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ARMY EDUCATIONAL OUTREACH PROGRAM

Apprenticeship Programs

2020 Annual Program Evaluation Report Findings

July 2021

AEOP 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 addition, this report includes an evaluation of a summer online course for high school apprentices that was provided as an option to the full apprenticeship program due to the COVID-19 pandemic in 2020. The apprenticeship programs are 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. 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 2020, 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.

Nineteen Army lab and centers accepted applications for CQL apprentices in 2020 (Table 1). Apprentices were hosted at 17 sites, an increase over the 16 participating host sites in 2019 and the 13 participating host sites in 2018. A total of 582 students applied for CQL apprenticeships, a slight decline compared to 2019 when 662 students applied, but a slight increase as compared to the 574 applicants in 2018. Of these applicants, 159 (27%) were placed in apprenticeships. This continues a downward trend in the number of participating apprentices and placement rate since 2017 (2019 -204 [31%]; 2018 - 214 [37%]; 2017 – 229 [39%]).

Table 1. 2020 CQL Site Applicant and Enrollment Numbers			
2020 CQL Site	**No. of Applicants**	**No. of Enrolled Participants**	**Placement Rate**
Army Cyber Institute - West Point	30	5	17%
U.S. Army DEVCOM - Armaments Center	60	25	42%
U.S. Army DEVCOM - Army Research Lab - Adelphi	135	25	19%
U.S. Army DEVCOM - Army Research Lab - Aberdeen Proving Ground	117	37	32%
U.S. Army DEVCOM - Army Research Lab - Central (Chicago)	21	5	24%
U.S. Army DEVCOM - Army Research Lab - Northeast (Boston)	18	1	5%
U.S. Army DEVCOM - Army Research Lab – South (Austin)	45	5	11%
U.S. Army DEVCOM - Army Research Lab - West (LA/Playa Vista)	16	0	0%
U.S. Army DEVCOM - Army Research Lab – White Sands Missile Range*	0	5	-
U.S. Army DEVCOM - Aviation and Missile Center	42	2	4%
U.S. Army DEVCOM - Chemical Biological Center- APG	66	1	2%
U.S. Army DEVCOM - Chemical Biological Center- RI	10	0	0
U.S. Army DEVCOM - Data & Analysis Center - White Sands Missile Range	9	4	44%
U.S. Army Defense Forensic Science Center	71	8	11%
U.S. Army Engineer Research and Development Center - Construction Engineering Research Laboratory	29	9	31%
U.S. Army Engineer Research and Development Center - Geospatial Research Laboratory	26	1	4%
U.S. Army Engineer Research and Development Center - MS	45	6	13%
U.S. Army MRDC - Center for Environmental Health Research	34	0	0%
U.S. Army MRDC - Medical Research Institute of Infectious Disease	54	1	1%
U.S. Army MRDC - Walter Reed Army Institute of Research	121	19	15%
Total[†] **949 applications received representing 582 individual applicants**		**159**	**27%**

[†]Applicants could apply for up to two locations

*This site did not collect unique applications in CVENT but hosted five students.

Table 2 provides demographic profiles for enrolled CQL apprentices. Just over a third (35%) of participants were female, a decrease as compared to previous years (2019, 51%; 2018, 45%; 2017, 54%). A somewhat larger proportion of CQL apprentices identified themselves as White (59%) as compared to 2019 (54%), although this is a decrease in comparison to 2018 (64%) and 2017 (67%). Likewise, the proportion of apprentices identifying themselves as Asian increased slightly (15%) as compared to 2019 (12%) and previous years (14% in both 2017 and 2018). The proportion of CQL apprentices identifying themselves as Black or African American (9%) decreased sharply as compared to 2019 (18%) and 2018 (13%) but was higher than in 2017 (7%). Participation by apprentices identifying as Hispanic or Latino remained relatively constant (5% in 2020; 6% in 2019; 6% in 2018; 5% in 2017). Fewer than a quarter (21%) were Pell grant recipients, a proxy for low-income status. Nearly all apprentices (94%) identified English as their first language, and a relatively small proportion (18%) were first generation college attendees. Slightly over a quarter of apprentices (26%) met the AEOP definition of students underserved or underrepresented

(Underserved) in STEM,[1] a decrease from 2019 when 35% of apprentices met the Underserved criteria, but an increase from the 20% who met the definition in 2018.

Table 2. 2020 CQL Student Participant Profile		
Demographic Category		
Gender (n=159)		
Female	56	35.2%
Male	103	64.8%
Choose not to report	0	0%
Race/Ethnicity (n=159)		
Asian	24	15.1%
Black or African American	14	8.8%
Hispanic or Latino	8	5.0%
Native American or Alaska Native	1	<1%
Native Hawaiian or Other Pacific Islander	0	0%
White	94	59.1%
More than one race	10	6.3%
Other race or ethnicity	1	<1%
Choose not to report	7	4.4%
Grade Level (n=159)		
11^{th}	1	<1%
12^{th}	3	1.9%
College – Freshman	19	11.9%
College – Sophomore	39	24.5%
College – Junior	40	25.2%
College – Senior	50	31.4%
Graduate student	5	3.1%
Choose not to report	2	1.3%
Pell Grant Recipient (n=159)		
Yes	33	20.8%
No	111	69.8%
Choose not to report	15	9.4%
English is First Language (n=159)		
Yes	150	94.3%
No	7	4.4%
Choose not to report	2	1.3%
One or More Parent/Guardian Graduated from College (n=159)		
Yes	128	80.5%
No	29	18.2%

[1] AEOP's definition of underserved (Underserved) 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).

Choose not to report	2	1.3%
Underserved Status (n=159)		
Yes	41	25.8%
No	106	66.7%
Insufficient data to make determination*	12	7.5%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

Cost data for 2020 CQL activities are provided in Table 3. The total cost for CQL was $1,482,699. The cost per student participant was $9,325. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 3. 2020 CQL Program Costs	
Total Cost	$1,482,699
Total Travel	$496
Participant Travel	$0
Total Awards	$1,413,821
Student Awards/Stipends	$1,413,821
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$9,325

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 2020, 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 2020. The COVID-19 pandemic had a profound effect on the placement of SEAP apprentices in 2020 and apprentices were hosted at only three of these sites (10 sites in 2019 and 11 sites in 2018). A total of 938 students applied for SEAP apprenticeships in 2020, a decrease of 27% as compared to 2019 when 1,286 students applied but an 8% increase compared to the 872 applications received in 2018 (852 applications received in 2017). Of these applicants, only 28, or 3%, were placed in apprenticeships. This is a marked decrease in both the number of apprentices placed and the placement rate as compared to previous years (108 [8%] in 2019; 114 [13%] in 2018; 113 [13%] in2017). In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP apprentices that served 31 students who had applied for SEAP apprenticeships. This course is described and evaluated separately within this report. Table 4 summarizes SEAP applicants and final enrollment by site.

Table 4. 2020 SEAP Site Applicant and Enrollment Numbers			
2020 SEAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
U.S. Army DEVCOM - Army Research Lab - Adelphi	288	9	3%
U.S. Army DEVCOM - Army Research Lab - Aberdeen Proving Ground	110	10	9%
U.S. Army DEVCOM - Army Research Lab - Central (Chicago)	68	0	0
U.S. Army DEVCOM - Army Research Lab - Northeast (Boston)	44	0	0
U.S. Army DEVCOM - Army Research Lab – South (Austin)	51	0	0
U.S. Army DEVCOM - Army Research Lab - West (LA/Playa Vista)	53	0	0
U.S. Army DEVCOM - Aviation and Missile Center	30	0	0
U.S. Army DEVCOM - Chemical Biological Center- APG	72	0	0
U.S. Army DEVCOM - Chemical Biological Center- RI	35	0	0
U.S. Army Engineer Research Center - Construction Engineering Research Laboratory	45	0	0
U.S. Army Engineer Research Center - Geospatial Research Laboratory	80	0	0
U.S. Army Engineer Research Center - MS	29	0	0
U.S. Army MRDC - Medical Research Institute of Chemical Defense	44	0	0
U.S. Army MRDC - Medical Research Institute of Infectious Disease	222	0	0
U.S. Army MRDC - Walter Reed Army Institute of Research	373	9	2%
Total† **1544 applications representing 938 individual applicants**		**28**	**3%**

†Applicants could apply for up to two locations

Table 5 displays demographic data for enrolled SEAP apprentices. Unlike previous years, less than half (36%) of SEAP apprentices were female (52% in 2019, 53% in 2018, and 54% in 2017). As in previous years, the most frequently represented races/ethnicities were White (32%) and Asian (39%), although 2020 was the first year that the most frequently represented race/ethnicity was Asian (24% in 2019, 27% in 2018, 32% in 2017). This also reverses a trend in which the proportion of White apprentices increased relative to previous years (32% in 2020; 54% in 2019; 47% in 2018, 42% in 2017). The proportion of apprentices identifying themselves as Black or African American (14%), however, began to reverse a multi-year downward trend (10% in 2019; 12% in 2018; 17% in 2017). The proportion of apprentices identifying themselves as Hispanic or Latino in 2020 (4%) was like previous years (4% in 2019, 4% in 2018, 3% in 2017). As in 2019, a majority of apprentices (82%) attended suburban schools (68% in 2019) and few (4%) received free or reduced-price school lunches (FARMS) (10% in 2019). All apprentices spoke English as their first language (100%) and none would-be first-generation college attendees. Less than a quarter of SEAP apprentices (21%) met the AEOP definition of Underserved, a decrease as compared to previous years (32% in 2019, 27% in 2018).

Table 5. 2020 SEAP Student Participant Profile		
Demographic Category		
Gender (n=28)		
Female	10	35.7%
Male	18	64.3%
Choose not to report	0	0%
Race/Ethnicity (n=28)		
Asian	11	39.3%
Black or African American	4	14.3%
Hispanic or Latino	1	3.6%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	9	32.1%
More than one race	2	7.1%
Other race or ethnicity	0	0%
Choose not to report	1	3.6%
Grade Level (n=28)		
9th grade	0	0%
10th grade	6	21.4%
11th grade	9	32.1%
12th grade	11	39.4%
College – Freshman	2	7.1%
School Location (n=28)		
Urban (city)	5	17.9%
Suburban	23	82.1%
Rural (country)	0	0%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Other	0	0%
Choose not to report	0	0%
Receives Free or Reduced-Price Lunch (FARMS) (n=28)		
Yes	1	3.6%
No	26	92.8%
Choose not to report	1	3.6%
English is First Language (n=28)		
Yes	28	100.0%
No	0	0%
One Parent/Guardian Graduated from College (n=28)		
Yes	28	100.0%
No	0	0%
Choose not to report	0	0%
Underserved Status (n=28)		
Yes	6	21.4%
No	22	78.6%

Insufficient data to make determination*	0	0%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

Cost data for 2020 SEAP activities are provided in Table 6. The total cost for FY20 for SEAP was $210,427. The cost per student participant was $7,515. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 6. 2020 SEAP Program Costs	
Total Cost	$210,427
Total Travel	$496
Participant Travel	$0
Total Awards	$141,549
Student Awards/Stipends	$141,549
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$7,515

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 2020, REAP received 802 applications from 527 students. This is a slight decrease in the number of applications as compared to 2019 when 857 applications were received (949 in 2018). A total of 86 students (16% of applicants) were placed in REAP apprenticeships at 47 colleges and universities around the country. This represents a slight decrease as compared to 2019 when 168 students were placed in apprenticeships at 55 colleges and universities and 2018 when 138 students were placed at 53 institutions in 2018. The 49% decrease in the number of students placed in apprenticeships in 2020 as compared to 2019 can be largely attributed to campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020. In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP apprentices that served 54 students who had applied for REAP apprenticeships. This course is described and evaluated separately within this report. Of the institutions hosting apprentices in 2020, 23 (49%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 29 (53%) in 2019 and 31 (57%) in 2018. Table7 displays the number of applicants and enrollment at each site in 2019.

Table 7. 2020 REAP Site Applicant and Enrollment Numbers

2020 REAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Alabama State University*	16	6	38%
Arizona State University	6	1	17%
Augusta University	39	0	0
Caldwell University	12	0	0
California State University – Sacramento*	5	0	0
City University of New York*	15	0	0
Colorado State University*	6	2	33%
Delaware State University*	17	0	0
Fayetteville State University*	14	2	14%
Georgia State University Research Foundation*	31	0	0
Iowa State University	2	0	0
Jackson State University*	17	3	18%
Johns Hopkins University	115	4	3%
Longwood University	13	0	0
Louisiana Tech University	5	3	60%
Marshall University	11	3	27%
Marshall University School of Pharmacy	8	2	25%
Morgan State University*	68	0	0
New Jersey Institute of Technology	25	6	24%
New Mexico State University*	3	0	0

Oakland University	10	2	20%
Purdue University	5	1	20%
Rutgers University*	17	1	6%
Savannah State University *	19	2	11%
Stockton University	17	0	0
Texas Southern University *	48	8	17%
Texas Tech University*	14	6	43%
University of Alabama at Huntsville	20	0	0
University of Arkansas – Fayetteville	5	3	60%
University of Arkansas at Pine Bluff*	2	0	0
University of Central Florida*	10	0	0
University of Houston*	39	8	21%
University of Illinois at Urbana-Champaign	7	0	0
University of Massachusetts - Lowell	8	0	0
University of Missouri	3	0	0
University of Nevada, Reno	3	2	67%
University of New Mexico*	17	8	47%
University of North Carolina – Charlotte	15	0	0
University of Northern Iowa	4	0	0
University of Pennsylvania	11	0	0
University of Puerto Rico*	33	6	18%
University of Southern California*	13	2	15%
University of Texas - El Paso*	4	0	0
University of Texas – Arlington*	22	0	0
University of the Virgin Islands*	6	3	50%
University of Vermont – Burlington	6	0	0
Yale University	16	2	13%
Total† 802 applications received representing 527 individual applicants		**86**	**16%**

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

Table 8 displays demographics for REAP apprentices. The proportion of female participants (70%) in 2020 was similar to 2019 when 67% of participants were female (62% in 2018, 61% in 2017). The proportion of apprentices identifying themselves as Black or African American (36%) declined somewhat compared to 2019 (44%) and 2018 (40%) but remained higher than in 2017 (29%). Participation by Hispanic or Latino apprentices (33% in 2020) continues to increase as compared to previous years (26% in 2019, 22% in 2018, and 15% in 2017). The proportion of REAP apprentices identifying themselves as White (4%) was lower than in previous years (9% in 2019, 8% in 2018, 27% in 2017). The proportion of REAP apprentices identifying as Asian (14%) remained at 2019 levels (14% in 2019, 20% in 2018, 27% in 2017). Over half of REAP apprentices attended urban (39%) or suburban (41%) schools. Half of REAP apprentices (50%) qualified for free or reduced-price school lunches (FARMS) (56% in 2019), a third (33%) spoke a language other than English as their first language (30% in 2019), and over a quarter (29%) would-be first-generation college attendees (36% in 2019). All but three REAP apprentices for whom data were available (94%) qualified as underserved status according to the AEOP definition (99% in 2019).

