apprentices agreed that CQL contributed in some way to each impact listed in this section (Table 215). Areas of greatest impact, with more than 90% of apprentices agreeing, were more confidence in STEM knowledge, skills, and abilities (96%); more awareness of DoD STEM research and careers (96%); and a greater appreciation of DoD STEM research (94%). 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.

[30] Cronbach's alpha reliability for overall program impact was 0.880.

Table 215. Apprentice Opinions of CQL Impacts (n=47)

	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	2.1%	2.1%	63.8%	31.9%	
	1	1	30	15	**47**
I am more interested in participating in STEM activities outside of school requirements	8.5%	17.0%	46.8%	27.7%	
	4	8	22	13	**47**
I am more aware of other AEOPs	12.8%	4.3%	48.9%	34.0%	
	6	2	23	16	**47**
I am more interested in participating in other AEOPs	23.4%	6.4%	36.2%	34.0%	
	11	3	17	16	**47**
I am more interested in taking STEM classes in school	6.4%	29.8%	48.9%	14.9%	
	3	14	23	7	**47**
I am more interested in earning a STEM degree	8.5%	31.9%	40.4%	19.1%	
	4	15	19	9	**47**
I am more interested in pursuing a career in STEM	8.5%	31.9%	34.0%	25.5%	
	4	15	16	12	**47**
I am more aware of Army or DoD STEM research and careers	2.1%	2.1%	40.4%	55.3%	
	1	1	19	26	**47**
I have a greater appreciation of Army or DoD STEM research	4.3%	2.1%	36.2%	57.4%	
	2	1	17	27	**47**
I am more interested in pursuing a STEM career with the Army or DoD	14.9%	6.4%	46.8%	31.9%	
	7	3	22	15	**47**

SEAP

Nearly all SEAP apprentices (91%-100%) agreed that SEAP contributed in some way to each impact listed in this section (Table 216). All apprentices agreed, for example, that SEAP contributed to their confidence in their STEM knowledge skills, and abilities; to their awareness of other AEOPs; and their interest in pursuing a STEM career with the Army or DoD. 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 or there was not enough data to determine group differences.

Table 216. Apprentice Opinions of SEAP Impacts (n=11)

	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%	0.0%	45.5%	54.5%	
	0	0	5	6	11
I am more interested in participating in STEM activities outside of school requirements	0.0%	9.1%	54.5%	36.4%	
	0	1	6	4	11
I am more aware of other AEOPs	0.0%	0.0%	36.4%	63.6%	
	0	0	4	7	11
I am more interested in participating in other AEOPs	0.0%	0.0%	45.5%	54.5%	
	0	0	5	6	11
I am more interested in taking STEM classes in school	0.0%	9.1%	63.6%	27.3%	
	0	1	7	3	11
I am more interested in earning a STEM degree	0.0%	0.0%	72.7%	27.3%	
	0	0	8	3	11
I am more interested in pursuing a career in STEM	0.0%	9.1%	63.6%	27.3%	
	0	1	7	3	11
I am more aware of Army or DoD STEM research and careers	0.0%	0.0%	63.6%	36.4%	
	0	0	7	4	11
I have a greater appreciation of Army or DoD STEM research	0.0%	0.0%	63.6%	36.4%	
	0	0	7	4	11
I am more interested in pursuing a STEM career with the Army or DoD	0.0%	0.0%	54.5%	45.5%	
	0	0	6	5	11

Overall Impact – University-Based Program

REAP

More than half of REAP apprentices agreed that REAP contributed in some way to each impact listed in this section (Table 217). Areas of impact noted by more than 80% of apprentices were confidence in STEM knowledge, skills, and abilities (97%), interest in participating in other AEOPs (84%), greater appreciation of DoD STEM research (84%), and interest in participating in STEM activities outside of school requirements (81%). 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=31)

	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%	3.2%	67.7%	29.0%	
	0	1	21	9	**31**
I am more interested in participating in STEM activities outside of school requirements	6.5%	12.9%	61.3%	19.4%	
	2	4	19	6	**31**
I am more aware of other AEOPs	22.6%	6.5%	32.3%	38.7%	
	7	2	10	12	**31**
I am more interested in participating in other AEOPs	3.2%	12.9%	48.4%	35.5%	
	1	4	15	11	**31**
I am more interested in taking STEM classes in school	3.2%	29.0%	48.4%	19.4%	
	1	9	15	6	**31**
I am more interested in earning a STEM degree	3.2%	25.8%	51.6%	19.4%	
	1	8	16	6	**31**
I am more interested in pursuing a career in STEM	6.5%	25.8%	54.8%	12.9%	
	2	8	17	4	**31**
I am more aware of Army or DoD STEM research and careers	22.6%	12.9%	32.3%	32.3%	
	7	4	10	10	**31**
I have a greater appreciation of Army or DoD STEM research	9.7%	6.5%	58.1%	25.8%	
	3	2	18	8	**31**

	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 interested in pursuing a STEM career with the Army or DoD	32.3%	12.9%	41.9%	12.9%	
	10	4	13	4	**31**

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). All apprentices reported that HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%). 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 or there was not enough data to determine group differences.

Table 218. Apprentice Opinions of HSAP Impacts (n=18)

	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%	50.0%	50.0%	
	0	0	9	9	**18**
I am more interested in participating in STEM activities outside of school requirements	0.0%	11.1%	44.4%	44.4%	
	0	2	8	8	**18**
I am more aware of other AEOPs	11.1%	0.0%	44.4%	44.4%	
	2	0	8	8	**18**
I am more interested in participating in other AEOPs	11.1%	0.0%	38.9%	50.0%	
	2	0	7	9	**18**
I am more interested in taking STEM classes in school	0.0%	33.3%	33.3%	33.3%	
	0	6	6	6	**18**
I am more interested in earning a STEM degree	0.0%	16.7%	55.6%	27.8%	
	0	3	10	5	**18**
I am more interested in pursuing a career in STEM	0.0%	11.1%	61.1%	27.8%	
	0	2	11	5	**18**

	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 aware of Army or DoD STEM research and careers	27.8%	0.0%	27.8%	44.4%	
	5	0	5	8	**18**
I have a greater appreciation of Army or DoD STEM research	11.1%	0.0%	38.9%	50.0%	
	2	0	7	9	**18**
I am more interested in pursuing a STEM career with the Army or DoD	27.8%	0.0%	33.3%	38.9%	
	5	0	6	7	**18**

URAP

Three-quarters or more of URAP apprentices agreed that URAP contributed in some way to each impact listed in this section (Table 219). Areas of impact noted by 90% or more of apprentices were increased confidence in their STEM knowledge, skills, and abilities (97%); greater appreciation of DoD STEM research (94%); and more interest in pursuing a STEM career with the DoD (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 by specific subgroups. There were, however, differences found by overall U2 status with U2 apprentices reporting greater contribution by URAP (effect size is large with d = 0.912).[24]

[24] Independent Samples t-test for Overall Impact by U2 status: t(25)=2.28, p=.031.

Table 219. Apprentice Opinions of URAP Impacts (n=31)

	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%	3.2%	54.8%	41.9%	
	0	1	17	13	**31**
I am more interested in participating in STEM activities outside of school requirements	9.7%	3.2%	48.4%	38.7%	
	3	1	15	12	**31**
I am more aware of other AEOPs	19.4%	0.0%	41.9%	38.7%	
	6	0	13	12	**31**
I am more interested in participating in other AEOPs	12.9%	3.2%	45.2%	38.7%	
	4	1	14	12	**31**
I am more interested in taking STEM classes in school	6.5%	12.9%	51.6%	29.0%	
	2	4	16	9	**31**
I am more interested in earning a STEM degree	6.5%	16.1%	45.2%	32.3%	
	2	5	14	10	**31**
I am more interested in pursuing a career in STEM	9.7%	9.7%	51.6%	29.0%	
	3	3	16	9	**31**
I am more aware of Army or DoD STEM research and careers	12.9%	6.5%	51.6%	29.0%	
	4	2	16	9	**31**
I have a greater appreciation of Army or DoD STEM research	6.5%	0.0%	51.6%	41.9%	
	2	0	16	13	**31**
I am more interested in pursuing a STEM career with the Army or DoD	9.7%	0.0%	58.1%	32.3%	
	3	0	18	10	**31**

8 | Findings and Recommendations

Summary of Findings

The 2019 evaluation of apprenticeship program collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to the AEOP's and the apprenticeship programs' objectives and intended outcomes. Findings for individual programs are provided in Tables 220-224.