Table 8. 2020 REAP Student Participant Profile

Demographic Category		
Gender (n=86)		
Female	60	69.8%
Male	26	30.2%
Choose not to report	0	0%
Race/Ethnicity (n=86)		
Asian	12	14.0%
Black or African American	31	36.0%
Hispanic or Latino	28	32.5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	1	1.2%
White	3	3.5%
More than one race	6	7.0%
Other race or ethnicity	2	2.3%
Choose not to report	3	3.5%
Grade Level (n=86)		
9^{th}	5	5.8%
10^{th}	22	25.6%
11^{th}	43	50.0%
12^{th}	15	17.4%
College – Junior	1	1.2%
School Location (n=86)		
Urban (city)	34	39.4%
Suburban	36	41.9%
Rural (country)	12	14.0%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	1	1.2%
Home school	0	0%
Online school	0	0%
Other	2	2.3%
Choose not to report	1	1.2%
Receives Free or Reduced-Price Lunch (FARMS) (n=86)		
Yes	43	50.0%
No	43	50.0%
Choose not to report	0	0%
English is First Language (n=86)		
Yes	58	67.4%
No	28	32.6%
One or More Parent/Guardian Graduated from College (n=86)		
Yes	60	69.7%
No	25	29.1%
Choose not to report	1	1.2%
Underserved Status (n=86)		
Yes	81	94.2%
No	3	3.5%
Insufficient data to make determination*	2	2.3%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

Cost data for 2020 REAP activities are provided in Table 9. The total cost for REAP was $393,099. The cost per student was $4,571. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 9. 2020 REAP Program Costs	
Total Cost	$393,099
Total Travel	$993
Participant Travel	$0
Total Awards	$265,821
Student Awards/Stipends	$211,821
Adult/Teacher/Mentor Awards	$54,000
Cost Per Student	$4,571

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) 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 2020, 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 2020, the program received a total of 434 student applications for HSAP apprenticeships, a 35% decrease as compared to the 670 student applications received in 2019 and a 22% decrease as compared to the 559 applications in 2018. Of these applicants, 32 students (7% of applicants) were placed in apprenticeships, a 10% increase over the 29 students placed (4% placement rate) in 2019, but a 33% decrease in enrollment as compared to 2018 when 48 students were placed. A total of 20 universities hosted HSAP apprentices in 2020, a 20% decrease as compared to 2019 when 25 institutions hosted HSAP apprentices and a 39% decrease from 2018 when 33 institutions hosted apprentices. Seven of the 20 host universities (35%) were HBCU/MSIs, compared to 10 of 25 (40%) in 2019 and 13 of 33 (39%) in 2018. The HSAP program was affected by campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020. In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP apprentices that served 17 students who had applied for HSAP apprenticeships. This course is described and evaluated separately within this report. Table 10 displays the number of applicants and enrollment at each HSAP site in 2020.

Table 10. 2020 HSAP Site Applicant and Enrollment Numbers

2020 HSAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Auburn University	6	1	17%
Columbia University	42	1	2%
Georgia Tech Research Corporation	27	1	4%
Iowa State University	1	1	100%
Louisiana State University	2	1	50%
New York Institute of Technology*	16	1	6%
New York University	64	2	3%
Norfolk State University*	16	4	25%
North Carolina A&T State University*	7	1	14%
Northeastern University	28	1	4%
Rutgers, The State University of New Jersey – Camden	32	1	3%
Stony Brook University	6	3	50%
University of Arizona*	21	4	19%
University of Central Florida*	14	2	14%
University of Memphis	9	1	11%
University of Southern California	72	1	1%
University of Texas – Arlington*	23	1	4%
University of Texas - San Antonio*	20	3	15%
Washington University	15	1	7%
Yale	13	1	8%
Total**	**434**	**32**	**7%**

*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. 2020 HSAP Student Participant Profile		
Demographic Category		
Gender (n=32)		
Female	14	43.8%
Male	18	56.2%
Choose not to report	0	0%
Race/Ethnicity (n=32)		
Asian	16	50.0%
Black or African American	2	6.3%
Hispanic or Latino	5	15.5%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	6	18.8%
More than one race	1	3.1%
Other race or ethnicity	0	0%
Choose not to report	2	6.3%
Grade Level (n=32)		
10th	9	28.1%
11th	21	65.7%
12th	1	3.1%
College – Junior	1	3.1%
School Location (n=32)		
Urban (city)	15	46.9%
Suburban	17	53.1%
Rural (country)	0	0%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Other	0	0%
Choose not to report	0	0%
Receives Free or Reduced-Price Lunch (FARMS) (n=32)		
Yes	5	15.6%
No	25	78.1%
Choose not to report	2	6.3%
English is First Language (n=32)		
Yes	21	65.6%
No	9	28.1%
Choose not to report	2	6.3%
One or More Parent/Guardian Graduated from College (n=32)		
Yes	29	90.6%
No	2	6.3%
Choose not to report	1	3.1%
Underserved Status (n=32)		
Yes	15	46.9%
No	14	43.8%
Missing or Insufficient Data*	3	9.3%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

Table 11 contains an overview of demographic information for enrolled HSAP apprentices in 2020. As opposed to previous years, less than half of apprentices (44%) were female in 2020 (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 and Asian, however fewer apprentices were White (19%) and more were Asian (50%) compared to previous years (31% White, 21% Asian in 2019; 31% White, 33% Asian in 2018; 42% White, 25% Asian in 2017). The proportion of students identifying as Black or African American declined markedly in 2020 (6% in 2020, 14% in 2019, 15% in both 2018 and 2017). The percentage of apprentices identifying as Hispanic or Latino (16%) decreased as compared to 2019 (24%) but increased slightly compared to previous years (15% in 2018, 14% in 2017). More than half of HSAP apprentices (66%) spoke English as their first language (86% in 2019), few (16%) received free and reduced-price school lunches (FARMS) (21% in 2019) and very few (6%) would-be first-generation college attendees (14% in 2019). Less than half of apprentices (47%) qualified for Underserved status under the AEOP definition, a decrease as compared to previous years (66% in 2019, 54% in 2018).

Cost data for 2020 HSAP activities are provided in Table 12. The total cost for HSAP was $181,626. The cost per student participant was $5,676. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 12. 2020 HSAP Program Costs	
Total Cost	$181,626
Total Travel	$110
Participant Travel	$0
Total Awards	$150,000
Student Awards/Stipends	$150,000
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$5,676

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 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 2020, 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 2020, URAP received 258 student applicants for URAP apprenticeships, an 8% decrease from the 281 applicants received in 2019, and a 20% decrease as compared to the 321 who applied in 2018. A total of 49 applicants (19% of applications) were placed in apprenticeships in 2020, a 9% decrease compared to the 54 students placed in 2019 and a 27% decrease in placement compared to 2018 when 67 students were placed. A total of 30 institutions (29 universities and one institute for psychiatric research) hosted apprentices, a 27% decrease as compared to the 41 host institutions in 2019 and a 38% decrease compared to the 48 host institutions in 2018. Of these institutions, six (20%) were HBCU/MSIs, a decrease as compared to previous years (10, or 24% in 2019; 22, or 46% in 2018). It should be noted that the URAP program was affected by campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020. Table 13 displays the number of applicants and enrollment at each site in 2020.

Table 13. 2020 URAP Site Applicant and Enrollment Numbers

2020 URAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
Auburn University	6	1	17%
Augusta University	14	3	21%
Carnegie Mellon University	2	1	50%
Columbia University	4	2	50%
Georgia Tech Research Corporation	12	1	8%
Iowa State University	2	1	50%

Johns Hopkins University	83	6	7%
Louisiana State University	2	1	50%
Nathan Kline Institute for Psychiatric Research (Research Foundation for Mental Hygiene, Inc.)	2	2	100%
New York Institute of Technology*	4	2	50%
New York University	22	1	5%
North Carolina A&T State University*	4	1	25%
Northeastern University	7	1	14%
Northwestern University	4	1	25%
Rutgers, The State University of New Jersey – Camden	5	1	20%
San Jose State University*	8	4	50%
St. John's University	5	1	20%
Stony Brook University	1	1	100%
Texas A&M International University*	3	3	100%
University of Delaware	5	1	20%
University of Memphis	2	1	50%
University of North Carolina – Charlotte	21	1	5%
University of Oklahoma	2	1	50%
University of Rochester	8	2	25%
University of Southern California	6	2	33%
University of Texas – Arlington*	6	1	17%
University of Texas - San Antonio*	12	3	25%
University of Wisconsin	1	1	100%
Washington University	3	1	33%
Yale University	2	1	50%
Total**	**258**	**49**	19%

*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 in 2020 (45%) grew relative to the two previous years (39% in 2019, 39% in 2018, 58% in 2017). The proportion of apprentices identifying as White (35%) decreased as compared to previous years (57% in 2019, 64% in 2018, 53% in 2017). The proportion of apprentices identifying as Asian (37%) increased sharply as compared to previous years (19% in 2019, 9% in 2018, 14% in 2017). The proportion of apprentices identifying as Black or African American (4%) continued a multi-year decline (6% in 2019, 9% in 2018, 8% in 2017). The proportion of apprentices identifying as Hispanic or Latino (12%) decreased from 2019 (15% in 2019, 10% in 2018, 15% in 2017). As in 2019, most apprentices (82% for both 2019 and 2020) spoke English as their first language, and few (14% in 2020, 13% in 2019) were first generation college attendees. A quarter (25%) of apprentices were Pell Grant recipients. Over a quarter (29%) of URAP apprentices met the AEOP definition of Underserved, an increase compared to previous years (22% in 2019, 18% in 2018).

Table 14. 2020 URAP Student Participant Profile		
Demographic Category		
Gender (n=49)		
Female	22	44.9%
Male	27	55.1%
Choose not to report	0	0%
Race/Ethnicity (n=49)		
Asian	18	36.8%
Black or African American	2	4.1%
Hispanic or Latino	6	12.2%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	17	34.7%
More than one race	5	10.2%
Other race or ethnicity	0	0%
Choose not to report	1	2.0%
Grade Level (n=49)		
12th	1	2.0%
College – Freshman	7	14.3%
College – Sophomore	12	24.5%
College – Junior	21	42.9%
College – Senior	8	16.3%
Other	0	0%
Pell Grant Recipient (n=49)		
Yes	12	24.5%
No	36	73.5%
Choose not to report	1	2.0%
English is First Language (n=49)		
Yes	40	81.6%
No	7	14.3%
Choose not to report	2	4.1%
One or More Parent/Guardian Graduated from College (n=49)		
Yes	41	83.7%
No	7	14.3%
Choose not to report	1	2.0%
Underserved Status (n=49)		
Yes	14	28.6%
No	32	65.3%
Insufficient data to make determination*	3	6.1%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

Cost data for 2020 URAP activities are provided in Table 15. The total cost for URAP was $338,126. The cost per student participant was $6,901. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 15. 2020 URAP Program Costs	
Total Cost	$338,126
Total Travel	$110
Participant Travel	$0
Total Awards	$292,500
Student Awards/Stipends	$292,500
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$6,901

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 Underserved. Overall, 2,739 students applied for AEOP apprenticeships and 354 (13%) were placed. This represents a 29% decline in applicants compared to the 3,876 students who applied in 2019 and a 37% decrease in overall participation as compared to 2019 when 563 students (15% of applicants) were placed in apprenticeships. This represents a 16% decrease in applicants as compared to 2018 when 3,275 apprenticeship applications were received, and a 39% decrease in the number of apprentices placed in 2018 (581). There was a corresponding decrease in the proportion of students placed in apprenticeships in 2020 (13%) compared to 2019 (15%) and 2018 (18%). Of those placed, 44% met the AEOP definition of Underserved, as compared to 53% in 2019 and 42% in 2018.

Table 16. 2020 Apprenticeship Participation

Type of Program	No. of Applicants	No. of Participants	Percentage of Underserved
Army Laboratory-Based Programs (CQL, SEAP)	1,520	187	25%
University-Based Programs (REAP, HSAP, URAP)	1,219	167	66%
Total	**2,739**	**354**	**44%**

The total cost of 2020 apprenticeship programs was $2,605,977. The average cost per apprentice for 2020 apprenticeship programs overall was $7,362. Table 17 summarizes these and other 2020 apprenticeship program costs. The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

Table 17. 2020 Apprenticeship Program Costs	
Total Program Costs	
Total Cost	$2,605,977
Total Travel	$2,205
Participant Travel	$0
Total Awards	$2,263,691
Student Awards/Stipends	$2,209,691
Adult/Teacher/Mentor Awards	$54,000
Cost Per Apprentice	$7,362
	Total Costs Per Type of Program
Army Laboratory-Based Programs – Total Cost	$1,693,126
University-Based Programs – Total Cost	$912,851
	Cost Per Student Participant By Type of Program
Cost Per Apprentice Army Laboratory & Center-Based Programs	$9,054
Cost Per Apprentice – University-Based Programs	$5,466

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 • 187 apprentices participating in Army laboratory-hosted apprenticeships • 167 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 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 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, and phone interviews with apprentices and mentors. Because of pandemic-related travel restrictions, no site visits were made in 2020 and phone interviews were held in lieu of focus groups for all apprenticeship programs. In addition, program administrators provided program information and other data from apprenticeship sites. Tables 18-22 outline the information collected in apprentice and mentor questionnaires and interviews as well as information from programs relevant to this evaluation report.

Table 18. 2020 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; 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 AEOP and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 19. 2020 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 AEOP, 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 AEOP 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. 2020 Apprentice 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. 2020 Mentor 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. 2020 Program-provided Information	
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 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. Interview protocols are provided in Appendix B (apprentices) and C (mentors). The questionnaire used to evaluate the summer apprenticeship course is provided in Appendix D. Sample apprentice and mentor questionnaires for each program are in Appendices E and F.

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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.

Overall Apprenticeship Programs - Study Sample

Overall apprentice and mentor evaluation survey participation, response rates, and margins of error at the 95% confidence level[3] (a measure of how representative the sample is of the population) are provided in Table 23. Participation rates for apprentices and mentors are lower than desired (27% and 14% respectively), resulting in somewhat larger than acceptable margins of error which suggests that samples may not be representative of the overall population. Therefore, conclusions must be interpreted with caution.

A total of 63 phone interviews were held with apprentices and mentors in 2020. These 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 CQL's efforts and impact and highlight areas for future exploration in programming and evaluation.

Table 23. 2020 Apprenticeship Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[4]
Apprentices	96	354	27%	±8.55%
Mentors	34	242	14%	±15.61%

Army Laboratory-Based Programs

Study Sample and Respondent Profiles

CQL

Table 24 shows apprentice and mentor participation in the CQL evaluation surveys, response rates, and margins 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 the generally acceptable ±2% - ±5%, suggesting samples may not be representative of their respective populations.

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

Table 24. 2020 CQL Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	52	159	32.7%	±11.18%
Mentors	6	89	6.7%	±38.86%

Phone interviews were conducted with nine CQL apprentices and four CQL 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 CQL's efforts and impact and highlight areas for future exploration in programming and evaluation.