CQL Findings

Table 220. 2019 CQL Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although substantially more students applied for CQL apprenticeships in 2019 compared to previous year, a downward trend in the number of students placed in apprenticeships continues.	A total of 662 students applied for CQL apprenticeships compared to 574 in 2018 and 575 in 2017.
	A total of 204 applicants (31%) were placed in apprenticeships. This continues a gradual downward trend in the number of participating apprentices and in placement rate since 2017 (in 2018, 214, or 37%, were placed; in 2017, 229, or 39% were placed.
	Eighteen Army labs and centers accepted applications for CQL apprentices in 2019. Apprentices were hosted at 16 of these sites, an increase over the 13 participating host sites in 2018.
Over a quarter of CQL apprentices met the AEOP definition of U2. Enrollment of apprentices from groups historically underserved and underrepresented in STEM increased in 2019 as compared to 2018.	Slightly over a third (35%) of apprentices met the AEOP definition of underserved or underrepresented (U2) in STEM, an increase from the 20% who met the definition in 2018.
	About half (51%) of participants were female, an increase as compared to 2018 when 45% were female, but a decrease as compared to 2017 when 54% of CQL apprentices were female.
	A somewhat smaller proportion of CQL apprentices identified themselves as White (54%) as compared to previous years (64% in 2018; 67% in 2017), and the proportion of apprentices identifying themselves as Asian decreased slightly (12%) compared to previous years (14% in both 2017 and 2018).

	The proportion of CQL apprentices identifying themselves as Black or African American (18%) increased as compared to 2018 (13%) and 2017 (7%), while participation by apprentices identifying as Hispanic or Latino remained relatively constant (6% in 2019; 6% in 2018; 5% in 2017).
	As in previous years, few CQL apprentices spoke English as a second language (5%) and relatively few were first generation college attendees (16%).
CQL mentors reported gains in 21st Century skills for the apprentices they assessed; gains were statistically significant in all but two areas.	Apprentices demonstrated statistically significant ($p<.05$) growth in all domains of 21st Century skills assessed except fort the domains of Information, Media, & Technology Literacy and Productivity, Accountability, Leadership, & Responsibility. Regardless of the domain, apprentices were observed to be slightly above the Progressing level at pre-observation (average 2.07 to 2.36), and by final observation CQL participants' skill ratings were closer to the Demonstrates Mastery level (average 2.53 to 2.80).
Apprentices reported engaging in STEM practices more frequently in CQL than in their typical college or university experiences; first generation college attendees reported more frequent engagement than those who had a parent who attended college.	More than half of apprentices (58%-98%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (26%) and building/making a computer model (45%). STEM practices CQL apprentices reported being most frequently (weekly or every day) engaged with during the program were interacting with STEM researchers (98%) and working with a STEM researcher or company on a real-world STEM research project (96%).
	No significant differences were found in reported frequency of engaging in STEM Practices in CQL by U2 classification, although first generation college attendees reported significantly greater engagement as compared to their peers who had a parent who attended college (medium effect size).
	Apprentices reported significantly higher frequency of engagement in STEM practices in CQL as compared to in their college or university courses (extremely large effect size), suggesting that CQL offers apprentices substantially more intensive STEM learning experiences than they would generally experience in their coursework.
Apprentices reported gains in their STEM knowledge as a result of participating in CQL; apprentices who met the AEOP definition of U2 and male apprentices reported larger gains than their non-U2 and female peers.	More than 80% of CQL apprentices indicated at least some gains in every area of STEM knowledge on the survey. All apprentices reported at least some gains in their in-depth knowledge of STEM topics (100%), and nearly all reported similarly about their gains in knowledge of research conducted in STEM fields (98%).
	Apprentices who met the AEOP definition of U2 reported significantly greater STEM knowledge gains than non-U2 apprentices (medium effect size), and male apprentices reported significantly greater STEM knowledge gains than female apprentices (large effect size).
Apprentices reported gains in their STEM competencies as a result of participating in CQL	More than half of the responding apprentices (57%-89%) reported at least some gain in all STEM competencies. Competencies most frequently reported as having been impacted (some or large gains) by CQL apprentices

with no significant differences across any of the constituent categories of U2 status.	were defining a problem that can be solved by developing a new or improved product or process (92%), using knowledge/creativity to suggest a solution to a problem (89%), and supporting an explanation with STEM knowledge (89%).
	There were no differences in gains in STEM competencies by U2 classification or by any of the individual demographic variables investigated.
Apprentices reported that CQL participation had positive impacts on their 21st Century skill; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	Approximately two-thirds or more of apprentices (68%-94%) reported at least some gains on each item associated with 21st Century skills with the exception of the following: creating media products (15%); analyzing media (32%); and leading others in a team (45%). Items with the greatest growth (at least some gains) were solving problems (94%); interacting effectively in a professional manner (94%); adapting to change when things do not go as planned (94%); and incorporating feedback into their work effectively (94%).
	Apprentices who met the AEOP definition of U2 reported significantly greater impacts on their 21st Century skills than non-U2 apprentices (medium effect size).
Apprentices reported gains in their STEM identities as a result of participating in CQL with no significant differences across any of the constituent categories of U2 status.	Approximately three-quarters or more of CQL apprentices (75%-92%) reported some gains or large gains on all items associated with STEM identity, and large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (92%) and sense of accomplishing something in STEM (92%).
	There were no significant differences in gains in STEM identity by U2 classification or by any of the individual demographic variables investigated.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
CQL mentors used a range of mentoring strategies with apprentices.	CQL mentors reported using strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Most mentors (65%-100%) used four of the strategies to establish relevance of learning activities. Less than half used the strategies of helping students understand how STEM can help them improve their own community (20%), helping students become aware of the role STEM plays in their everyday lives (33%), and asking students to relate real-life events or activities to topics covered in CQL (47%). 2. Most mentors (67%-93%) used five of the strategies associated with supporting the diverse needs of learners. Less than half used strategies of highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (20%) and integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (7%).

	3. Most mentors (53%-93%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Most mentors (67%-100%) reported using all strategies to support students' engagement in authentic STEM activities. 5. More than half of mentors (53%-100%) reported implementing six of the strategies focused on supporting students' STEM educational and career pathway. Less than half used strategies of helping students with their resumé, application, personal statement, and/or interview preparations (33%); recommending AEOPs aligned with student goals (40%); discussing economic, political, ethical, and/or social context of a STEM career (40%); and recommending professional organizations in STEM to students (40%).
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.	More than 80% of CQL apprentices (81%-94%) being somewhat or very much satisfied with all of the listed program features except for other administrative tasks (47%). Features apprentices reported being most satisfied with included the amount of the stipend (94%), the teaching or mentoring provided (94%), and applying or registering for the program (92%).
	Few apprentices expressed dissatisfaction with CQL program features, although 21% of apprentices were not satisfied with administrative tasks such as security clearances and issuing CAC cards.
	A large majority of apprentices (90%-98%) reported being at least somewhat satisfied with each element of their CQL experience. Nearly all were at least somewhat satisfied with their working relationship with their mentor (98%).
	Nearly all (98%) 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 specific STEM skills, career information, and the networking opportunities and mentoring they experienced in CQL.
	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 better communication from the program.
CQL mentors were 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 of mentors (53%-87%) reported being at least somewhat satisfied with all program features except for the following two items that large proportions of mentors had not experienced: communicating with RIT (53% had not experienced) and support for instruction/mentorship during program activities (40% had not experienced).
	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, followed by the career information apprentices receive, the opportunities for apprentices to network, and the value of CQL in developing the future workforce.

	In open-ended responses, the improvement most frequently suggested by mentors was to provide better communication with the program, followed by administrative improvements such as less paperwork and streamlining apprentice onboarding procedures.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Both CQL apprentices and mentors learned about AEOP primarily through DoD and personal contacts.	CQL apprentices most frequently learned about AEOP through someone who works with the DoD (43%), a family member (27%), and someone who works at the school/university they attend (25%).
	More than a third (41%) of mentors reported learning about AEOP through someone who works with the DoD; the same proportion learned about AEOP through workplace communications.
Apprentices were motivated to participate in CQL primarily by the learning opportunities and their interest in STEM.	More than 85% of apprentices indicated that they were motivated to participate in CQL by their interest in STEM (96%), the desire to learn something new or interesting (89%), the opportunity to learn in ways that are not possible in school (86%), and their desire to expand laboratory or research skills (84%).
Most CQL apprentices had not participated in AEOPs in the past although most are interested in participating in AEOPs in the future.	More than half (55%) of CQL apprentices indicated they had never participated in any AEOPs previously. Smaller proportions of apprentices reported having participated in the following AEOPs, however: GEMS (23%), CQL (11%), Camp Invention (4%), and eCM (2%). Few responding CQL participants (6%) reported participating in other STEM programs.
	More than three-quarters of apprentices were at least somewhat interested in participating in CQL again (85%), and approximately half or more of apprentices reported being at least somewhat interested in the SMART Scholarship (70%) and NDSEG Fellowship (47%). More than a third of apprentices had never heard of the NDSEG Fellowship (34%), GEMS-NPM (40%), and URAP (40%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in CQL (77%) and their program mentors (64%). More than half of responding apprentices had not experienced AEOP resources such as AEOP on social media (77%) and the AEOP brochure (51%).
Most mentors discussed CQL and the SMART scholarship with apprentices, however few discussed any other AEOPs.	More than half of mentors discussed CQL (87%) and SMART (53%) with their apprentices, however fewer than a quarter discussed any other specific program with apprentices. Over a quarter (27%) reported discussing AEOP in general, but without reference to any specific program.
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs was participation in CQL (73%) followed by the CQL program administrator or site coordinator (60%). Most mentors reported that they did not experience materials

	provided by AEOP such as social media (73%) and the AEOP brochure (73%) as resources for exposing apprentices to AEOPs.
Most apprentices learned about STEM careers generally and DoD STEM careers specifically during CQL.	A large majority of CQL apprentices (94%) reported learning about at least one STEM job/career and that most (75%) reported learning about three or more general STEM careers. Similarly, a large majority of apprentices (87%) reported learning about at least one DoD STEM job/career, although slightly fewer (72%) reported learning about three or more Army or DoD STEM jobs during CQL.
	Participation in the apprenticeship program (77%) and apprentices' mentors (77%) were most often reported as being somewhat or very much impactful on CQL apprentices' awareness of DoD STEM careers. More than a third of CQL apprentices reported they had not experienced AEOP resources such as the AEOP brochure (36%), the ARO website (61%), and AEOP on social media (70%).
	CQL mentors were most likely to rate participation in CQL (80%) and program mentors (33%) as at least somewhat useful resources for exposing apprentices to DoD STEM careers.
CQL apprentices expressed positive opinions about DoD research and researchers.	CQL apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 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 CQL with no significant differences across any of the constituent categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL except watching/reading non-fiction STEM (43%). Activities for which more than three-quarters of CQL apprentices reported increased likelihood of engagement were: working on a STEM project in a university or professional setting (85%); talking with friends/family about STEM (77%); and mentoring/teaching other students about STEM (77%).
	There were no differences in likelihood of future engagement by U2 classification or by any of the individual demographic variables investigated.
Nearly all CQL apprentices planned to at least complete a Bachelor's degree and many reported an interest in a graduate or terminal degree.	Nearly all CQL apprentices (98%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's (26%) or terminal degree (55%) in their field.
CQL apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in	Approximately 60% or more of apprentices agreed that CQL contributed in some way to each impact listed in this section. Areas of greatest impact, with more than 90% of apprentices agreeing, were: more confidence in STEM knowledge, skills, and abilities (9%), more awareness of DoD STEM research and careers (96%), and a greater appreciation of DoD STEM research (94%).

impact across any constituent categories of U2 status.	No significant differences were found in impact of CQL by U2 classification or by any of the individual demographic variables investigated.

SEAP Findings

Table 221. 2019 SEAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although SEAP received applications from substantially more students in 2019, the number of students placed in apprenticeships decreased relative to previous years.	A total of 1,286 applications were received in 2019, a substantial increase (32%) over the 872 applications received in 2018, and a 34% increase over slight the 852 applications received in 2017.
	A total of 108 students (8% of applicants), were placed in apprenticeships, representing a slight decrease in enrollment and a substantial decrease in placement rate as compared to previous years (in 2018, 114, or 13%, of applicants were placed; in 2017, 113, or 13%, were placed).
	Fifteen Army labs accepted applications for SEAP apprentices in 2019 and apprentices were hosted at 10 of these sites (11 sites hosted apprentices in 2018).
Nearly a third of SEAP apprentices met the AEOP definition of U2. While SEAP continues to serve apprentices from a variety of races and ethnicities, somewhat fewer apprentices from groups historically underserved and underrepresented in STEM were enrolled in 2019 as compared to previous years.	Nearly a third of SEAP apprentices (32%) met the met the AEOP definition of U2, an increase from 2018 when 27% of apprentices qualified for U2 status.
	Similar to previous years lightly more than half of SEAP apprentices (52%) were female (53% in 2018 and 54% in 2017).
	As in previous years, the most frequently represented races/ethnicities were White (55%) and Asian (24%). The proportion of White apprentices continues to increase (47% in 2018, 42% in 2017), however the proportion of Asian apprentices decreased as compared to 2018 (27%) and 2017 (32%).
	The proportion of apprentices identifying themselves as Black or African American (10%) continues to trend downward as compared to 2018 (12%) and 2017 (17%), while a similar proportion of apprentices identified themselves as Hispanic or Latino in 2019 (4%) as in 2018 (4%) and 2017 (3%)
	As in previous years, few apprentices received free or reduced price school lunches (10% in 2019, 9% in 2018), spoke a language other English as their first language (8% in 2019, 5% in 2018), and would be first generation college attendees (4% in 2019, 2% in 2018).
SEAP mentors reported significant gains in apprentices'	While apprentices demonstrated an increase in all 21st Century skills domains, only one (Information, Media, & Technological Literacy) had large

21st Century skills; gains were statistically significant in only one area.	enough average increases to be considered statistically significant growth (p<.05). All assessed skills showed increases from pre- to post-observations with the exception of “Think creatively”, which showed a very slight decline over time, and “Communicate clearly”, which had no growth. None of the items tested demonstrated enough growth to be considered statistically significant due to the small sample size (5-6 apprentices).
Apprentices reported engaging in STEM practices more frequently in SEAP than in their typical school experiences with no differences in engagement across any of the constituent categories of U2 status.	More than half of SEAP apprentices (55%-100%) reported participating in all STEM activities about which they were asked at least monthly. STEM practices SEAP apprentices reported being engaged in most frequently (weekly or every day) during their program were using laboratory procedures and tools (91%) and solving real world problems (91%).
	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 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 of the constituent categories of U2 status.	Nearly all SEAP apprentices (91%-100%) reported at least some gains in their STEM knowledge as a result of participating in their program
	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 of the constituent categories of U2 status.	More than 80% (82%-100%) of SEAP apprentices reported at least some gains in all STEM competencies (Table 64) as a result of participation in their program.
	No significant differences were found in 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 of the constituent categories of U2 status.	Nearly three-quarters or more of SEAP apprentices (73%-100%) reported at least some gains in all 21st Century skills items except for creating media products (46%) as a result of their program participation.
	No significant differences were found in 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 of participating in SEAP with no differences in gains across any	All SEAP apprentices (100%) reported some gains or large gains on all items associated with STEM Identity,
	No significant differences were found in gains in STEM identity in SEAP by U2 classification or by any constituent group of U2 classification.