CQL Apprentice Respondent Demographics

Demographic data gathered from the 52 CQL apprentice evaluation survey participants are provided in Table 25. More males (60%) completed the survey compared to females (40%). Approximately two-thirds of CQL apprentices reported being White (64%), followed by Asian (19%) and Black/African American (8%). Approximately a quarter of CQL apprentices reported they were either college juniors (25%), seniors (25%), or graduates (27%). Almost all apprentices reported speaking English as a first language (94%) and having a parent who had attended college (81%). Nearly a quarter (23%) of survey respondents met the AEOP criteria for Underserved status.

Table 25. 2020 CQL Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=52)		
Female	21	40.4%
Male	31	59.6%
Choose not to report	0	0%
Race/Ethnicity (n=52)		
Asian	10	19.2%
Black or African American	4	7.7%
Hispanic or Latino	1	1.9%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	33	63.5%
More than one race	3	5.8%
Other race or ethnicity	0	0%
Choose not to report	1	1.9%
Grade Level (n=52)		

College – Freshman	2	3.8%
College – Sophomore	8	15.5%
College – Junior	13	25.0%
College – Senior	13	25.0%
College Graduate (may or may not be in graduate school)	14	26.9%
Other	0	0%
Choose not to report	2	3.8%
Pell Grant Recipient (n=52)		
Yes	9	17.3%
No	42	80.8%
Choose not to report	1	1.9%
English is First Language (n=52)		
Yes	49	94.2%
No	3	5.8%
Choose not to report	0	0%
One or More Parent/Guardian Graduated from College (n=52)		
Yes	42	80.8%
No	10	19.2%
Choose not to report	0	0%
Underserved Status (n=52)		
Yes	12	23.1%
No	39	75.0%
Insufficient data to make determination*	1	1.9%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

CQL Mentor Respondent Demographics

Table 26 provides demographic data for CQL mentors who responded to the survey. Approximately two-thirds of responding mentors were male (67%), and all indicated they were White (100%). Most mentors (83%) said they were professional scientists, engineers, or mathematicians.

Table 26. 2020 CQL Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=6)		
Female	2	33.3%
Male	4	66.7%
Choose not to report	0	0%
Race/Ethnicity (n=6)		
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	6	100%
More than one race	0	0%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Occupation (n=6)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	5	83.3%
Other	1	16.7%
Primary Area of Research (n=6)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	1	16.7%
Biological science	1	16.7%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	0	0%
Computer science	0	0%
Technology	0	0%
Engineering	3	50.0%
Mathematics or statistics	0	0%
Medical, health, or behavioral science	0	0%
Social Science (psychology, sociology, anthropology)	0	0%
Other, (specify):	1	16.7%

SEAP

SEAP apprentice and mentor participation in the evaluation survey, response rates, and margins of error are presented in Table 27. Both apprentice and mentor margins of error for the evaluation surveys are larger than generally acceptable, signaling the samples may not be representative of their respective populations.

Table 27. 2020 SEAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	3	28	10.7%	±54.44%
Mentors	3	22	13.6%	±53.82%

Because of COVID-19 restrictions, phone interviews were held in lieu of on-site focus groups. Five SEAP apprentices and one mentor participated in phone interviews. All apprentices interviewed had participated in fully online SEAP experiences. 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 SEAP's efforts and impact and highlight areas for future exploration in programming and evaluation.

SEAP Apprentice Respondent Demographics

Very few SEAP apprentices completed the evaluation survey (*n*=3). Their demographic information is presented in Table 28. All SEAP respondents (100%) self-identified as females in 11th grade who speak English as a primary language, do not receive free/reduced lunch, and have at least one parent who attended college. Two apprentices reported they were Asian, and one chose to not report their race/ethnicity. Additionally, two SEAP apprentices indicated they attended an urban school, and one was enrolled in a suburban school. Two of the three SEAP apprentices who responded to the questionnaire were classified as underprivileged according to AEOP Underserved standards.

Table 28. 2020 SEAP Apprentice Respondent Profile

Demographic Category	Questionnaire Respondents	
Gender (n=3)		
Female	3	100%
Male	0	0%
Choose not to report	0	0%
Race/Ethnicity (n=3)		
Asian	2	66.7%
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	0	0%
More than one race	0	0%
Other race or ethnicity	0	0%
Choose not to report	1	33.3%
Grade Level (n=3)		
10th	0	0%
11th	3	100%
12th	0	0%
College – Freshman	0	0%
College - Sophomore	0	0%
Other	0	0%
Choose not to report	0	0%
School Location (n=3)		

Urban (city)	2	66.7%
Suburban	1	33.3%
Rural (country)	0	0%
Frontier or tribal school	0	0%
DoDDS/DoDEA school	0	0%
Home school	0	0%
Online school	0	0%
Other	0	0%
Choose not to report	0	0%
Receives Free or Reduced-Price Lunch (FARMS) (n=3)		
Yes	0	0%
No	3	100%
Choose not to report	0	0%
English is First Language (n=3)		
Yes	3	100%
No	0	0%
Choose not to report	0	0%
One or More Parent/Guardian Graduated from College (n=3)		
Yes	3	100%
No	0	0%
Choose not to report	0	0%
Underserved Status (n=3)		
Yes	2	66.7%
No	1	33.3%
Insufficient data to make determination*	0	0%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

SEAP Mentor Respondent Demographics

Table 29 presents demographic data for the three SEAP mentors who responded to the mentor evaluation survey. All responding mentors (100%) indicated they were male, research mentors who held an occupation of scientist, engineer, or mathematics professional. Two mentors reported being White, and one indicated they were Native Hawaiian/Other Pacific Islander.

Table 29. 2020 SEAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=3)		
Female	0	0%
Male	3	100%
Choose not to report	0	0%

Race/Ethnicity (n=3)		
Asian	0	0%
Black or African American	0	0%
Hispanic or Latino	0	0%
Native American or Alaskan Native	0	0%
Native Hawaiian or Other Pacific Islander	1	33.3%
White	2	66.7%
More than one race	0	0%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Occupation (n=3)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	3	100%
Other, (specify)	0	0%
Role in SEAP (n=3)		
Research Mentor	3	100%
Research Team Member	0	0%
Other	0	0%

University-Based Programs

Study Sample and Respondent Profiles

REAP

Apprentice and mentor participation in the REAP evaluation survey, response rates, and margins of error are presented in Table 30. Both the apprentice and mentor margins of error for the surveys are larger than generally acceptable, implying the samples may not be representative of the overall populations.

Table 30. 2020 REAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Apprentices	17	86	19.8%	±21.41%
Mentors	14	66	21.2%	±23.43%

Individual phone interviews were conducted with 11 REAP apprentices and two mentors. All apprentices interviewed had participated in their apprenticeships virtually due to COVID-19 restrictions. 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 REAP's efforts and impact and highlight areas for future exploration in programming and evaluation.

REAP Apprentice Respondent Demographics

Few REAP apprentices completed the evaluation survey (*n*=17). Their demographic data are displayed in Table 31. Large proportions of survey participants self-reported being female (82%), were high school seniors (82%), had a parent who attended college (71%), and spoke English as their first language (65%). More than a third of REAP survey participants self-identified as Hispanic/Latino (35%) and almost a quarter as Asian (24%). School location was primarily reported as suburban (41%) or urban (41%). A little over half of REAP survey participants indicated they do not receive free/reduced lunch (59%). Overall, more than 80% of respondents (82%) met the AEOP definition of Underserved.

Table 31. 2020 REAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=17)		
Female	14	82.3%
Male	2	11.8%
Choose not to report or did not provide	1	5.9%
Race/Ethnicity (n=17)		
Asian	4	23.5%
Black or African American	3	17.6%
Hispanic or Latino	6	35.3%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	1	5.9%
More than one race	1	5.9%
Other race or ethnicity	0	0%
Choose not to report or did not provide	2	11.8%
Grade Level (n=17)		
High school – Freshman	0	0%
High school – Sophomore	0	0%
High school – Junior	3	17.6%
High school – Senior	14	82.4%
Other	0	0%
Choose not to report or did not provide	0	0%
School Location (n=17)		
Urban (city)	7	41.2%
Suburban	7	41.2%
Rural (country)	1	5.9%
Frontier or tribal school	0	0%
DoDDS/DoDEA school	0	0%
Home school	0	0%
Online school	0	0%
Other	1	5.9%

Choose not to report or did not provide	1	5.9%
Receives Free or Reduced-Price Lunch (FARMS) (n=17)		
Yes	6	35.3%
No	10	58.8%
Choose not to report or did not provide	1	5.9%
English is First Language (n=17)		
Yes	11	64.7%
No	5	29.4%
Choose not to report or did not provide	1	5.9%
One or More Parent/Guardian Graduated from College (n=17)		
Yes	12	70.6%
No	4	23.5%
Choose not to report or did not provide	1	5.9%
Underserved Status (n=17)		
Yes	14	82.3%
No	1	5.9%
Insufficient data to make determination*	2	11.8%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

REAP Mentor Respondent Demographics

Table 32 presents demographics for REAP mentors who responded to the survey. More males (64%) responded than females (36%). Most mentors who responded to the survey were either Asian (43%) or White (43%). The primary area of mentor research interest varied widely with engineering (36%) and physical science (21%) being the most frequently reported areas.

Table 32. 2020 REAP Mentor Respondent Profiles		
Demographic Category	**Questionnaire Respondents**	
Gender (n=14)		
Female	5	35.7%
Male	9	64.3%
Choose not to report	0	0%
Race/Ethnicity (n=14)		
Asian	6	42.9%
Black or African American	1	7.1%
Hispanic or Latino	1	7.1%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	6	42.9%
More than one race	0	0%
Choose not to report	0	0%
Other race or ethnicity	0	0%
Primary Area of Research (n=14)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	3	21.4%
Biological science	0	0%
Earth, atmospheric, or oceanic science	0	0%
Environmental science	0	0%
Computer science	2	14.3%
Technology	0	0%
Engineering	5	35.8%
Mathematics or statistics	1	7.1%
Medical, health, or behavioral science	0	0%
Social Science (psychology, sociology, anthropology)	1	7.1%
Other	2	14.3%

HSAP

Apprentice and mentor participation in the HSAP evaluation survey, response rates, and margins of error are documented in Table 33. Both margins of error for apprentices and mentors are much larger than generally acceptable implying the samples may not be representative of their respective populations.

Table 33. 2020 HSAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	8	32	25.0%	±30.49%
Mentors	1	26	3.8%	±98.00%

Individual phone interviews were conducted with five HSAP apprentices and four mentors recruited by the ARO. All apprentices interviewed had participated in virtual apprenticeships. 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

Only eight HSAP apprentices completed the evaluation survey. Their demographic data are presented in Table 34. More females (63%) completed the survey than males (38%). Most participants reported their race/ethnicity to be White (63%) followed by Asian (25%) and Hispanic/Latino (13%). All HSAP survey respondents said they were either high school juniors (36%) or seniors (63%). Half indicated they attend either an urban school (50%) or suburban school (50%). More than half of participants said they spoke English as a first language (63%), had a parent who went to college (100%), and did not receive free or reduced lunch (75%). Among HSAP apprentices who completed the questionnaire, 50% were classified according to the AEOP definition as underserved participants.

Table 34. 2020 HSAP Apprentice Respondent Profile

Demographic Category	Questionnaire Respondents	
Gender (n=8)		
Female	5	62.5%
Male	3	37.5%
Choose not to report	0	0%
Race/Ethnicity (n=8)		
Asian	2	25.0%
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%
More than one race	0	0%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Grade Level (n=8)		
9th	0	0%
10th	0	0%
11th	3	37.5%
12th	5	62.5%
Choose not to report	0	0%
Other	0	0%
School Location (n=8)		
Urban (city)	4	50.0%

Suburban	4	50.0%
Rural (country)	0	0%
Frontier or tribal school	0	0%
DoDDS/DoDEA school	0	0%
Home school	0	0%
Online school	0	0%
Other	0	0%
Choose not to report	0	0%
Receives Free or Reduced-Price Lunch (FARMS) (n=8)		
Yes	2	25.0%
No	6	75.0%
Choose not to report	0	0%
English is First Language (n=8)		
Yes	5	62.5%
No	2	25.0%
Choose not to report	1	12.5%
One or More Parent/Guardian Graduated from College (n=8)		
Yes	8	100%
No	0	0%
Choose not to report	0	0%
Underserved Status (n=8)		
Yes	4	50.0%
No	3	37.5%
Insufficient data to make determination*	1	12.5%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

HSAP Mentor Respondent Demographics

Only one HSAP mentor completed the evaluation survey. Their demographic data is in Table 35. This mentor self-reported to be an Asian male who is a university educator.

Table 35. 2020 HSAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=1)		
Female	0	0%
Male	1	100%
Choose not to report	0	0%
Race/Ethnicity (n=1)		
Asian	1	100%
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	0	0%
More than one race	0	0%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Occupation (n=1)		
University educator	1	100%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	0	0%
Scientist, Engineer, or Mathematics professional	0	0%
Teacher	0	0%
Other	0	0%

URAP

Table 36 provides apprentice and mentor participation in the URAP evaluation survey, response rates, and margins of error. Margins of error for both apprentices and mentors are larger than is generally acceptable, signaling the samples may not be representative of their respective populations.

Table 36. 2020 URAP Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence**
Apprentices	16	49	32.7%	±20.31%
Mentors	10	39	25.6%	±27.07%

Fifteen phone interviews were conducted with URAP apprentices and six with mentors recruited by the ARO. All but one apprentice had completed entirely virtual apprenticeships; one apprentice began his apprenticeship in an online format and completed the apprenticeship in person. 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 16 URAP participants who completed the evaluation survey, are found in Table 37. Most respondents were male (63%) and a quarter or more indicated their race/ethnicity was either White (31%), Asian (31%), or Hispanic/Latino (25%). A quarter or more of participants reported their grade level to be either college sophomore (31%), junior (37%), or senior (25%). Most apprentices reported that at least one of their parents had attended college (75%), English was their first language (88%), and they were not a Pell Grant recipient (63%). Just over a third (38%) of URAP apprentices who responded to the survey met the AEOP definition of Underserved.

Table 37. 2020 URAP Apprentice Respondent Profile

Demographic Category	Questionnaire Respondents	
Gender (n=16)		
Female	6	37.5%
Male	10	62.5%
Choose not to report	0	0%
Race/Ethnicity (n=16)		
Asian	5	31.3%
Black or African American	0	0%
Hispanic or Latino	4	25.0%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	5	31.3%
More than one race	2	12.4%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Grade Level (n=16)		
College – Freshman	1	6.3%
College – Sophomore	5	31.3%
College – Junior	6	37.4%
College – Senior	4	25.0%
Choose not to report	0	0%
Other	0	0%
Pell Grant Recipient (n=16)		
Yes	6	37.5%
No	10	62.5%

Choose not to report	0	0%
English is First Language (n=16)		
Yes	14	87.5%
No	2	12.5%
Choose not to report	0	0%
One or More Parent/Guardian Graduated from College (n=16)		
Yes	12	75.0%
No	3	18.7%
Choose not to report	1	6.3%
Underserved Status (n=16)		
Yes	6	37.5%
No	10	62.5%
Insufficient data to make determination*	0	0%

* Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for Underserved status.