of the constituent categories of U2 status.	
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
SEAP Mentors used a range of mentoring strategies with apprentices.	SEAP mentors reported using strategies associated with each of the five areas of effective mentoring about which they were asked: 1. More than half of (55%-100%) reported using all strategies to help make learning activities relevant to students except for helping students understand how STEM can help them improve their own community (36%). 2. More than half of SEAP mentors (55%-91%) reported using all but two strategies to support the diverse needs of students as learners. Less than half used the strategies of integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (18%) and highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (18%). 3. Approximately two-thirds or more of SEAP mentors (64%-91%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Approximately two-thirds or more (64%-100%) of SEAP mentors reported using all strategies to support students' engagement in authentic STEM activities. 5. Approximately two-thirds or more of SEAP mentors (64%-91%) reported using all but three strategies focused on supporting students' STEM educational and career pathways. Less than half used the strategies of helping students with their resumé, application, personal statement, and/or interview preparations (9%); discussing the economic, political, ethical, and/or social context of a STEM career (36%); and discussing STEM career opportunities in private industry or academia (46%).
SEAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of SEAP. Apprentices also offered various suggestions for program improvement.	More than 80% of SEAP apprentices (82%-100%) reported being somewhat or very much satisfied with all of the listed program features except for other administrative tasks such as security clearance and CAC card issuance (27%). All apprentices reported being at least somewhat satisfied with the physical location of their apprenticeship activities (100%).
	Few apprentices expressed dissatisfaction with SEAP program features, although 18% of apprentices were not satisfied with administrative tasks such as security clearances and issuing CAC cards and 18% were not satisfied with the timeliness of payment of stipends.
	More than 90% of SEAP apprentices reported being at least somewhat satisfied with each element of their apprenticeship experience. All reported

	being at least somewhat satisfied with the research experience overall (100%) and the amount of time they spent doing meaningful research (100%).
	Nearly all SEAP apprentices (91%) 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 real-world research experience, networking opportunities, and career information and exposure.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide guidance or orientation for new apprentices orientation and/or improve in-processing procedures, followed by suggestions for improving communication and providing more opportunities for apprentices to interact with one another.
SEAP mentors were 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.	More than half of mentors (55%-73%) reported being at least somewhat satisfied with all features except for the following three: communicating with SEAP organizers (82% did not experience); other administrative tasks (18% did not experience and 27% were not at all satisfied); and research abstract preparation requirements (27% did not experience).
	Some mentors (two of five respondents) made positive comments about SEAP in their response to an open-ended questionnaire item. Mentors identified a number of strengths of the program including the value of apprentices' exposure to hands-on real-world research, the value of the mentorship experience, the exposure to DoD research, the career information apprentices received, the value of networking with STEM professionals, and the program structure.
	Mentors offered a wide variety of suggestions for program improvement, however none were mentioned by more than 4 respondents (50%). The most frequently mentioned suggestions were to reduce the amount of paperwork and/or improving in-processing procedures, provide seminars or training for apprentices throughout the summer, and provide more clear learning objectives and/or expectations for apprentices' presentations.
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 primarily through DoD and personal contacts.	Apprentices most frequently learned about AEOP through family members (75%) and someone who works for the DoD (63%).
	Responding mentors most frequently learned about AEOP through workplace communications (46%) and through past participants (36%).
Apprentices were motivated to participate in SEAP primarily by the learning opportunities and their interest in STEM.	More than 85% of apprentices indicated that they were motivated to participate in SEAP by their interest in STEM (100%), the opportunity to use advanced laboratory technology (100%), their desire to expand laboratory or research skills (88%), and figuring out education or career goals (88%).

Few apprentices had participated in AEOPs other than GEMS and SEAP in the past but are interested in participating in AEOPs in the future.	Half (50%) of the eight respondents for whom data were available indicated they had not previously participated in any AEOPs. Smaller proportions reported having participated in the following AEOPs in the past: GEMS (38%), SEAP (25%), and JSS (13%). More than a third of SEAP participants reported participating in other STEM programs (38%).
	Approximately three-quarters or more of apprentices were at least somewhat interested in participating in each program. Less than 20% of apprentices had never heard of each AEOP listed (9%-18%).
	Approximately two-thirds or more (73%-91%) of SEAP apprentices indicated all resources except two were at least somewhat impactful on their awareness of AEOPs. More than a third (36%) had not experienced either AEOP on social media and the AEOP brochure.
No mentors discussed AEOPs other than SMART and CQL with apprentices.	The only programs SEAP mentors reported discussing with their apprentices were SMART (55%) and CQL (36%). Over a third (36%) of mentors reported talking about AEOP in general with their apprentices 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 SEAP (91%) and SEAP program administrators (36%). All other resources were not experienced my more than half of SEAP mentors.
SEAP apprentices learned about STEM careers generally and STEM careers within the DoD during SEAP.	All SEAP apprentices (100%) reported learning about at least one STEM job/career, and most (73%) reported learning about three or more general STEM careers. Similarly, a large majority of apprentices (91%) reported learning about at least one DoD STEM job/career, and slightly more than half (55%) reported learning about three or more Army or DoD STEM jobs or careers during SEAP.
	Participation in the apprenticeship program (91%) and apprentices' mentors (82%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. Many apprentices reported that they had not experienced AEOP resources such as AEOP on social media (46%), the ARO website (36%), and the AEOP brochure (36%).
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers was participation in SEAP (82%). Few mentors rated any other resource as being useful, and more than half of SEAP mentors reported having not experienced all other resources for this purpose.
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 categories of U2 status.	Approximately three-quarters or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after their SEAP experience. Activities all SEAP apprentices (100%) reported being more likely to engage in after their program were talking with friends/family about STEM, taking an elective STEM class, and working on a STEM project in a university or professional setting.
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any of the individual demographic variables investigated.
All SEAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in earning a graduate or terminal degree.	All responding SEAP apprentices (100%) reported wanting to at least earn a Bachelor's degree and many reported a desire to earn a master's degree (18%) or terminal degree (64%) 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.	Nearly all SEAP apprentices (91%-100%) agreed that SEAP contributed in some way to each impact listed. All apprentices (100%) agreed, for example, that SEAP contributed to their confidence in their STEM knowledge skills, and abilities; to their awareness of other AEOPs; and their interest in pursuing a STEM career with the Army or DoD.
	No significant differences were found in impact of SEAP by U2 classification or by any of the individual demographic variables investigated.

REAP Findings

Table 222. 2019 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 as compared to previous years.	In 2019, 857 students applied for the REAP program, an 11% decrease from the 949 applicants in 2018, and a 17% increase over the 709 applicants in 2017.
	A total of 168 students were placed in apprenticeships, an 18% increase over the 138 placed in 2018, and a 30% increase over the 118 apprentices placed in 2017.
Two more colleges and universities hosted REAP apprentices in 2019 than in 2018; a slightly smaller percentages of those	A total of 55 colleges and universities participated in REAP in 2019, a slight increase (4%) from the 53 institutions that participated in 2018 and a 25% increase over the 41 participating institutions in 2017. Of these institutions, 29 (53%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 31 (57%) in 2018 and 25 (60%) in 2017.

institutions were HBCUs/MSIs than in previous years.	
REAP continues to serve apprentices from groups historically underserved and underrepresented in STEM, with increases in the participation of some racial/ethnic groups and a large majority of apprentices meeting the AEOP definition of U2.	Nearly all REAP apprentices (99%) qualified for U2 status under the AEOP definition (96% in 2018).
	The proportion of female participants (67%) increased somewhat as compared to previous years (62% in 2018; 61% in 2017).
	The proportion of REAP apprentices identifying themselves as White (9%) was similar to 2018 (8%) but substantially lower than in 2017 (27%). The proportion of REAP apprentices identifying as Asian continues to decrease relative to previous years (14% in 2019 as compared to 20% in 2018 and 27% in 2017).
	The proportions of apprentices identifying themselves as Black or African American continues to increase as compared to previous years (44% in 2019 as compared to 40% in 2018 and 29% in 2017). Likewise, participation by Hispanic or Latino apprentices continues to increase (26% in 2019 as compared to 22% in 2018 and 15% in 2017).
	More than half of REAP apprentices (56%) qualified for free or reduced-price school lunches (FARMS), and over a quarter (30%) spoke a language other than English as their first language.
REAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	Statistically significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their REAP experiences ($p<.001$) were found in all six skill sets of 21st Century skills. Apprentices demonstrated the most growth in the Creativity & Innovation skill set.
Apprentices reported engaging in STEM practices more frequently in REAP than in their typical school experiences with no significant differences in engagement across any of the constituent categories of U2 status.	More than half of REAP apprentices (61%-90%) reported participating at least monthly in all activities with the exceptions of presenting their STEM research to a panel of judges (23%), designing research investigation based on their own questions (45%), and building/making a computer model (45%). Nearly all REAP apprentices reported regularly (weekly or every day) working collaboratively as part of a team (90%).
	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 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 with no significant differences in knowledge gains across any	A large majority of REAP apprentices (90%-94%) reported at least some gains in their STEM knowledge as a result of participating in the program.
	No significant differences were found in STEM knowledge gains in REAP by U2 classification or by any constituent group of U2 classification.

of the constituent categories of U2 status.	
Apprentices reported gains in their STEM competencies as a result of participating in REAP with no differences in gains across any of the constituent categories of U2 status.	Approximately three-quarters or more of REAP apprentices (74%-97%) reported at least some gains on all STEM competencies items. More than 90% of apprentices reported at least some gains in supporting an explanation with STEM knowledge (97%) and carrying out an experiment and recording data accurately (94%).
	No significant differences were found in 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 of the constituent categories of U2 status.	Approximately two-thirds or more of REAP apprentices (65%-100%) reported at least some gains in all 21st Century skills items with the exception of creating media products (42%)
	No significant differences were found in 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 of participating in REAP with no differences in gains across any of the constituent categories of U2 status.	More than three-quarters of REAP apprentices (77%-97%) reported at least some gains on all items associated with STEM identity and nearly all reported at least some gains in their sense of accomplishing something in STEM (97%) and interest in a new STEM topic (97%).
	No significant differences were found in reported gains in STEM identity in REAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
REAP mentors used a range of mentoring strategies with apprentices.	A majority of REAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. More than three-quarters of REAP mentors (78%-98%) reported using all strategies to help make learning activities relevant to students. 2. More than half of REAP mentors (60%-95%) reported using all strategies to support the diverse needs of students as learners. 3. More than three-quarters of REAP mentors (78-98%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Nearly all REAP mentors used strategies to support students' engagement in authentic STEM activities (95%-100%). 5. More than half of REAP mentors (58%-95%) reported using strategies to support students' STEM educational and career pathways.
REAP apprentices were satisfied with program features that they had experienced and	Approximately two-thirds or more of REAP apprentices (61%-94%) reported being somewhat or very much satisfied with all of the listed program features. Aspects of the program apprentices reported being most satisfied

identified a number of benefits of REAP. Apprentices also offered various suggestions for program improvement.	with included applying/registering for the program (94%) and the amount of the stipend (90%).
	Few apprentices expressed dissatisfaction with REAP program features, although 10% of apprentices were not satisfied with timeliness of stipend payments.
	More than 80% of REAP apprentices (83%-100%) reported being at least somewhat satisfied with all elements of their research experience. All REAP apprentices (100%) indicated being at least somewhat satisfied with the amount of time they spend doing meaningful research and nearly all felt similarly about their overall research experience (97%).
	All apprentices 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 and experience they gained, followed by their STEM learning, the teamwork they experienced, and the opportunity to present and/or write about their research findings.
	In open-ended responses, the improvements most frequently suggested by apprentices were related to communication, including suggestions for better program communication with mentors, faster replies, more frequent communication, information about symposiums and conferences, and providing more program information in advance of the start of the apprenticeship. Other improvements suggested included providing more choice in projects, improvements to the stipend (e.g., a larger stipend, faster payment, or more frequent payment), and improvements to mentoring (e.g., providing more mentors, more contact with the mentor, more instruction on content such as stoichiometry, and help with presentations).
REAP mentors were 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 half of REAP mentors (55%-73%) reported being at least somewhat satisfied with various program features of REAP. Very few mentors (one or two) reporting being dissatisfied with any program feature, however up to a third of mentors had not experienced some of the features such as the research abstract preparation requirements (18% had not experienced), application/registration process (25% had not experienced), and communication with REAP organizers (33% had not experienced).
	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 opportunity for hands-on laboratory experiences, followed by REAP's focus on engaging students underserved or underrepresented in STEM fields and other strengths such as the career information apprentices receive, apprentices' acquisition of specific STEM skills, the stipend, and the program's administration.
	In open-ended responses, the improvements most frequently suggested by mentors were focused on communication, including suggestions that the program provide mentors with more information or guidelines, that communication be faster, or better in general. Other suggestions for

	program improvements included providing more DoD information and/or career information (for example, providing more DoD speakers or webinars), extending the length of the program, providing more funding to the host institution (e.g., for materials), improving the apprentice stipend (e.g., a larger stipend or earlier payment of the stipend), and accepting more apprentices into the program.
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 through professional or AEOP contacts.	The most frequently selected sources of information about AEOP, selected by more than a quarter of apprentices, were someone who works at the school they attend (39%); school/university newsletter, email, or website (29%); and someone who works with the program (25%).
	More than a quarter of mentors reported they learned about AEOP from a colleague (33%), a supervisor or superior (33%), or from the AEOP website (28%). Slightly less than a quarter (23%) of REAP mentors indicated that they had learned about AEOP through an AEOP site director or host.
Apprentices were motivated to participate in REAP primarily by the learning opportunities and their interest in STEM.	More than two-thirds of apprentices indicated that they were motivated to participate in REAP by their desire to learn something new or interesting (89%), interest in STEM (86%), and learning in ways that are not possible in school (71%).
Most apprentices had not participated in AEOPs other than REAP, and were interested in participating in URAP and SMART, although many had not heard of other AEOPs.	While 54% indicated they had never participated in any AEOP programs in the past, smaller proportions reported having participated in the following AEOPs: REAP (14%), UNITE (11%), and GEMS (4%). Twenty-eight percent of responding REAP participants reported participating in other STEM programs.
	More than half of apprentices reported being at least somewhat interested in participating in URAP (61%) and SMART (58%). More than half of apprentices reported not having heard of CQL, NDSEG, and GEMS (52%-58%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in REAP (74%) and the AEOP website (74%). More than a third of apprentices had not experienced AEOP on social media (58%), the AEOP brochure (42%), and presentations shared through the program (36%).
Few mentors discussed specific AEOPs with their apprentices although most discussed AEOP generally.	A third or less of REAP mentors discussed any of the specific AEOPs with their apprentices, however nearly three-quarters (73%) reported discussing AEOPs in general with their apprentices.
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs was participation in REAP (75%). Half or more of mentors also indicated that the REAP program administrator (58%) and the AEOP website (55%) were at least somewhat

	useful. More than a third of mentors reported not experiencing AEOP on social media (53%), invited speakers (50%), and AEOP printed materials (38%).
Apprentices learned about STEM careers during REAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	Nearly all REAP apprentices (94%) reported learning about at least one STEM job/career, and approximately two-thirds (68%) reported learning about three or more general STEM careers during their apprenticeship. Much smaller proportions of apprentices (45%) reported learning about at least one DoD STEM job/career, and even fewer (19%) reported learning about three or more Army or DoD STEM jobs during REAP.
	More than half of REAP participants reported the following resources as being somewhat or very much impactful on their awareness of DoD STEM careers: participation in REAP (61%), program mentors (58%), and the AEOP website (52%). More than a third of apprentices indicated they had not experienced all other resources such as AEOP on social media (55% had not experienced) and the ARO website (55% had not experienced).
	Approximately half or more of mentors reported the following resources as being at least somewhat useful for exposing apprentices to DoD STEM careers: participation in REAP (65%), AEOP administrator/site coordinator (55%), AEOP website (50%), and AEOP printed materials (48%). Half or more of responding mentors reported not experiencing AEOP on social media (53%) and invited speakers (50%).
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 with no significant differences across any of the constituent categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after REAP. Items for which more than 85% of REAP apprentices expressed increased likelihood of engagement were talking with friends/family about STEM (90%) and working on a STEM project in a university or professional setting (87%).
	No differences were found in future STEM engagement by overall U2 classification or by any of the individual demographic variables investigated.
Nearly all REAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in earning a graduate or terminal degree.	Nearly all (97%) REAP apprentices reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (19%) or terminal degree (71%) 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.	More than half of REAP apprentices agreed that REAP contributed in some way to each impact listed in this section. Areas of impact noted by more than 80% of apprentices were confidence in STEM knowledge, skills, and abilities (97%), interest in participating in other AEOPs (84%), greater appreciation of DoD STEM research (84%), and interest in participating in STEM activities outside of school requirements (81%).
	No significant differences were found in impact in REAP by U2 classification or by any of the individual demographic variables investigated.