URAP Mentor Respondent Demographics

URAP mentor survey participant demographics are in Table 38. More than three-quarters of responding mentors were male (80%). Most mentors indicated they were either White (50%) or Asian (30%). Mentors primarily reported their occupation to be university educator (70%), and all said they served as research mentors.

Table 38. 2020 URAP Mentor Respondent Profile

Demographic Category	Questionnaire Respondents	
Gender (n=10)		
Female	2	20.0%
Male	8	80.0%
Choose not to report	0	0%
Race/Ethnicity (n=10)		
Asian	3	30.0%
Black or African American	0	0%
Hispanic or Latino	1	10.0%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	5	50.0%
More than one race	0	0%
Other race or ethnicity	1	10.0%
Choose not to report	0	0%
Occupation (n=10)		
University educator	7	70.0%
Scientist, Engineer, or Mathematics professional	1	10.0%
Teacher	0	0%
Graduate student	2	20.0%

Other, (specify):	0	0%
Role in URAP (n=10)		
Research Mentor	10	100%
Research Team Member but not a Principal Investigator	0	0%
Other, (specify)	0	0%

5 | Priority #1 Findings

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

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 4 = "Every day" and the item average was calculated. Composite scores were used to look for differences in apprentice STEM Engagement experiences by program level (high school vs. undergraduate) and setting (army lab vs. university-based). There were no statistically significant differences found in STEM Engagement by grade level or program setting.

STEM Practices – Army Laboratory-Based Programs

CQL

CQL apprentices reported being actively engaged in STEM practices during their program experiences (Table 39). More than 70% of apprentices (71%-98%) said they participated "at least once" in all activities. Nearly all apprentices reported being most frequently (weekly or every day) engaged with the following

[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] Engagement in STEM Practices during Program (10 items) Cronbach's alpha reliability = 0.852.

two STEM practices during CQL: interacting with STEM researchers (94%) and working with a STEM researcher or company on a real-world STEM research project (92%).

Table 39. Apprentice Engagement in STEM Practices in CQL (n=52)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	1.9%	5.8%	34.6%	57.7%	
	1	3	18	30	**52**
Work with a STEM researcher on a research project of your own choosing	26.9%	28.8%	25.0%	19.2%	
	14	15	13	10	**52**
Design my own research or investigation based on my own question(s)	28.8%	36.5%	21.2%	13.5%	
	15	19	11	7	**52**
Present my STEM research to a panel of judges from industry or the military	25.0%	67.3%	3.8%	3.8%	
	13	35	2	2	**52**
Interact with STEM researchers	0.0%	5.8%	23.1%	71.2%	
	0	3	12	37	**52**
Use laboratory procedures and tools	9.6%	13.5%	23.1%	53.8%	
	5	7	12	28	**52**
Design and carry out an investigation	9.6%	26.9%	23.1%	40.4%	
	5	14	12	21	**52**
Analyze data or information and draw conclusions	3.8%	13.5%	28.8%	53.8%	
	2	7	15	28	**52**
Work collaboratively as part of a team	5.8%	13.5%	21.2%	59.6%	
	3	7	11	31	**52**
Solve real world problems	1.9%	11.5%	34.6%	51.9%	
	1	6	18	27	**52**

Composite scores for STEM Engagement in CQL were used to determine if there were differences in apprentice experiences by overall Underserved classification and individual demographics where there were a minimum of five participants in each demographic group: gender, first generation college going status, low-SES, and race/ethnicity. There were no significant differences in composite scores by overall Underserved classification or any demographic variable investigated.

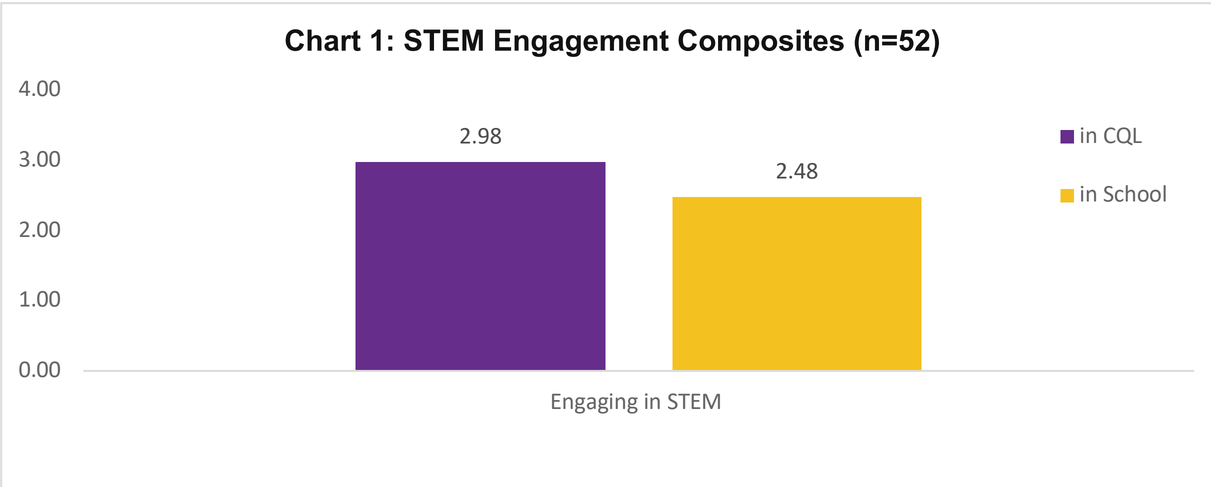
To compare how apprentices engage in STEM activities to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 40). These responses were also combined into a composite variable[5] parallel to the STEM Engagement in program variable. Apprentice-reported engagement in STEM practices in CQL was significantly higher than their engagement in the same practices in school (effect size is large with d = 1.26).[6] These findings indicate that CQL provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 40. Apprentice Engagement in STEM Practices in School (n=52)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	21.2%	25.0%	34.6%	19.2%	
	11	13	18	10	**52**
Work with a STEM researcher on a research project of your own choosing	38.5%	38.5%	15.4%	7.7%	
	20	20	8	4	**52**
Design my own research or investigation based on my own question(s)	40.4%	40.4%	17.3%	1.9%	
	21	21	9	1	**52**
Present my STEM research to a panel of judges from industry or the military	55.8%	38.5%	3.8%	1.9%	
	29	20	2	1	**52**
Interact with STEM researchers	7.7%	32.7%	26.9%	32.7%	
	4	17	14	17	**52**
Use laboratory procedures and tools	11.5%	19.2%	42.3%	26.9%	
	6	10	22	14	**52**
Design and carry out an investigation	15.4%	32.7%	36.5%	15.4%	
	8	17	19	8	**52**
Analyze data or information and draw conclusions	5.8%	21.2%	46.2%	26.9%	
	3	11	24	14	**52**
Work collaboratively as part of a team	3.8%	21.2%	32.7%	42.3%	
	2	11	17	22	**52**
Solve real world problems	7.7%	30.8%	40.4%	21.2%	
	4	16	21	11	**52**

[5] Engagement in STEM Practices during School (10 items) Cronbach's alpha reliability = 0.778.

[6] Dependent Samples *t*-test for STEM Engagement – CQL vs. School: $t(51)=2.17$, $p=.000$.



CQL apprentices participating in interviews were asked to comment on how their apprenticeship experiences compared to their typical school experiences in STEM. Participants' comments suggested their STEM work in CQL was substantially different than in their college course experiences. Apprentices noted that their work in CQL was more hands-on than in their courses, that CQL provides opportunities to apply learning that they typically did not experience in their coursework, that they had more opportunities for problem-solving in CQL, that they had more access to technology in CQL, and that they learned about a wider range of topics in CQL than in their typical coursework. Apprentices said, for example,

> *"I would say [CQL is] definitely more hands-on and more practical [than school]. I'm one of those people who would much rather work a job that I'm going to be doing in the future than to have a class to learn about it.... I think that [the hands-on experience] is invaluable."* (CQL Apprentice)

> *"School can be very stuck on…theory, and we don't actually know how to apply any of the theory… being able to have a mentor…walk me through that process and do it for myself has really made a difference in my engineering skills."* (CQL Apprentice)

> *"[CQL] makes [what I learned in my courses] real. It makes me realize that the courses I'm taking are actually pretty useful… I wasn't the best at coding…and then [during CQL] I'm watching people do things with code that would make my life so much easier. I'm like, alright, maybe I need to spend a little bit more extra time on this."* (CQL Apprentice)

> *"It was just a whole new experience... [CQL] was a lot more of thinking critically about different problems. And so that was something that I… appreciated and wished there was more of in school, but it was just getting that hands-on experience you really can't get in the classroom."* CQL Apprentice)

SEAP

The three SEAP apprentices who responded to the evaluation survey were asked how often they engaged in various STEM practices during their program (Table 41). Except for one item (present my STEM research to a panel of judges from industry or military), at least two out of three responding SEAP apprentices indicated they had engaged in each STEM activity at least once. STEM practices in which all three SEAP apprentices reported engaging in frequently (most days or every day) during SEAP were: working with a STEM researcher or company on a real-world STEM research project (100%); designing and carrying out an investigation (100%); analyzing data or information and drawing conclusions (100%); and solving real world problems (100%).

Table 41. Apprentice Engagement in STEM Practices in SEAP (n=3)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Work with a STEM researcher on a research project of your own choosing	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Design my own research or investigation based on my own question(s)	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Present my STEM research to a panel of judges from industry or the military	66.7%	0.0%	33.3%	0.0%	
	2	0	1	0	**3**
Interact with STEM researchers	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Use laboratory procedures and tools	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Design and carry out an investigation	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Analyze data or information and draw conclusions	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Work collaboratively as part of a team	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**

Solve real world problems	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**

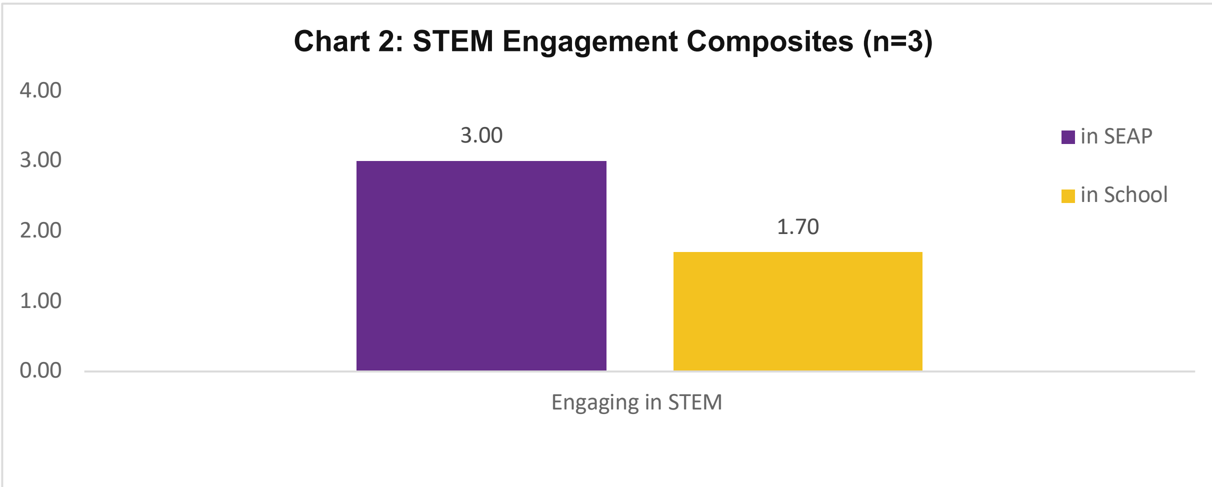
Composite scores for STEM Engagement in SEAP were calculated, but they were not able to be used for group comparisons because the sample size was too small (fewer than 5 participants per group).

To explore how apprentice engagement in STEM compared to their typical school experiences, they were asked how often they engaged in the same activities in school (Table 42). These responses were also combined into a composite variable parallel to the STEM Engagement in SEAP variable. Chart 2 shows that apprentice engagement in STEM practices in SEAP were higher than their engagement in the same practices in school, however, these differences cannot be assessed statistically due to the small sample size. Descriptive statistics suggest SEAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 42. Apprentice Engagement in STEM Practices in School (n=3)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	66.7%	33.3%	0.0%	0.0%	
	2	1	0	0	**3**
Work with a STEM researcher on a research project of your own choosing	66.7%	33.3%	0.0%	0.0%	
	2	1	0	0	**3**
Design my own research or investigation based on my own question(s)	66.7%	33.3%	0.0%	0.0%	
	2	1	0	0	**3**
Present my STEM research to a panel of judges from industry or the military	100.0%	0.0%	0.0%	0.0%	
	3	0	0	0	**3**
Interact with STEM researchers	0.0%	100.0%	0.0%	0.0%	
	0	3	0	0	**3**
Use laboratory procedures and tools	33.3%	66.7%	0.0%	0.0%	
	1	2	0	0	**3**
Design and carry out an investigation	66.7%	33.3%	0.0%	0.0%	
	2	1	0	0	**3**
Analyze data or information and draw conclusions	0.0%	66.7%	33.3%	0.0%	
	0	2	1	0	**3**
Work collaboratively as part of a team	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**

Solve real world problems	0.0%	66.7%	33.3%	0.0%	
	0	2	1	0	**3**



SEAP apprentices participating in interviews pointed out several important differences between their SEAP experiences and their typical in-school STEM experiences. Apprentices indicated that they learned information in SEAP they did not learn in school, that SEAP learning was more in-depth and oriented toward real world application, that they experienced more hands-on learning in SEAP, that they were challenged to take more responsibility than in school, and that they received more career information in SEAP. As one SEAP apprentice said, SEAP is "a more immersive type of learning" than in-school learning.

STEM Practices – University-Based Programs

REAP

REAP apprentices were asked how often they engaged in various STEM practices during their program (Table 43). Nearly half or more of REAP apprentices (47%-100%) reported participating at least once during their program in all activities. All REAP apprentices responding to the evaluation survey indicated regularly (most days or every day) interacting with STEM researchers (100%) and analyzing data/information and drawing conclusions (100%).

Table 43. Apprentice Engagement in STEM Practices in REAP (n=17)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	0.0%	11.8%	29.4%	58.8%	
	0	2	5	10	**17**

Work with a STEM researcher on a research project of your own choosing	11.8%	47.1%	23.5%	17.6%	
	2	8	4	3	**17**
Design my own research or investigation based on my own question(s)	11.8%	35.3%	23.5%	29.4%	
	2	6	4	5	**17**
Present my STEM research to a panel of judges from industry or the military	52.9%	35.3%	5.9%	5.9%	
	9	6	1	1	**17**
Interact with STEM researchers	0.0%	0.0%	29.4%	70.6%	
	0	0	5	12	**17**
Use laboratory procedures and tools	23.5%	11.8%	35.3%	29.4%	
	4	2	6	5	**17**
Design and carry out an investigation	11.8%	17.6%	23.5%	47.1%	
	2	3	4	8	**17**
Analyze data or information and draw conclusions	0.0%	0.0%	41.2%	58.8%	
	0	0	7	10	**17**
Work collaboratively as part of a team	0.0%	17.6%	29.4%	52.9%	
	0	3	5	9	**17**
Solve real world problems	0.0%	11.8%	35.3%	52.9%	
	0	2	6	9	**17**

Composite scores for STEM engagement in REAP were used to assess for differences in apprentice experiences by a few individual demographic variables: low-SES, ELL, race/ethnicity, and school location. Overall Underserved classification and all other individual demographics that work to comprise the Underserved classification were not able to be used for comparison as there were not a minimum of five participants fitting in each group of each variable. No significant differences in composite scores were found by any tested demographic.

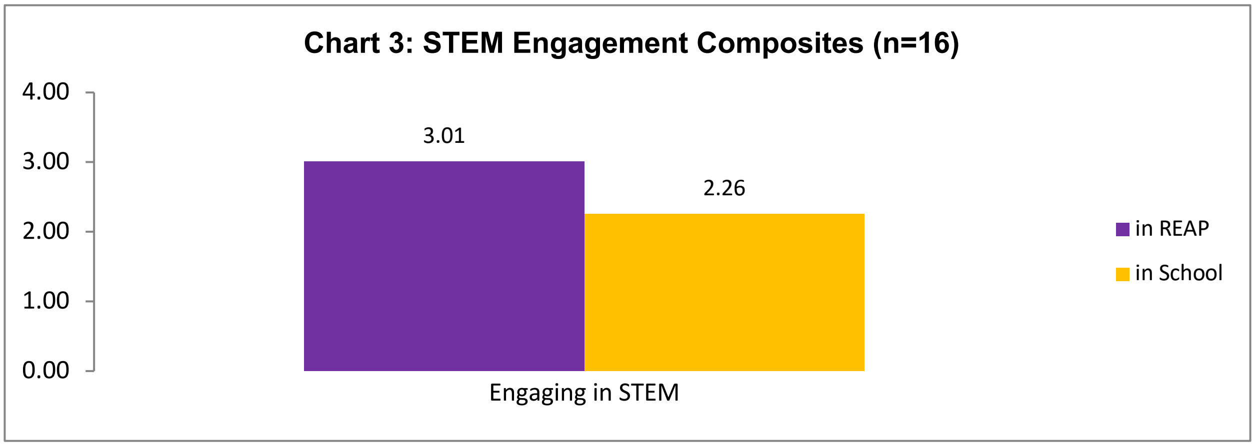
To explore apprentice engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 44). These responses were also combined into a composite variable parallel to the STEM Engagement in REAP variable. Chart 3 shows apprentices reported that their engagement in STEM practices in REAP was significantly higher than their engagement in the same practices in school (effect size is large with d = 2.79).[7] These findings indicate

[7] Dependent Samples *t*-test for STEM Engagement – REAP vs. School: $t(16)=5.58$, $p=.000$.

that REAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 44. Apprentice Engagement in STEM Practices in School (n=17)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	52.9%	11.8%	29.4%	5.9%	
	9	2	5	1	**17**
Work with a STEM researcher on a research project of your own choosing	52.9%	35.3%	11.8%	0.0%	
	9	6	2	0	**17**
Design my own research or investigation based on my own question(s)	47.1%	35.3%	17.6%	0.0%	
	8	6	3	0	**17**
Present my STEM research to a panel of judges from industry or the military	64.7%	29.4%	5.9%	0.0%	
	11	5	1	0	**17**
Interact with STEM researchers	41.2%	11.8%	29.4%	17.6%	
	7	2	5	3	**17**
Use laboratory procedures and tools	5.9%	29.4%	58.8%	5.9%	
	1	5	10	1	**17**
Design and carry out an investigation	0.0%	41.2%	52.9%	5.9%	
	0	7	9	1	**17**
Analyze data or information and draw conclusions	0.0%	29.4%	52.9%	17.6%	
	0	5	9	3	**17**
Work collaboratively as part of a team	0.0%	23.5%	52.9%	23.5%	
	0	4	9	4	**17**
Solve real world problems	11.8%	29.4%	41.2%	17.6%	
	2	5	7	3	**17**



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 in-depth STEM learning, more rigorous exposure to research, more opportunities to apply their learning to real-world situations, more information about careers, and was more hands-on than their in-school STEM experiences. Apprentices said, for example,

> *"A lot of regular academic settings have to do with following rules and replicating what a teacher expects of you. [In REAP], I was really able to take my own lead and make my own way forward. That was valuable just as a skill, and also as a confidence booster. That, more than anything, would help me in a career-based setting."* (REAP Apprentice)

> *"[In school], we're not exposed to that many software that they use in real life. Say, for example, in chemistry, we're just exposed to a few materials that scientists can use to conduct research, whereas in REAP, I've been exposed to actual software that they do use more commonly, and how they use new software…In school, we just learn facts. In REAP, I'm able to apply these facts to learn new things."* (REAP Apprentice)

HSAP

HSAP apprentices were asked how often they engaged in various STEM practices during their apprenticeships (Table 45). Half or more of HSAP apprentices (50%-100%) reported participating at least once in all STEM practices during their apprenticeship. STEM practices that more than 85% of apprentices reported being frequently (most days or every day) engaged in during HSAP were: designing their own research/investigation based on their own question(s) (88%); interacting with STEM researchers (88%); analyzing data/information and drawing conclusions (88%); and solving real world problems (100%).

Table 45. Apprentice Engagement in STEM Practices in HSAP (n=8)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	12.5%	25.0%	25.0%	37.5%	
	1	2	2	3	**8**
Work with a STEM researcher on a research project of your own choosing	25.0%	0.0%	37.5%	37.5%	
	2	0	3	3	**8**
Design my own research or investigation based on my own question(s)	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**
Present my STEM research to a panel of judges from industry or the military	25.0%	62.5%	12.5%	0.0%	
	2	5	1	0	**8**
Interact with STEM researchers	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**
Use laboratory procedures and tools	50.0%	25.0%	0.0%	25.0%	
	4	2	0	2	**8**
Design and carry out an investigation	0.0%	25.0%	37.5%	37.5%	
	0	2	3	3	**8**
Analyze data or information and draw conclusions	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**
Work collaboratively as part of a team	0.0%	37.5%	25.0%	37.5%	
	0	3	2	3	**8**
Solve real world problems	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**

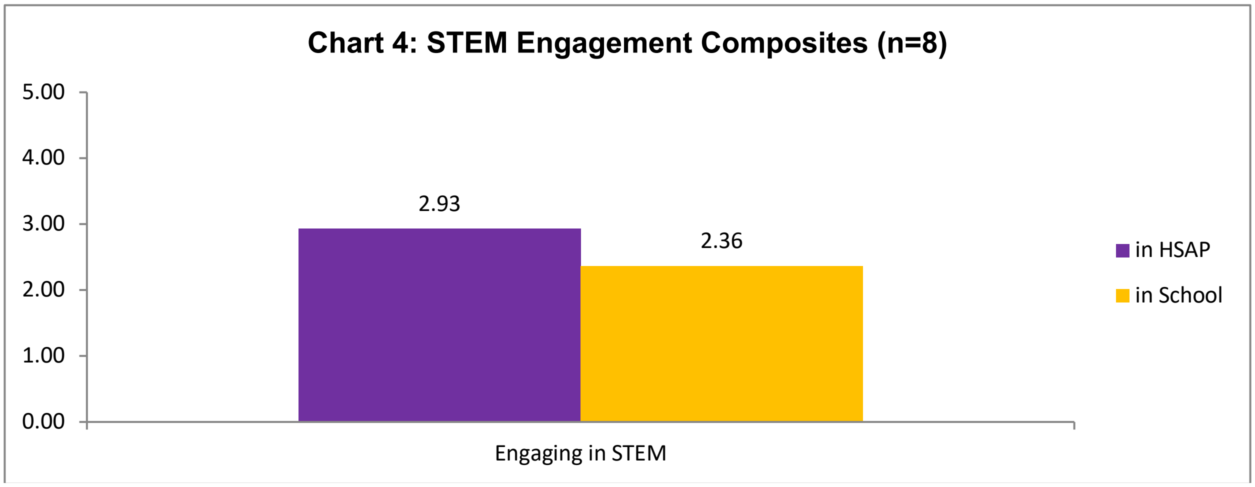
Composite scores for STEM engagement in HSAP were developed but they were not able to be used for group comparisons because the sample size was too small (fewer than five participants per group).

To examine the difference between apprentice reported engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 46). These responses were also combined into a composite variable parallel to the STEM Engagement in HSAP variable. Chart 4 shows apprentice reported engagement in HSAP STEM practices were significantly higher than their engagement in the same practices in school (effect size is large with d = 2.26).[8] These data suggest HSAP provides apprentices with more intensive engagement in STEM than they typically experience in school.

Table 46. Apprentice Engagement in STEM Practices in School (n=8)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	62.5%	12.5%	12.5%	12.5%	
	5	1	1	1	**8**
Work with a STEM researcher on a research project of your own choosing	75.0%	0.0%	25.0%	0.0%	
	6	0	2	0	**8**
Design my own research or investigation based on my own question(s)	37.5%	12.5%	37.5%	12.5%	
	3	1	3	1	**8**
Present my STEM research to a panel of judges from industry or the military	62.5%	25.0%	12.5%	0.0%	
	5	2	1	0	**8**
Interact with STEM researchers	25.0%	37.5%	25.0%	12.5%	
	2	3	2	1	**8**
Use laboratory procedures and tools	12.5%	37.5%	37.5%	12.5%	
	1	3	3	1	**8**
Design and carry out an investigation	12.5%	37.5%	25.0%	25.0%	
	1	3	2	2	**8**
Analyze data or information and draw conclusions	12.5%	12.5%	62.5%	12.5%	
	1	1	5	1	**8**
Work collaboratively as part of a team	0.0%	25.0%	37.5%	37.5%	
	0	2	3	3	**8**
Solve real world problems	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**

[8] Dependent Samples *t*-test for STEM Engagement – HSAP vs. School: $t(7)=2.99$, $p=.020$.



Apprentices participating in interviews indicated that their HSAP experience differed in several significant ways from their typical in-school STEM experiences. Apprentices reported that their learning in HSAP was less structured, more in-depth, more oriented toward problem solving, more interesting, and more oriented toward application than their learning school. Apprentices said, for example,

> *"In-school [learning] is very structured. The teachers need to have a certain lesson plan, certain things that the state requires them to teach. [HSAP] was a lot more hands-off, a lot more free, so you can explore questions that you have - not the ones that the teachers planned or have been mandated by the state to be answered."* (HSAP Apprentice)

> *"In school, a lot, we're taught, 'Here's the information. Do the work.' This was a lot of, 'We'll give you some ideas, but we're here to help you, not tell you what to do,' which was nice, and a lot closer to what actually happens once you're out in a career."* (HSAP Apprentice)

> *"STEM classes [in school] are boring and…they don't have any rigor…whereas with HSAP, I certainly actually learned stuff, and I had the chance to apply my knowledge to some real problems"* (HSAP Apprentice)

URAP

URAP apprentices were asked how often they engaged in various STEM practices during their program (Table 47). More than half of URAP apprentices (56%-100%) reported participating in all STEM practices at least once during their program except for presenting their STEM research to a panel of judges (0%). STEM practices that more than 90% of apprentices reported being frequently (most days or every day) engaged in included: working with a STEM researcher or company on a real-world STEM research project (94%); working collaboratively as part of a team (94%); and analyzing data/information and drawing conclusions (100%).

Table 47. Apprentice Engagement in STEM Practices in URAP (n=16)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	0.0%	6.3%	50.0%	43.8%	
	0	1	8	7	**16**
Work with a STEM researcher on a research project of your own choosing	18.8%	12.5%	43.8%	25.0%	
	3	2	7	4	**16**
Design my own research or investigation based on my own question(s)	18.8%	25.0%	37.5%	18.8%	
	3	4	6	3	**16**
Present my STEM research to a panel of judges from industry or the military	68.8%	31.3%	0.0%	0.0%	
	11	5	0	0	**16**
Interact with STEM researchers	6.3%	6.3%	50.0%	37.5%	
	1	1	8	6	**16**
Use laboratory procedures and tools	6.3%	31.3%	25.0%	37.5%	
	1	5	4	6	**16**
Design and carry out an investigation	6.3%	25.0%	31.3%	37.5%	
	1	4	5	6	**16**
Analyze data or information and draw conclusions	0.0%	0.0%	43.8%	56.3%	
	0	0	7	9	**16**
Work collaboratively as part of a team	0.0%	6.3%	37.5%	56.3%	
	0	1	6	9	**16**
Solve real world problems	0.0%	18.8%	31.3%	50.0%	
	0	3	5	8	**16**

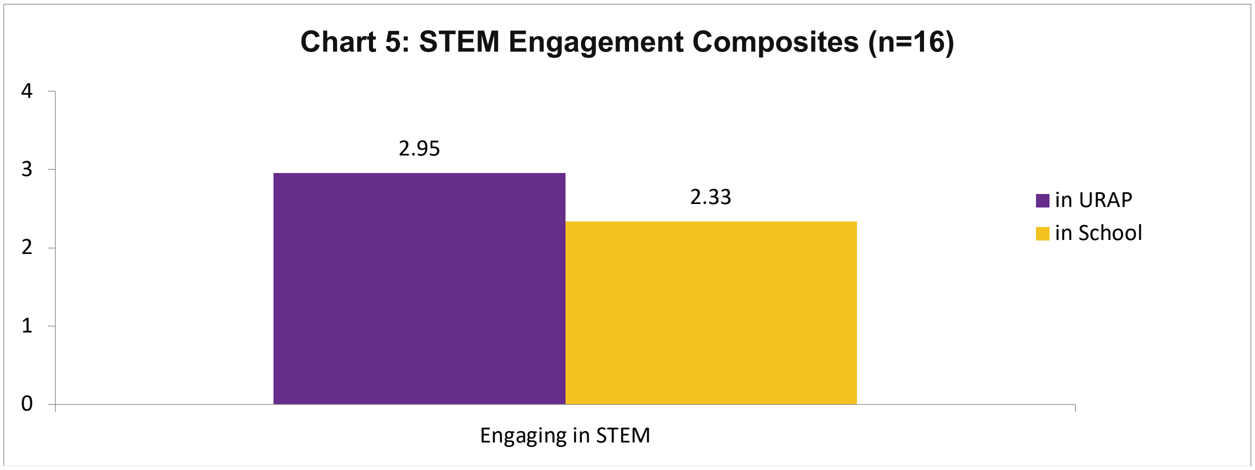
Composite scores for URAP STEM Engagement were used to assess whether differences existed in apprentice experiences by overall Underserved classification and the following individual demographics meeting the minimum five participants per group: gender, low-SES, and race/ethnicity. No significant differences in composite scores were found by overall Underserved status of any of the individual demographic components compared.