HSAP Findings

Table 223. 2019 HSAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although more students applied for HSAP apprenticeships, fewer were placed in apprenticeships than in previous years.	In 2019, 670 students applied for HSAP apprenticeships, a 17% increase as compared to the 559 applicants in 2018 and a 6% increase over the 629 students who applied to HSAP in 2017.
	A total of 29 applicants (4%) were placed in apprenticeships, a 66% decrease in enrollment as compared to 2018 when 48 students were placed in HSAP apprenticeships and an 86% decrease in enrollment compared to 2017 when 54 apprentices were placed.
Slightly fewer colleges and universities hosted HSAP apprentices than in previous years, and fewer of those institutions were HBCUs/MSIs than in previous years.	Ten of the 25 host institutions (40%) in 2019 were HBCU/MSIs, compared to the 13 of the 33 host institutions (39%) in 2018 and 19 of 36 (53%) in 2017.
Nearly two-thirds of HSAP apprentices met the AEOP definition of U2. Enrollment demographics showed slight variations from previous years.	Nearly two-thirds of apprentices (66%) qualified for U2 status under the AEOP definition, an increase as compared to 2018 when 54% met the AEOP definition of underserved.
	As in previous years, over half of apprentices were female (62% in 2019, 60% in both 2018 and 2017).
	As in previous years, the most commonly reported races/ethnicities were White (31% in 2019, 31% in 2018, 42% in 2017) and Asian (21% in 2019, 33% in 2018, 25% in 2017).
	The percentage of apprentices identifying as Hispanic or Latino (24%) increased as compared to previous years' enrollment (15% in 2018, 14% in 2017).

	Relatively few apprentices received free or reduced price school lunch (21%), spoke English as a second language (14%), and would be first generation college attendees (14%).
HSAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their HSAP experiences (*p*<.01-.001) for all areas of 21st Century skills. Skills associated with media and information management saw the largest increases from pre- to post- observations.
Apprentices reported engaging in STEM practices more frequently in HSAP than in their typical school experiences with no significant differences in engagement across any of the constituent categories of U2 status.	Half or more of HSAP apprentices (67%-94%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (11%). STEM practices HSAP apprentices reported being most frequently (weekly or every day) engaged in during their program were interacting with STEM researchers (94%), working with a STEM researcher or company on a real-world STEM research project (89%), and analyzing data or information and drawing conclusions (89%).
	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 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 of the constituent categories of U2 status.	More than 90% (90%-100%) of HSAP apprentices reported at least some gains in all areas of their STEM knowledge as a result of participating in the program.
	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 result of participating in HSAP with no differences in gains across any of the constituent categories of U2 status.	More than 60% (61%-100%) of HSAP apprentices reported at least some gains in all STEM competencies
	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 with no differences in gains across any of the constituent categories of U2 status.	With the exception of two items, half or more of apprentices (56%-100%) reported at least some gains in all areas of 21st Century skills due to their participation in HSAP. The exceptions were analyzing media (44%) and creating media products (28%).
	No significant differences in impacts on HSAP apprentices' 21st Century skills were found by U2 classification or by any constituent group of U2 classification.

Apprentices reported gains in their STEM identities as a result of participating in HSAP with no differences in gains across any of the constituent categories of U2 status.	More than three-quarters of HSAP apprentices (78%-95%) reported at least some gains on all STEM identity items, and nearly all reported at least some gains in feeling prepared for more challenging STEM activities (95%) and confidence to try out new ideas/procedures on their own in a STEM project (95%).
	No significant differences were found in 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.*	
HSAP mentors used a range of mentoring strategies with apprentices.	A majority of HSAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Half or more of HSAP mentors (50%-86%) reported using all strategies to help make learning activities relevant to students. 2. More than half of HSAP mentors (57%-93%) reported using each strategies to support the diverse needs of students as learners. 3. More than three-quarters of mentors (79%-100%) indicated using each strategy to support student development of collaboration and interpersonal skills. 4. More than 90% of responding HSAP mentors (all or all but one) indicated using each strategy to support student engagement in authentic STEM activities. 5. More than half of HSAP mentors (57%-100%) reported using all strategies focused on supporting students' STEM educational and career pathways.
HSAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of HSAP. Apprentices also offered various suggestions for program improvement.	Two-thirds or more of HSAP apprentices (67%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of stipend payment (56%). Features apprentices reported being most satisfied with included applying or registering for the program (100%) and the physical location of their program activities (94%).
	Very few apprentices expressed dissatisfaction with any program feature although 11% indicated that they were "not at all" satisfied with the timeliness of the stipend payment.
	A large majority (89%-100%) of HSAP apprentices reported being at least somewhat satisfied with various elements of their research experience. Two aspects with which all apprentices were somewhat or very much satisfied were their working relationship with their mentors (100%) and the overall research experience (100%).
	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 laboratory experience and the STEM skills apprentices gained during HSAP, followed by the opportunity to develop 21st Century or workplace skills such as the ability to

	work independently, critical thinking, time management, collaboration, and communication; career and college information; STEM learning; and opportunities for networking.
	In open-ended responses, the improvements most frequently suggested by apprentices focused on communication from the program and information about the program, including communication generally, providing clearer objectives and/or communication with mentors about guidelines, defining the start and end date of the apprenticeship, and providing clearer instructions or clearer descriptions of research topics. Other suggestions for improvement include providing more networking opportunities (e.g., with mentors and alumni) and providing a longer program or opportunities for apprentices to extend their research experience by, for example, writing a paper.
HSAP mentors were 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.	More than 80% of HSAP mentors (86%-93%) reported being at least somewhat satisfied with all program features except for communication with the ARO (50%) and research abstract preparation requirements (71%); relatively large numbers of mentors reported having not experienced either of these features (43% and 14% respectively).
	Mentors who responded to open-ended items all made positive comments about HSAP. Mentors most frequently mentioned as program strengths the hands-on research experience apprentices receive, followed by the career information apprentices receive, the stipends apprentices are paid, and the program's administration.
	The program improvements most frequently suggested by mentors related to funding, including faster or smoother stipend payment, providing funding for mentors, and providing funding for more apprentices or increasing stipends. The next most frequently suggested improvements were to accept more apprentices and provide apprentices with opportunities to present their research.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices and mentors learned about AEOP through their school or workplace, the AEOP website, or a DoD contact.	The most frequently selected sources of information about AEOP for apprentices were someone who works at their school/university (61%), followed by the AEOP website (28%) and school/university newsletter, email, or website (22%).
	More than a third of mentors reported learning about AEOP through the AEOP website (43%), their supervisor or superior (36%), or someone who works with the DoD (36%).
Apprentices were motivated to participate in HSAP primarily	More than 80% of apprentices indicated that they were motivated to participate in HSAP by their desire to learn something new/interesting (94%), their interest in STEM (89%), the opportunity to use advanced