To explore how apprentice reported URAP engagement in STEM compared to their typical school experiences, apprentices were asked how often they engaged in the same activities in school (Table 48). These responses were also combined into a composite variable parallel to the STEM Engagement in URAP variable. Chart 5 shows apprentice reported engagement in URAP STEM practices were significantly higher than their engagement in the same practices in school (effect size is large with d = 2.45).[9] These data suggest URAP provides apprentices with more intensive STEM engagement than they typically experience in school.

Table 48. Apprentice Engagement in STEM Practices in School (n=16)

	Not at all	At least once	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	25.0%	37.5%	31.3%	6.3%	
	4	6	5	1	**16**
Work with a STEM researcher on a research project of your own choosing	56.3%	25.0%	18.8%	0.0%	
	9	4	3	0	**16**
Design my own research or investigation based on my own question(s)	43.8%	43.8%	12.5%	0.0%	
	7	7	2	0	**16**
Present my STEM research to a panel of judges from industry or the military	93.8%	6.3%	0.0%	0.0%	
	15	1	0	0	**16**
Interact with STEM researchers	25.0%	6.3%	37.5%	31.3%	
	4	1	6	5	**16**
Use laboratory procedures and tools	0.0%	37.5%	50.0%	12.5%	
	0	6	8	2	**16**
Design and carry out an investigation	12.5%	37.5%	43.8%	6.3%	
	2	6	7	1	**16**
Analyze data or information and draw conclusions	0.0%	18.8%	62.5%	18.8%	
	0	3	10	3	**16**
Work collaboratively as part of a team	0.0%	6.3%	75.0%	18.8%	
	0	1	12	3	**16**
Solve real world problems	6.3%	31.3%	50.0%	12.5%	
	1	5	8	2	**16**

[9] Dependent Samples *t*-test for STEM Engagement – URAP vs. School: $t(15)=4.74$, $p=.000$.



Apprentices participating in interviews were also asked to reflect on how their URAP experiences compared with their typical coursework experiences in STEM. These apprentices noted substantial differences between their URAP experiences and their typical STEM coursework experiences. Apprentices noted that URAP is more oriented toward real-life application, is focused on more specific topics, provides more career information, allows for more self-pacing, focuses more on open-ended questions, allows for more personal interactions with mentors, is more in-depth, provides more access to cutting-edge technologies, and is more impactful than their school STEM experiences. Apprentices said, for example,

> *"In school, my professor knows all the answers to the questions he's giving us. What he's trying to do is trying to teach us what he knows... [In URAP] we are doing research because we don't know the answers. When we get stuck, we ask our professor; our professor will guide us, but he himself might not know the answer."* (URAP Apprentice)

> *"[URAP is] a lot more hands on, and I would say it's even a lot more enjoyable. You get to work with other people that are working on similar things to you but also, you get that independent time. Also, a mentor that's readily available. It helps a lot, because you can get instant feedback, or if you have any questions, you can ask them and you'll get instant responses."* (URAP Apprentice)

> *"I've taken courses in biology and chemistry, I know those type of topics, but... [in URAP] you're applying things that you learned in class, but you're also learning new information as you go."* (URAP Apprentice)

> *"[In URAP I was] able to dive deep into a specific topic and learn how to use different types of software that I wasn't familiar with and hadn't gotten an exposure to at the school."* (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 section.[10] Response categories were converted to a scale of 1 = "No gain" to 4 = "Large gain" and the average across items in each scale was computed. Composite scores were used to test whether for 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 grade level or program setting.

CQL

All CQL apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in CQL (Table 49). More than 90% indicated that they had experienced medium or large gains in each area of STEM knowledge. For example, nearly all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (98%) and knowledge of what everyday research work is like in STEM (96%). STEM knowledge gain composites were used to test for differential impacts by overall Underserved classification and across demographic subgroups of apprentices. Significant differences were found by gender (females reported greater gains) and race/ethnicity (minority students reported greater gains) (effect sizes were large d = 0.931 and medium d = 0.588 respectively).[11]

Table 49. Student Report of Impacts on STEM Knowledge (n=52)

	No gain	Small gain	Medium gain	Large gain	Response Total

[10] Cronbach's alpha reliabilities for: STEM Knowledge (4 items) = 0.722; STEM Competencies (13 items) = 0.902; and 21st Century Skills (23 items) = 0.937.

[11] Independent Samples *t*-tests for STEM knowledge: Gender – $t(50)=3.29$, $p=.002$; Race/ethnicity – $t(50)=2.08$, $p=.042$.

In depth knowledge of a STEM topic(s)	0.0%	5.8%	32.7%	61.5%	
	0	3	17	32	**52**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	5.8%	38.5%	55.8%	
	0	3	20	29	**52**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	1.9%	32.7%	65.4%	
	0	1	17	34	**52**
Knowledge of what everyday research work is like in STEM	0.0%	3.8%	26.9%	69.2%	
	0	2	14	36	**52**

The impact of CQL on apprentices' STEM competencies was assessed with a series of survey questions (Table 50). More than 70% of participating apprentices (71%-89%) noted at least medium gains across competencies, and 85% or more of responding apprentices reported medium or large gains in the following two domains: using knowledge/creativity to suggest a solution to a problem (85%) and identifying limitations of methods/tools used for collecting data (89%). STEM competencies composites were used to test for differential gain impacts by overall Underserved classification and across demographic subgroups of apprentices. Significant differences were found by overall Underserved status with Underserved participants reporting greater gains (effect size was medium d = 0.614).[12] No differences in STEM competencies gains were found by individual demographics.

Table 50. Apprentices Reporting Gains in Their STEM Competencies (n=52)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	3.8%	17.3%	42.3%	36.5%	
	2	9	22	19	**52**
Creating a hypothesis or explanation that can be tested in an experiment/problem	5.8%	23.1%	36.5%	34.6%	
	3	12	19	18	**52**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	15.4%	36.5%	48.1%	
	0	8	19	25	**52**
Making a model to show how something works	9.6%	15.4%	34.6%	40.4%	
	5	8	18	21	**52**
Designing procedures or steps for an experiment or designing a solution that works	3.8%	19.2%	32.7%	44.2%	
	2	10	17	23	**52**
	0.0%	11.5%	46.2%	42.3%	

[12] Independent Samples *t*-tests for STEM competencies by Underserved status: *t*(50)=2.17, *p*=.035.

Identifying the limitations of the methods and	0	6	24	22	**52**
Carrying out an experiment and recording data accurately	5.8%	13.5%	36.5%	44.2%	
	3	7	19	23	**52**
Creating charts or graphs to display data and find patterns	9.6%	17.3%	23.1%	50.0%	
	5	9	12	26	**52**
Considering multiple interpretations of data to decide if something works as intended	5.8%	11.5%	40.4%	42.3%	
	3	6	21	22	**52**
Supporting an explanation with STEM knowledge	1.9%	17.3%	40.4%	40.4%	
	1	9	21	21	**52**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	1.9%	19.2%	40.4%	38.5%	
	1	10	21	20	**52**
Presenting an argument that uses data and/or findings from an experiment or investigation	5.8%	15.4%	42.3%	36.5%	
	3	8	22	19	**52**
Defending an argument based upon findings from an experiment or other data	5.8%	21.2%	42.3%	30.8%	
	3	11	22	16	**52**

CQL apprentices were asked to report on the program's impact on their 21st Century skills (Table 51). Half or more of apprentices (50%-94%) reported at least medium gains across all items except for creating media products (23%) and analyzing media (37%). CQL apprentices experienced the greatest impacts (medium or large gains) in 21st Century Skills such as solving problems (92%) 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 Underserved status and subgroups. Significant differences in 21st Century skills gains were not found by individual variables or overall Underserved status.

Table 51. Apprentice Report of Impacts on 21st Century Skills (n=52)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	3.8%	19.2%	30.8%	46.2%	
	2	10	16	24	**52**
Working creatively with others	5.8%	15.4%	34.6%	44.2%	
	3	8	18	23	**52**
Using my creative ideas to make a product	13.5%	26.9%	21.2%	38.5%	
	7	14	11	20	**52**
Thinking about how systems work and how parts interact with each other	0.0%	9.6%	36.5%	53.8%	
	0	5	19	28	**52**

Evaluating others' evidence, arguments, and beliefs	1.9%	19.2%	38.5%	40.4%	
	1	10	20	21	**52**
Solving problems	1.9%	5.8%	30.8%	61.5%	
	1	3	16	32	**52**
Communicating clearly (written and oral) with others	5.8%	11.5%	26.9%	55.8%	
	3	6	14	29	**52**
Collaborating with others effectively and respectfully in diverse teams	1.9%	11.5%	30.8%	55.8%	
	1	6	16	29	**52**
Interacting effectively in a respectful and professional manner	1.9%	5.8%	36.5%	55.8%	
	1	3	19	29	**52**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	1.9%	13.5%	32.7%	51.9%	
	1	7	17	27	**52**
Using and managing data accurately, creatively, and ethically	3.8%	11.5%	34.6%	50.0%	
	2	6	18	26	**52**
Analyzing media (news) - understanding points of view in the media	44.2%	19.2%	21.2%	15.4%	
	23	10	11	8	**52**
Creating media products like videos, blogs, social media	59.6%	17.3%	7.7%	15.4%	
	31	9	4	8	**52**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	23.1%	36.5%	40.4%	
	0	12	19	21	**52**
Adapting to change when things do not go as planned	0.0%	9.6%	30.8%	59.6%	
	0	5	16	31	**52**
Incorporating feedback into my work effectively	0.0%	5.8%	30.8%	63.5%	
	0	3	16	33	**52**
Setting goals and utilizing time wisely	1.9%	13.5%	38.5%	46.2%	
	1	7	20	24	**52**
Working independently and completing tasks on time	1.9%	11.5%	21.2%	65.4%	
	1	6	11	34	**52**
	1.9%	11.5%	40.4%	46.2%	

Taking initiative and doing work without being told to	1	6	21	24	**52**
Prioritizing, planning, and managing projects to achieve completion	3.8%	15.4%	34.6%	46.2%	
	2	8	18	24	**52**
Producing results - sticking with a task until it is finished	0.0%	13.5%	28.8%	57.7%	
	0	7	15	30	**52**
Leading and guiding others in a team or group	19.2%	30.8%	25.0%	25.0%	
	10	16	13	13	**52**
Being responsible to others - thinking about the larger community	1.9%	21.2%	44.2%	32.7%	
	1	11	23	17	**52**

SEAP

All SEAP apprentices (100%) reported a high degree of STEM knowledge gains (medium or large) as a result of participating in CQL (Table 52) for all items except for knowledge of what everyday research work is like in STEM (67%). STEM knowledge gain composites could not be compared due to small sample size.

Table 52. Student Report of Impacts on STEM Knowledge (n=3)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Knowledge of what everyday research work is like in STEM	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**

Table 53 shows that two-thirds or more of SEAP apprentices (67%-100%) indicated medium or large gains in all STEM competencies about which they were asked except for creating a hypothesis that can be tested in an experiment (33%). All (100%) of responding apprentices report medium or large gains as a result of participating in SEAP for the following items: identifying limitations of methods/tools used for collecting data (100%); supporting explanation with STEM knowledge (100%); identifying strengths/limitations of data presented in technical/STEM texts (100%); presenting an argument using data from an experiment

(100%); and defending an argument based upon findings from an experiment (100%). STEM Competency composites could not be compared due to small sample size.

Table 53. Apprentices Reporting Gains in Their STEM Competencies (n=3)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Creating a hypothesis or explanation that can be tested in an experiment/problem	0.0%	66.7%	0.0%	33.3%	
	0	2	0	1	**3**
Using my knowledge and creativity to suggest a solution to a problem	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Making a model to show how something works	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Designing procedures or steps for an experiment or designing a solution that works	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Identifying the limitations of the methods and tools used for collecting data	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Carrying out an experiment and recording data accurately	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Creating charts or graphs to display data and find patterns	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Considering multiple interpretations of data to decide if something works as intended	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Supporting an explanation with STEM knowledge	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Presenting an argument that uses data and/or findings from an experiment or investigation	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Defending an argument based upon findings from an experiment or other data	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**

SEAP apprentices were asked to report on the program's impact on their 21st Century skills (Table 54). Two or three responding apprentices (67%-100%) reported at least medium gains across all items except for working creatively with others (33%); using creative ideas to make a product (33%); leading others in a team (33%); analyzing media (0%); and creating media products (0%). Composites from the 21st Century skills section of the survey could not be calculated due to small sample size.

Table 54. Apprentice Report of Impacts on 21st Century Skills (n=3)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Working creatively with others	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
Using my creative ideas to make a product	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
Thinking about how systems work and how parts interact with each other	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Evaluating others' evidence, arguments, and beliefs	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Solving problems	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Communicating clearly (written and oral) with others	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Collaborating with others effectively and respectfully in diverse teams	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Interacting effectively in a respectful and professional manner	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Using and managing data accurately, creatively, and ethically	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Analyzing media (news) - understanding points of view in the media	0.0%	100.0%	0.0%	0.0%	
	0	3	0	0	**3**
Creating media products like videos, blogs, social media	33.3%	66.7%	0.0%	0.0%	
	1	2	0	0	**3**

Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Adapting to change when things do not go as planned	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Incorporating feedback into my work effectively	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Setting goals and utilizing time wisely	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Working independently and completing tasks on time	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Taking initiative and doing work without being told to	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Prioritizing, planning, and managing projects to achieve completion	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Producing results - sticking with a task until it is finished	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Leading and guiding others in a team or group	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
Being responsible to others - thinking about the larger community	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**

STEM Knowledge and Skills – University-Based Programs

REAP

All REAP apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in REAP (Table 55). More than 90% indicated medium or large gains in every survey area of STEM knowledge. For example, all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (100%) and in-depth knowledge of a STEM topic (100%). STEM knowledge gain composites were used to test for differential impacts by overall Underserved classification and across demographic subgroups of apprentices; significant differences were not found.

Table 55. Apprentice Report of Impacts on STEM Knowledge (n=17)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	23.5%	76.5%	
	0	0	4	13	**17**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	5.9%	29.4%	64.7%	
	0	1	5	11	**17**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	23.5%	76.5%	
	0	0	4	13	**17**
Knowledge of what everyday research work is like in STEM	0.0%	5.9%	11.8%	82.4%	
	0	1	2	14	**17**

The impact of REAP on apprentices' STEM competencies was assessed with a series of survey questions (Table 56). More than 70% of participating apprentices (71%-100%) noted at least medium gains across competencies. All responding apprentices reported medium or large gains in supporting an explanation with STEM knowledge (100%). STEM competency composites were used to test for differential impacts by overall Underserved and specific demographics that contribute to Underserved status. No significant differences were found by overall Underserved classification or any of the individual demographics investigated.