by the learning opportunities and their interest in STEM.	laboratory technology (83%), and the opportunity to expand their laboratory/research skills (83%).
Only one apprentice reported participating in an AEOP in the past, but most were interested in participating in AEOPs in the future.	Seventy percent of HSAP apprentices indicated they had never participated in any AEOPs in the past, and only one apprentice reported having participated in JSHS (5%). One quarter of responding HSAP participants reported participating in other STEM programs (25%).
	With the exception of CQL (39%), half or more of apprentices reported being at least somewhat interested in participating in all other AEOPs (50-83%), however more than a third of HSAP apprentices indicated they had never heard of each AEOP (39%-61%) except URAP, which all had heard of.
	Half or more HSAP apprentices reported all resources except two were at least somewhat impactful on their awareness of AEOPs. Over half had not experienced AEOP on social media (56%) and over a third had not experienced the AEOP brochure (39%).
Mentors primarily discussed HSAP and URAP with their apprentices.	More than three-quarters of mentors reportedly discussed HSAP (93%) and URAP (79%) with their apprentices. Slightly more than a third also discussed SMART (36%) and NDSEG (36%). Additionally, more than a third (36%) discussed AEOPs in general with apprentices.
	More than half indicated the following resources were at least somewhat useful for this purpose: the AEOP website (79%), HSAP participation (79%), and AEOP program administrator/ coordinator (57%). More than a third reported not experiencing other resources such as AEOP on social media (64%) and invited speakers or "career" events (64%).
Apprentices learned about STEM careers during HSAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	All HSAP apprentices (100%) reported learning about at least one STEM job/career, although only a third (33%) reported learning about three or more general STEM careers during their apprenticeships. Considerably fewer apprentices (50%) reported learning about at least one DoD STEM job/career, and very few (11%) reported learning about three or more Army or DoD STEM jobs during HSAP.
	Participation in the apprenticeship program (61%) was the only resource reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers by a majority of apprentice respondents. A majority of apprentices reported that they had not experienced AEOP on social media (56%).
	Half or more of HSAP mentors indicated that participation in HSAP (64%) and the AEOP website (50%) were at least somewhat useful for exposing apprentices to DoD STEM careers. Most mentors had not experienced invited speakers (79%), AEOP on social media (71%), AEOP printed materials (57%), and AEOP program administrators (57%) as resources for exposing apprentices 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 categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after HSAP. Activities for which more than three-quarters of HSAP apprentices indicated an increased likelihood of engagement were using a computer to design/program something (83%), talking with friends/family about STEM (78%), taking a STEM elective (78%), and working on a STEM project in a university/professional setting (78%).
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any of the individual demographic variables investigated.
All HSAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in earning a graduate or terminal degree.	When asked about how much formal education REAP apprentices wanted to earn after participating in their program, all (100%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (22%) or terminal degree (61%) in their field.
HSAP 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 U2 categories.	Approximately two-thirds or more of HSAP apprentices agreed that HSAP contributed in some way to each impact listed in this section. All apprentices reported that HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%).
	No significant differences were found in overall impact by U2 classification or by any of the individual demographic variables investigated.

URAP Findings

Table 224. 2019 URAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
The number of URAP applicants decreased as compared to 2018, and fewer students were placed in URAP apprenticeships in 2019 than in previous years.	In 2019, 281 students applied for URAP apprenticeships, a 14% decrease as compared to the 321 who applied in 2018 and a 15% increase in applicants as compared to the 239 students who applied in 2017.
	A total of 54 applicants (19%) were placed in apprenticeships, a 24% decrease in number of students placed compared to 2018 when 67 were placed, and a 9% decrease compared to 2017 when 59 apprentices were placed.

Fewer colleges and universities hosted URAP apprentices in 2019 than in 2018, and fewer were HBCUs/MSIs than in previous years.	41 colleges and universities hosted URAP apprentices in 2018 (compared to 48 in 2018, and 39 in 2017). Of these institutions, 10 (24%) were HBCU/MSIs, a notable decrease as compared to 2018 (22, or 46% of institutions) and 2017 (17, or 44% of institutions).
Over a fifth of URAP apprentices met the AEOP definition of U2; demographic characteristics of participants varied as compared to previous years.	Over a fifth (22%) of URAP apprentices met the AEOP definition of U2, compared to 18% in 2018.
	The proportion of female apprentices was the same as in 2018 and smaller than in 2017 (39% in 2019, 39% in 2018, 58% in 2017).
	The proportion of apprentices identifying as White (57%) decreased as compared to 2018 (64%) but was higher than in 2017 (53%). The proportion of apprentices identifying as Asian (19%) increased as compared to both 2018 (9%) and 2017 (14%).
	The proportion of apprentices identifying as Black or African American (6%) was smaller than in previous years (9% in 2018; 8% in 2017), although the proportion of apprentices identifying as Hispanic or Latino (15%) increased as compared to 2018 (10%) and was the same as in 2017 (15%).
	Most apprentices (82%) spoke English as their first language, and few (13%) were first generation college attendees.
URAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	Significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their URAP experiences (*p*<.001) were found for all six skill sets of 21st Century skills. Skills associated with accessing information and applying technological skills saw the largest increases from pre- to post-observations.
Apprentices reported engaging in STEM practices more frequently in URAP than in their typical college or university experiences; apprentices meeting the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices.	More than half of URAP apprentices (61%-97%) reported participating at least monthly in all STEM practices except presenting their STEM research to a panel of judges (16%) and building or making a computer model (45%). STEM practices URAP apprentices reported engaging with most frequently (weekly or every day) during the program were working with a STEM researcher or company on a real-world STEM research project (97%) and interacting with STEM researchers (94%).
	Although no significant differences in engaging in STEM practices composite scores were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (very large effect size).
	Apprentices reported significantly more frequent engagement in STEM practices in URAP as compared to in their college or university coursework (very 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 met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	Approximately 90%-93% of URAP participants indicated at least some gains in each area of STEM knowledge, and nearly all apprentices reported at least some gain in their knowledge of research conducted in a STEM topic or field (94%) and knowledge of what everyday research work is like in STEM (94%).
	Although no significant differences in gains in STEM knowledge were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).
Apprentices reported gains in their STEM competencies as a result of participating in URAP; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	About two-thirds or more of URAP apprentices (65%-90%) reported some gains or large gains in their STEM competencies as a result of participation in the program. Apprentices were most likely to report gains (some or large) in the following competencies: using knowledge/creativity to suggest a solution to a problem (90%). supporting an explanation with relevant STEM knowledge (90%), and presenting an argument that uses data from an experiment (90%).
	Although no significant differences in gains in STEM competencies were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).
Apprentices reported that URAP participation had positive impacts on their 21st Century skills; apprentices who met the AEOP definition of U2 and female apprentices reported greater gains than their peers.	Approximately two-thirds or more of URAP apprentices (65%-100%) reported at least some gains in all areas of 21st Century skills except for analyzing media (26%) and creating media products (16%). All URAP apprentices reported at least some gains in adapting to change when things do not go as planned (100%) and working independently and complete tasks on time (100%).
	Apprentices who met the AEOP definition of underserved reported greater gains in their 21st Century skills than non-U2 apprentices (large effect size), and females reported greater gains than males (large effect size).
Apprentices reported gains in their STEM identities as a result of participating in URAP; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	A large majority of URAP apprentices (81%-94%) reported at least medium gains on all items associated with STEM identity. Apprentices were most likely to report gained in their sense of accomplishing something in STEM (94%), feeling prepared for more challenging STEM activities (94%), and their confidence to try out new ideas/procedures on their own in a STEM project (94%).
	No significant differences existed by individual demographics used to determine U2 classification, however, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	

URAP mentors used a range of mentoring strategies with apprentices.	A majority of URAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to help make learning activities relevant to students. 2. Approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to support the diverse needs of students as learners. 3. More than 70% of URAP mentors (71%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. More than 90% of URAP mentors (93%-100%) reported using all strategies to support students' engagement in authentic STEM activities. 5. More than half of URAP mentors (54%-93%) reported using all strategies focused on supporting students' STEM educational and career pathways
URAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of URAP. Apprentices also offered various suggestions for program improvement.	About three-quarters or more of URAP apprentices (74%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of payment (58%). Features apprentices reported being most satisfied with included the physical location of their program (100%), application/registration for the program (97%), and the teaching or mentoring provided (97%).
	Few apprentices expressed dissatisfaction with any feature, although 16% reported being "not at all" satisfied with timeliness of stipend payments.
	More than 90% of URAP apprentices (94%-100%) indicated they were at least somewhat satisfied with all aspects of their apprenticeship experience. All apprentices reported being somewhat or very much satisfied with the amount of time spent with their research mentor (100%) and the overall research experience (100%).
	All apprentices 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 real-world laboratory experience they gained, followed by the career information they received, the mentoring, and their STEM learning generally.
	Apprentices suggested a wide variety of improvements in open-ended responses. The most frequently mentioned improvements related to communication with the program, including suggestions for clearer or more concise communication from the program or more frequent communication, followed by suggestions for improvements to the stipend, including more frequent payment of the stipend, a larger stipend, or better communication about the stipend. Other suggested improvements included providing apprentices with more information about the DoD or STEM careers within the DoD and improvements to mentoring, including suggestions for apprentices to have more contact with or more guidance