Table 56. Apprentices Reporting Gains in STEM Competencies (n=17)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	5.9%	11.8%	17.6%	64.7%	
	1	2	3	11	**17**
Creating a hypothesis or explanation that can be tested in an experiment/problem	0.0%	29.4%	5.9%	64.7%	
	0	5	1	11	**17**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	5.9%	41.2%	52.9%	
	0	1	7	9	**17**
Making a model to show how something works	5.9%	5.9%	23.5%	64.7%	
	1	1	4	11	**17**
	5.9%	11.8%	23.5%	58.8%	

Designing procedures or steps for an	1	2	4	10	**17**
Identifying the limitations of the methods and tools used for collecting data	0.0%	5.9%	35.3%	58.8%	
	0	1	6	10	**17**
Carrying out an experiment and recording data accurately	11.8%	11.8%	5.9%	70.6%	
	2	2	1	12	**17**
Creating charts or graphs to display data and find patterns	0.0%	5.9%	11.8%	82.4%	
	0	1	2	14	**17**
Considering multiple interpretations of data to decide if something works as intended	0.0%	5.9%	29.4%	64.7%	
	0	1	5	11	**17**
Supporting an explanation with STEM knowledge	0.0%	0.0%	41.2%	58.8%	
	0	0	7	10	**17**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	17.6%	29.4%	52.9%	
	0	3	5	9	**17**
Presenting an argument that uses data and/or findings from an experiment or investigation	0.0%	5.9%	23.5%	70.6%	
	0	1	4	12	**17**
Defending an argument based upon findings from an experiment or other data	0.0%	17.6%	35.3%	47.1%	
	0	3	6	8	**17**

REAP apprentices were asked to report on the program's impact on their 21st Century skills (Table 57). More than half of apprentices (59%-100%) reported at least medium gains across all items except for: creating media products (36%) and analyzing media (35%). REAP impacted apprentices the greatest (medium or large gains) in 21st Century Skills including the following: solving problems (100%); interacting effectively in a respectful/professional manner (100%); setting goals and utilizing time wisely (100%); working independently and completing tasks on time (100%); and producing results (100%). Composites from the 21st Century skills section of the survey were used to test for differential impacts by overall Underserved status and subgroups; no differences were found.

Table 57. Apprentice Report of Impacts on 21st Century Skills (n=17)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	0.0%	11.8%	41.2%	47.1%	
	0	2	7	8	**17**
Working creatively with others	0.0%	17.6%	23.5%	58.8%	
	0	3	4	10	**17**

Using my creative ideas to make a product	5.9%	23.5%	35.3%	35.3%	
	1	4	6	6	**17**
Thinking about how systems work and how parts interact with each other	0.0%	11.8%	5.9%	82.4%	
	0	2	1	14	**17**
Evaluating others' evidence, arguments, and beliefs	11.8%	29.4%	11.8%	47.1%	
	2	5	2	8	**17**
Solving problems	0.0%	0.0%	47.1%	52.9%	
	0	0	8	9	**17**
Communicating clearly (written and oral) with others	0.0%	11.8%	5.9%	82.4%	
	0	2	1	14	**17**
Collaborating with others effectively and respectfully in diverse teams	0.0%	11.8%	29.4%	58.8%	
	0	2	5	10	**17**
Interacting effectively in a respectful and professional manner	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	5.9%	0.0%	17.6%	76.5%	
	1	0	3	13	**17**
Using and managing data accurately, creatively, and ethically	0.0%	5.9%	23.5%	70.6%	
	0	1	4	12	**17**
Analyzing media (news) - understanding points of view in the media	41.2%	23.5%	5.9%	29.4%	
	7	4	1	5	**17**
Creating media products like videos, blogs, social media	41.2%	23.5%	23.5%	11.8%	
	7	4	4	2	**17**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	5.9%	11.8%	82.4%	
	0	1	2	14	**17**
Adapting to change when things do not go as planned	5.9%	5.9%	35.3%	52.9%	
	1	1	6	9	**17**
Incorporating feedback into my work effectively	0.0%	5.9%	17.6%	76.5%	
	0	1	3	13	**17**
Setting goals and utilizing time wisely	0.0%	0.0%	47.1%	52.9%	
	0	0	8	9	**17**

Working independently and completing tasks on time	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Taking initiative and doing work without being told to	0.0%	11.8%	17.6%	70.6%	
	0	2	3	12	**17**
Prioritizing, planning, and managing projects to achieve completion	0.0%	11.8%	5.9%	82.4%	
	0	2	1	14	**17**
Producing results - sticking with a task until it is finished	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Leading and guiding others in a team or group	5.9%	29.4%	23.5%	41.2%	
	1	5	4	7	**17**
Being responsible to others - thinking about the larger community	5.9%	11.8%	17.6%	64.7%	
	1	2	3	11	**17**

HSAP

All HSAP apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in HSAP (Table 58). Nearly 90% or more (88%-100%) indicated medium or large gains in every survey area of STEM knowledge. For example, all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (100%) and in-depth knowledge of a STEM topic (100%). Due to small sample size, group comparisons of STEM knowledge impact were not able to be conducted.

Table 58. Apprentice Report of Impacts on STEM Knowledge (n=8)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Knowledge of what everyday research work is like in STEM	0.0%	12.5%	37.5%	50.0%	
	0	1	3	4	**8**

The impact of HSAP on apprentices' STEM competencies was assessed with a series of survey questions (Table 59). Half or more of participating apprentices (50%-100%) noted at least medium gains across competencies. All responding HSAP apprentices reported medium or large gains in two domains: defining a problem that can be solved by developing a new product/process (100%) and supporting an explanation with STEM knowledge (100%). Due to small sample size, group comparisons of STEM competencies impact were not able to be conducted.

Table 59. Apprentice Report of Gains in STEM Competencies (n=8)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Creating a hypothesis or explanation that can be tested in an experiment/problem	25.0%	12.5%	25.0%	37.5%	
	2	1	2	3	**8**
Using my knowledge and creativity to suggest a solution to a problem	12.5%	0.0%	12.5%	75.0%	
	1	0	1	6	**8**
Making a model to show how something works	0.0%	12.5%	25.0%	62.5%	
	0	1	2	5	**8**
Designing procedures or steps for an experiment or designing a solution that works	0.0%	37.5%	25.0%	37.5%	
	0	3	2	3	**8**
Identifying the limitations of the methods and tools used for collecting data	0.0%	25.0%	12.5%	62.5%	
	0	2	1	5	**8**
Carrying out an experiment and recording data accurately	25.0%	0.0%	37.5%	37.5%	
	2	0	3	3	**8**
Creating charts or graphs to display data and find patterns	12.5%	25.0%	12.5%	50.0%	
	1	2	1	4	**8**
Considering multiple interpretations of data to decide if something works as intended	12.5%	37.5%	12.5%	37.5%	
	1	3	1	3	**8**
Supporting an explanation with STEM knowledge	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**

Presenting an argument that uses data and/or findings from an experiment or investigation	12.5%	12.5%	0.0%	75.0%	
	1	1	0	6	**8**
Defending an argument based upon findings from an experiment or other data	12.5%	25.0%	25.0%	37.5%	
	1	2	2	3	**8**

HSAP apprentices were asked to report on the program's impact on their 21st Century skills (Table 60). More than half of apprentices (63%-100%) reported at least medium gains across all items except for creating media products (0%) and analyzing media (38%). HSAP impacted apprentices the greatest (medium or large gains) in 21st Century Skills such as the following: using technology as a tool (100%); incorporating feedback into their work effectively (100%); setting goals and utilizing time wisely (100%); working independently and completing tasks on time (100%); taking initiative (100%); and prioritizing, planning, and managing projects (100%). Due to small sample size, group comparisons of 21st Century Skills impact were not able to be conducted.

Table 60. Apprentice Report of Impacts on 21st Century Skills (n=8)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	0.0%	12.5%	25.0%	62.5%	
	0	1	2	5	**8**
Working creatively with others	12.5%	25.0%	12.5%	50.0%	
	1	2	1	4	**8**
Using my creative ideas to make a product	0.0%	25.0%	12.5%	62.5%	
	0	2	1	5	**8**
Thinking about how systems work and how parts interact with each other	12.5%	12.5%	12.5%	62.5%	
	1	1	1	5	**8**
Evaluating others' evidence, arguments, and beliefs	0.0%	25.0%	25.0%	50.0%	
	0	2	2	4	**8**
Solving problems	0.0%	12.5%	37.5%	50.0%	
	0	1	3	4	**8**
Communicating clearly (written and oral) with others	0.0%	12.5%	0.0%	87.5%	
	0	1	0	7	**8**
Collaborating with others effectively and respectfully in diverse teams	0.0%	25.0%	25.0%	50.0%	
	0	2	2	4	**8**

Interacting effectively in a respectful and professional manner	12.5%	0.0%	12.5%	75.0%	
	1	0	1	6	**8**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	12.5%	37.5%	50.0%	
	0	1	3	4	**8**
Using and managing data accurately, creatively, and ethically	12.5%	0.0%	37.5%	50.0%	
	1	0	3	4	**8**
Analyzing media (news) - understanding points of view in the media	50.0%	12.5%	25.0%	12.5%	
	4	1	2	1	**8**
Creating media products like videos, blogs, social media	75.0%	25.0%	0.0%	0.0%	
	6	2	0	0	**8**
Use technology as a tool to research, organize, evaluate, and communicate information	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
Adapting to change when things do not go as planned	0.0%	12.5%	0.0%	87.5%	
	0	1	0	7	**8**
Incorporating feedback into my work effectively	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**
Setting goals and utilizing time wisely	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
Working independently and completing tasks on time	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**
Taking initiative and doing work without being told to	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**
Prioritizing, planning, and managing projects to achieve completion	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
Producing results - sticking with a task until it is finished	0.0%	12.5%	25.0%	62.5%	
	0	1	2	5	**8**
Leading and guiding others in a team or group	25.0%	12.5%	37.5%	25.0%	
	2	1	3	2	**8**
Being responsible to others - thinking about the larger community	0.0%	25.0%	12.5%	62.5%	
	0	2	1	5	**8**

URAP

All URAP apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in URAP (Table 61). Three quarters or more (75%-100%) of apprentices reported medium or large gains in each surveyed area of STEM knowledge. For example, all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (100%) and in their in-depth knowledge of a STEM topic (100%). STEM knowledge gain composites were used to test for differential impacts by overall Underserved classification and across demographic subgroups of apprentices with five or more participants in each group – gender, low-SES, and race/ethnicity. No significant differences existed by demographic variables making up Underserved classification. However, there was a significant difference by Underserved status with Underserved-identified apprentices reporting greater gains (effect size is large with d = 1.59).[13]

Table 61. Apprentice Report of Impact on STEM Knowledge (n=16)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	0.0%	25.0%	75.0%	
	0	0	4	12	**16**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	18.8%	25.0%	56.3%	
	0	3	4	9	**16**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	0.0%	31.3%	68.8%	
	0	0	5	11	**16**
Knowledge of what everyday research work is like in STEM	0.0%	25.0%	0.0%	75.0%	
	0	4	0	12	**16**

The impact of URAP on apprentices' STEM competencies was assessed with a series of survey questions (Table 62). More than half of participating apprentices (56%-94%) noted at least medium gains across competencies. More than 90% of responding apprentices reported medium or large gains in two domains: using knowledge/creativity to suggest a solution to a problem (94%) and defining a problem than can be solved by developing a new product/process (94%). STEM competency composites were used to test for differential impacts by overall Underserved and specific demographics that contribute to Underserved status. Significant differences existed by gender with females reporting greater gains than males (effect

[13] Independent Samples *t*-test for STEM Knowledge by Underserved status: *t*(14)=2.97, p=.010.

size is large with d = 1.38).[14] Additionally, a significant difference by overall Underserved status with Underserved apprentices indicating greater gains was also found (effect size is large with d = 2.60).[15]

Table 62. Apprentices Reporting Gains in Their STEM Competencies (n=16)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	6.3%	43.8%	50.0%	
	0	1	7	8	**16**
Creating a hypothesis or explanation that can be tested in an experiment/problem	0.0%	25.0%	37.5%	37.5%	
	0	4	6	6	**16**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	6.3%	43.8%	50.0%	
	0	1	7	8	**16**
Making a model to show how something works	0.0%	12.5%	31.3%	56.3%	
	0	2	5	9	**16**
Designing procedures or steps for an experiment or designing a solution that works	0.0%	37.5%	43.8%	18.8%	
	0	6	7	3	**16**
Identifying the limitations of the methods and tools used for collecting data	0.0%	12.5%	43.8%	43.8%	
	0	2	7	7	**16**
Carrying out an experiment and recording data accurately	6.3%	12.5%	37.5%	43.8%	
	1	2	6	7	**16**
Creating charts or graphs to display data and find patterns	0.0%	12.5%	31.3%	56.3%	
	0	2	5	9	**16**
Considering multiple interpretations of data to decide if something works as intended	0.0%	18.8%	50.0%	31.3%	
	0	3	8	5	**16**
Supporting an explanation with STEM knowledge	0.0%	12.5%	50.0%	37.5%	
	0	2	8	6	**16**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	0.0%	18.8%	37.5%	43.8%	
	0	3	6	7	**16**
	0.0%	43.8%	25.0%	31.3%	

[14] Independent Samples *t*-test for STEM competencies by Gender: $t(14)=2.58$, $p=.020$.
[15] Independent Samples *t*-test for STEM competencies by Underserved status: $t(14)=4.86$, $p=.000$.

Presenting an argument that uses data and/or findings from an experiment or investigation	0	7	4	5	**16**
Defending an argument based upon findings from an experiment or other data	6.3%	31.3%	43.8%	18.8%	
	1	5	7	3	**16**

URAP apprentices were asked to report on the program's impact on their 21st Century skills (Table 63). Half or more of apprentices (50%-100%) reported at least medium gains across all items except for creating media products (13%) and analyzing media (25%). CQL impacted all apprentices (medium or large gains) in the 21st Century skills area of adapting to change when things do not go as planned (100%). Composites from the 21st Century skills section of the survey were used to test for differential impacts by overall Underserved status and subgroups. Significant differences in 21st Century skills gains were found by overall Underserved status, with Underserved apprentices identifying greater gains (effect size is large with d = 1.65).[16] Additionally, there were significant differences noted by gender with females reporting greater gains compared to males (effect size is large with d = 1.20).[17]

Table 63. Apprentice Reports of Impacts on 21st Century Skills (n=16)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	0.0%	6.3%	43.8%	50.0%	
	0	1	7	8	**16**
Working creatively with others	0.0%	31.3%	18.8%	50.0%	
	0	5	3	8	**16**
Using my creative ideas to make a product	12.5%	37.5%	18.8%	31.3%	
	2	6	3	5	**16**
Thinking about how systems work and how parts interact with each other	6.3%	6.3%	25.0%	62.5%	
	1	1	4	10	**16**
Evaluating others' evidence, arguments, and beliefs	0.0%	31.3%	43.8%	25.0%	
	0	5	7	4	**16**
Solving problems	0.0%	6.3%	25.0%	68.8%	
	0	1	4	11	**16**
Communicating clearly (written and oral) with others	0.0%	6.3%	25.0%	68.8%	
	0	1	4	11	**16**

16 Independent Samples *t*-test for 21st Century Skills by Underserved status: $t(14)=3.09$, $p=.008$.
17 Independent Samples *t*-test for 21st Century Skills by Gender: $t(14)=2.24$, $p=.042$.