	from mentors, the program providing better information to mentors, and providing earlier contact with mentors.
URAP mentors were 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.	Nearly two-thirds or more of the responding URAP mentors (61%-89%) reported being at least somewhat satisfied with all program components they experienced except for communicating with ARO (25% somewhat or very much satisfied), a feature that 71% of mentors reported having not experienced. Program features mentors were most satisfied (somewhat/very much) with were the stipends (89%) and the application/registration process (82%).
	All mentors who responded to open-ended items made positive comments about URAP. The most frequently mentioned strength was apprentices' exposure to research and the research experience they gain in URAP, followed by the apprentice stipends, the quality of the apprentices the program recruits, and communication with the program and/or program administration.
	In open-ended responses, mentors' most frequently mentioned suggestions were to increase the number of apprentices in the program; to provide ways for apprentices to disseminate their research (e.g., a virtual symposium, a post-program event, or an abstract book); and improvements to the apprentice stipend, including providing a larger stipend, faster processing, or more frequent payment. Other suggestions included providing a longer program and clearer information about applications, guidelines, and goals.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices and mentors learned about AEOP primarily through their school or workplace or from the AEOP website or DoD contacts.	The most frequently selected sources of information about AEOP for apprentices were someone who works at the school they attend (60%), followed by school communications (newsletter, email, or website) (40%) and someone who works with the program (17%).
	A quarter or more of mentors reported learning about AEOP through the AEOP website (32%), their supervisor or superior (32%), or someone who works with the DoD (25%).
Apprentices were motivated to participate in URAP primarily by the learning opportunities and their interest in STEM.	Approximately three-quarters or more of apprentices indicated that they were motivated to participate in URAP by their interest in STEM (90%), their desire to learn something new or interesting (90%), their desire to expand laboratory/research skills (83%), and the opportunity to learn in ways that are not possible in school (73%).
Only two URAP apprentices reported having participated in other AEOPs in the past but many expressed some interest in future participation,	Eighty percent of URAP apprentices reported having not participated in any AEOP, and only one indicated participating in Camp Invention (3%) and URAP (3%). Approximately 13% of apprentices reported participating in other STEM programs. Most URAP participants had not heard of CQL (77%) and GEMS NPM (71%).

although large proportions had not heard of AEOPs other than URAP.	More than half of URAP apprentices reported that the following three resources were at least somewhat impactful on their awareness of AEOPs: participation in URAP (61%), the AEOP website (61%), and their URAP mentor (55%). Large proportions of apprentices had not experienced other resources such as AEOP on social media (65%) and the AEOP brochure (52%).
Most mentors discussed SMART with their apprentices, although few discussed any other AEOP besides NDSEG.	SMART was the only AEOP that a majority of mentors (79%) reported speaking to apprentices about, although 43% discussed NDSEG. Large proportions of mentors (71%-93%) reported not discussing AEOPs other than SMART and NDSEG 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 URAP (79%) and the AEOP website (61%). Between 50% and 75% of mentors also reported not having experienced all other resources for this purpose.
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 (84%) reported learning about at least one STEM job/career, and slightly more than half (55%) reported learning about three or more general STEM careers. Considerably fewer apprentices (45%) reported learning about at least one DoD STEM job/career, and even less (10%) reported learning about three or more Army or DoD STEM jobs during URAP.
	When asked about resources that impacted their awareness of DoD STEM careers, apprentices most frequently chose "did not experience" for each resource. The resources most frequently cited as at least somewhat useful for this purpose were participation in URAP (43%), the AEOP website (39%), and mentors (37%).
	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 (79%) and the AEOP website (61%). Between 50% and 75% of mentors also reported not having experienced all other resources for this purpose.
Apprentices expressed positive opinions about DoD research and researchers.	URAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements about DoD research and researchers.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in URAP; apprentices who met the AEOP definition of U2 were more likely to report increased likelihood of engagement than non-U2 apprentices.	More than half of URAP apprentices reported more likelihood of engaging with all activities about which they were asked except for tinkering with mechanical/electrical devices (48%) and working on solving math/science puzzles (48%).Activities for which more than three-quarters of URAP apprentices reported increased likelihood of engagement were talking with friends/family about STEM (81%); and working on a STEM project in a university/professional setting (81%).
	Apprentices who met the AEOP definition of underserved reported greater gains in their 21st Century skills than non-U2 apprentices (large effect size).

All URAP apprentices planned to at least complete a Bachelor's degree and many reported an interest in earning a graduate or terminal degree.	All responding apprentices (100%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (26%) or terminal degree (58%) in their field.
URAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers; apprentices who met the AEOP definition of U2 reported greater impacts than non-U2 apprentices.	Three-quarters or more of URAP apprentices agreed that URAP contributed in some way to each area of program impact. Areas of impact noted by 90% or more of apprentices were increased confidence in their STEM knowledge, skills, and abilities (97%); greater appreciation for DoD STEM research (94%); and more interest in pursuing a STEM career with the DoD (90%).
	Although no significant differences in engaging in STEM practices composite scores were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater impacts than non-U2 apprentices (large effect size).

Overall Recommendations for FY20 Program Improvement/Growth

Evaluation findings for apprenticeship programs overall were very positive. All programs (CQL, SEAP, REAP, HSAP, URAP) enabled participants to experience some growth in their STEM practices, STEM knowledge, STEM competencies, and STEM identities. 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 FY20 and beyond:

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

1. Some of the apprenticeship programs experienced an increase in the number of applications in FY19 (CQL, SEAP, HSAP). However, despite the growth in number of applicants, CQL (FY18 214 students to FY19 194 students), SEAP (FY18 114 students to F19 108 students), HSAP (FY18 48 students, FY19 29 students) placed a smaller number and percentage of students than in FY18. Other programs experienced a decrease in applications in FY19, including REAP which dropped 11% but was able to place 30 more apprentices in FY19 – an 18% increase overall. URAP also saw a decrease in applications (14%) and an accompanying 24% decrease in participation (FY19 54 participants compared to FY18 67 participants). The overwhelming demand for AEOP apprenticeship programs is something that must be strongly considered by the consortium. The evaluation team recommends investing more resources into funding, recruiting mentors and sites, and overall efforts to providing access and opportunity to more applicants in FY20 and the future.

2. All apprenticeship programs were successful in growing their percentage of underserved participants in FY19. CQL increased from 20% to 28%, SEAP from 27% to 32%, REAP from 96% to 99%, HSAP from 54% to 66%, and URAP from 18% to 22%. However, there is still room for growth with four of the five programs. The evaluation team commends apprenticeship programs for their efforts in this area and encourages RIT and ARO to continue to focus on this in FY20 and the future.

AEOP Priority: Support and empower educators with unique Army research and technology resources

No recommendations

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

1. Apprenticeship participation in the annual AEOP evaluation is still much lower than desirable. HSAP, URAP, SEAP, and CQL had very poor participation in the evaluation questionnaires for both participants and mentors. Program participation in the required 21st Century Skills Assessment for all apprentices was also very low in FY19 for CQL, SEAP, HSAP, URAP. RIT and ARO must work directly with mentors for the programs to convey these required components of the AEOP evaluation early and frequently across the summer to provide reminders and support for participants to complete the questionnaire. It is recommended that this become a required activity on the last day of the apprenticeship for both the student and the mentor. In regard to the 21st Century Skills Assessment, NCSU provides live webinars that are an orientation to the tool with follow-up support as needed. It is strongly recommended that the apprenticeship programs invest extra efforts to achieve at least 40% participation in all AEOP evaluation tasks for FY20.

2. Across all apprenticeship programs in FY19, as in FY18, the majority of mentors are not discussing specific AEOP programs with students. For example, 40% of CQL participants had never heard of URAP and 27% of CQL mentors reported only discussing AEOP generally – with the other 73% not discussing AEOP at all. Findings for the other apprenticeship programs were similar – a pervasive concern that has been highlighted for multiple years. It is recommended that RIT, as it fully assumes leadership in FY20, make this an area of emphasis and expectation for mentors in AEOP apprenticeship programs. The consortium has developed materials that can be provided to help support this effort.

3. As in FY18, the FY19 apprentices from all programs indicated very little engagement with AEOP on 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. It is recommended that the IPAs promote the social media hashtags, etc. in communications with sites in FY20.