Collaborating with others effectively and respectfully in diverse teams	0.0%	6.3%	37.5%	56.3%	
	0	1	6	9	**16**
Interacting effectively in a respectful and professional manner	0.0%	12.5%	12.5%	75.0%	
	0	2	2	12	**16**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	0.0%	12.5%	31.3%	56.3%	
	0	2	5	9	**16**
Using and managing data accurately, creatively, and ethically	0.0%	25.0%	25.0%	50.0%	
	0	4	4	8	**16**
Analyzing media (news) - understanding points of view in the media	37.5%	37.5%	25.0%	0.0%	
	6	6	4	0	**16**
Creating media products like videos, blogs, social media	62.5%	25.0%	0.0%	12.5%	
	10	4	0	2	**16**
Use technology as a tool to research, organize, evaluate, and communicate information	6.3%	0.0%	18.8%	75.0%	
	1	0	3	12	**16**
Adapting to change when things do not go as planned	0.0%	0.0%	12.5%	87.5%	
	0	0	2	14	**16**
Incorporating feedback into my work effectively	0.0%	6.3%	31.3%	62.5%	
	0	1	5	10	**16**
Setting goals and utilizing time wisely	0.0%	18.8%	18.8%	62.5%	
	0	3	3	10	**16**
Working independently and completing tasks on time	0.0%	6.3%	37.5%	56.3%	
	0	1	6	9	**16**
Taking initiative and doing work without being told to	6.3%	6.3%	31.3%	56.3%	
	1	1	5	9	**16**
Prioritizing, planning, and managing projects to achieve completion	0.0%	12.5%	31.3%	56.3%	
	0	2	5	9	**16**
Producing results - sticking with a task until it is finished	0.0%	6.3%	31.3%	62.5%	
	0	1	5	10	**16**
Leading and guiding others in a team or group	6.3%	43.8%	31.3%	18.8%	
	1	7	5	3	**16**

Being responsible to others - thinking about the larger community	6.3%	6.3%	43.8%	43.8%	
	1	1	7	7	**16**

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 apprenticeship experiences on apprentices' STEM identities and confidence.

STEM Identity and Confidence – Level and Setting Comparisons

Apprentices were asked to report their gains in STEM identity after 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 items was computed. Composite scores were used to test for 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 program setting.

CQL

Three-quarters or more of CQL apprentices (75%-98%) reported medium or large gains across all items of the STEM identity scale (Table 64). More than 90% of apprentices reported at least medium gains as a result of CQL in their desire to build relationships with mentors who work in STEM (98%). STEM identity composite scores were used to evaluate differences by overall Underserved status and demographic variables contributing to Underserved. No significant differences existed by overall Underserved classification or demographics investigated.

Table 64. Apprentice Report of Impacts on STEM Identity (n=52)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	5.8%	19.2%	21.2%	53.8%	
	3	10	11	28	**52**

[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] STEM Identity (6 items) Cronbach's alpha reliability = 0.876.

Interest in pursuing a STEM career	5.8%	19.2%	26.9%	48.1%	
	3	10	14	25	**52**
Sense of accomplishing something in STEM	1.9%	11.5%	25.0%	61.5%	
	1	6	13	32	**52**
Feeling prepared for more challenging STEM activities	3.8%	11.5%	28.8%	55.8%	
	2	6	15	29	**52**
Confidence to try out new ideas or procedures on my own in a STEM project	3.8%	9.6%	32.7%	53.8%	
	2	5	17	28	**52**
Desire to build relationships with mentors who work in STEM	0.0%	1.9%	28.8%	69.2%	
	0	1	15	36	**52**

SEAP

Two to three of the responding SEAP apprentices (67%-100%) reported at least medium gains on all survey items associated with STEM Identity (Table 65). STEM identity composite scores were unable to be used for group comparisons due to the small sample size.

Table 65. Apprentice Report of Impacts on STEM Identity (n=3)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
Interest in pursuing a STEM career	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Sense of accomplishing something in STEM	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**
Feeling prepared for more challenging STEM activities	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Desire to build relationships with mentors who work in STEM	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**

STEM Identity and Confidence – University-Based Programs

REAP

More than 85% of REAP apprentices (88%-100%) reported at least medium gains on all STEM identity survey items (Table 66). All noted at least medium gains in their feeling of preparedness for more challenging STEM activities (100%). STEM identity composite scores were used to evaluate differences by overall Underserved status and demographic variables contributing to Underserved. No significant differences existed by overall Underserved classification or individual demographics investigated.

Table 66. Apprentice Report of Impacts on STEM Identity (n=17)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	5.9%	5.9%	17.6%	70.6%	
	1	1	3	12	**17**
Interest in pursuing a STEM career	0.0%	11.8%	5.9%	82.4%	
	0	2	1	14	**17**
Sense of accomplishing something in STEM	0.0%	5.9%	11.8%	82.4%	
	0	1	2	14	**17**
Feeling prepared for more challenging STEM activities	0.0%	0.0%	17.6%	82.4%	
	0	0	3	14	**17**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	11.8%	11.8%	76.5%	
	0	2	2	13	**17**
Desire to build relationships with mentors who work in STEM	5.9%	0.0%	5.9%	88.2%	
	1	0	1	15	**17**

HSAP

Three-quarters or more of HSAP apprentices (75%-100%) reported at least medium gains on all surveyed STEM identity items (Table 67). All apprentices reported at least medium gains in their sense of accomplishing something in STEM (100%) and desire to build relationships with mentors who work in STEM (100%). STEM identity composite scores were unable to be used to look for group differences due to the small sample size.

Table 67. Apprentice Report of Impacts on STEM Identity (n=8)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	0.0%	25.0%	0.0%	75.0%	
	0	2	0	6	**8**
Interest in pursuing a STEM career	25.0%	0.0%	25.0%	50.0%	
	2	0	2	4	**8**
Sense of accomplishing something in STEM	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**
Feeling prepared for more challenging STEM activities	0.0%	12.5%	25.0%	62.5%	
	0	1	2	5	**8**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	12.5%	25.0%	62.5%	
	0	1	2	5	**8**
Desire to build relationships with mentors who work in STEM	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**

URAP

More than 80% of URAP apprentices (81%-100%) indicated at least medium gains on all survey items associated with STEM identity (Table 68). All reported at least medium gains in their feeling prepared for more challenging STEM activities (100%). STEM identity composite scores were used to look for differences by overall Underserved status and demographic variables contributing to Underserved. No significant differences existed by overall Underserved status. However, there were significant differences in STEM identity gains by race/ethnicity with minority students reporting greater gains (effect size is large with d = 1.21).[18]

Table 68. Apprentice Report of Impacts on STEM Identity (n=16)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	6.3%	6.3%	31.3%	56.3%	
	1	1	5	9	**16**
Interest in pursuing a STEM career	0.0%	18.8%	12.5%	68.8%	

[18] Independent Samples *t*-test for STEM Identity by Race/Ethnicity: $t(14)=2.26$, p=.040.

	0	3	2	11	**16**
Sense of accomplishing something in STEM	0.0%	12.5%	18.8%	68.8%	
	0	2	3	11	**16**
Feeling prepared for more challenging STEM activities	0.0%	0.0%	31.3%	68.8%	
	0	0	5	11	**16**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	18.8%	31.3%	50.0%	
	0	3	5	8	**16**
Desire to build relationships with mentors who work in STEM	0.0%	6.3%	18.8%	75.0%	
	0	1	3	12	**16**

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.

Mentor Strategies and Support – Army-Based Laboratory Programs

CQL

At least two-thirds of CQL mentors (67%-100%) reported using all strategies except one (asking students to relate real life events to CQL topics – 33%) to help make learning activities relevant to students (Table 69). All CQL mentors indicated using strategies such as: becoming familiar with their students' backgrounds and interests (100%); giving students real-life problems to investigate or solve (100%); and encouraging students to suggest new readings, activities, or projects (100%).

[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.

Table 69. Mentors Using Strategies to Establish Relevance of Learning Activities (n=6)

	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%	
	6	0	6
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	6	0	6
Selecting readings or activities that relate to students' backgrounds	66.7%	33.3%	
	4	2	6
Encouraging students to suggest new readings, activities, or projects	100.0%	0.0%	
	6	0	6
Helping students become aware of the role(s) that STEM plays in their everyday lives	50.0%	50.0%	
	3	3	6
Helping students understand how STEM can help them improve their own community	50.0%	50.0%	
	3	3	6
Asking students to relate real-life events or activities to topics covered in CQL	33.3%	66.7%	
	2	4	6

Half or more of CQL mentors (50%-100%) noted using all strategies to support the diverse needs of students as learners (Table 70) with the exception of one item (highlighting under-representation of women and racial/ethnic minority populations in STEM – 33%). Strategies in this domain reportedly used by all mentors are interacting with students and other personnel the same way regardless of their background (100%); using a variety of teaching and/or mentoring activities to meet the needs of all students (100%); and directing students to other individuals or programs for additional support as needed (100%).

Table 70. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=6)

	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	66.7%	33.3%	
	4	2	6
Interact with students and other personnel the same way regardless of their background	100.0%	0.0%	
	6	0	6

Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	6	0	**6**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	50.0%	50.0%	
	3	3	**6**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	83.3%	16.7%	
	5	1	**6**
Directing students to other individuals or programs for additional support as needed	100.0%	0.0%	
	6	0	**6**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	33.3%	66.7%	
	2	4	**6**

With the exception of one item (allowing students to resolve conflicts within their team – 33%), half or more of CQL mentors (50%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 71). All mentors reported using the following strategies: having students give/receive constructive feedback with others (100%); and having students work on collaborative activities as a member of a team (100%).

Table 71. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=6)

	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	50.0%	50.0%	
	3	3	**6**
Having my student(s) explain difficult ideas to others	66.7%	33.3%	
	4	2	**6**
Having my student(s) listen to the ideas of others with an open mind	83.3%	16.7%	
	5	1	**6**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	50.0%	50.0%	
	3	3	**6**
Having my student(s) give and receive constructive feedback with others	100.0%	0.0%	
	6	0	**6**
	100.0%	0.0%	

Having students work on collaborative activities or projects as a member of a team	6	0	**6**
Allowing my student(s) to resolve conflicts and reach agreement within their team	33.3%	66.7%	
	2	4	**6**

Half or more (50%-100%) of CQL mentors said they implemented all strategies to support students' engagement in authentic STEM activities (Table 72). All mentors reported using the following strategies: providing students with constructive feedback to improve their STEM competencies (100%); allowing students to work independently to improve their self-management abilities (100%); and encouraging students to seek support from other team members (100%).

Table 72. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=6)

	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%	
	4	2	**6**
Having my student(s) search for and review technical research to support their work	83.3%	16.7%	
	5	1	**6**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	66.7%	33.3%	
	4	2	**6**
Supervising my student(s) while they practice STEM research skills	83.3%	16.7%	
	5	1	**6**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	6	0	**6**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	6	0	**6**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	50.0%	50.0%	
	3	3	**6**
Encouraging students to seek support from other team members	100.0%	0.0%	
	6	0	**6**

Half or more of CQL mentors (50%-100%) reported using seven of the strategies focused on supporting students' STEM educational and career pathways (Table 73). All responding mentors said they discussed STEM career opportunities within the DoD (100%) and in private industry or academia (100%). A third or fewer (17%-33%) reported implementing the following strategies: recommending extracurricular programs that align with students' goals (33%); recommending student and professional organizations in STEM to students (33%); and discussing the economic, political, ethical, and/or social context of a STEM career (17%).

Table 73. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=6)

	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	83.3%	16.7%	
	5	1	**6**
Recommending extracurricular programs that align with students' goals	33.3%	66.7%	
	2	4	**6**
Recommending Army Educational Outreach Programs that align with students' goals	50.0%	50.0%	
	3	3	**6**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	83.3%	16.7%	
	5	1	**6**
Discussing STEM career opportunities within the DoD or other government agencies	100.0%	0.0%	
	6	0	**6**
Discussing STEM career opportunities in private industry or academia	100.0%	0.0%	
	6	0	**6**
Discussing the economic, political, ethical, and/or social context of a STEM career	16.7%	83.3%	
	1	5	**6**
Recommending student and professional organizations in STEM to my student(s)	33.3%	66.7%	
	2	4	**6**
Helping students build a professional network in a STEM field	66.7%	33.3%	
	4	2	**6**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	50.0%	50.0%	
	3	3	**6**

Apprentices were also asked about the use of teaching and mentoring strategies by their mentor during CQL (Table 74). Approximately two-thirds or more of apprentices reported their mentor used each strategy (62%-100%). The most frequently reported strategies include Learning or practicing a variety of STEM skills (100%); Giving extra support when needed (96%); and Giving feedback to improve in STEM (96%).

Table 74. CQL Apprentice Reports of Teaching and Mentoring Strategies used by Mentors (n=52)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	75.0%	25.0%	
	39	13	**52**
Helped me understand how I can use STEM to improve my community	75.0%	25.0%	
	39	13	**52**
Used a variety of strategies to help me learn	92.3%	7.7%	
	48	4	**52**
Gave me extra support when I needed it	96.2%	3.8%	
	50	2	**52**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	84.6%	15.4%	
	44	8	**52**
Allowed me to work on a team project or activity	90.4%	9.6%	
	47	5	**52**
Helped me learn or practice a variety of STEM skills	100.0%	0.0%	
	52	0	**52**
Gave me feedback to help me improve in STEM	96.2%	3.8%	
	50	2	**52**
Talked to me about the education I need for a STEM career	84.6%	15.4%	
	44	8	**52**
Recommended Army Educational Outreach Programs that match my interests	61.5%	38.5%	
	32	20	**52**
Discussed STEM careers with the DoD or government	80.8%	19.2%	
	42	10	**52**

SEAP

Only three SEAP mentors completed the evaluation survey. Thus, results must be interpreted with caution. Two or three SEAP mentors (67%-100%) indicated they used all but two of the strategies to help make learning activities relevant to students (Table 75). The two strategies used by only one mentor were:

encouraging students to suggest new readings, activities, or projects (33%); and helping students understand how STEM can help them improve their own community (33%). Strategies all three SEAP mentors reported using were: Becoming familiar with student backgrounds and interests at the beginning of the program (100%); Giving students real-life problems to investigate (100%); and Helping students become aware of the roles STEM plays in their everyday lives (100%).

Table 75. Mentors Using Strategies to Establish Relevance of Learning Activities (n=3)

	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 program experience	100.0%	0.0%	
	3	0	**3**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	3	0	**3**
Selecting readings or activities that relate to students' backgrounds	66.7%	33.3%	
	2	1	**3**
Encouraging students to suggest new readings, activities, or projects	33.3%	66.7%	
	1	2	**3**
Helping students become aware of the role(s) that STEM plays in their everyday lives	100.0%	0.0%	
	3	0	**3**
Helping students understand how STEM can help them improve their own community	33.3%	66.7%	
	1	2	**3**
Asking students to relate real-life events or activities to topics covered in apprenticeship	66.7%	33.3%	
	2	1	**3**

Again, two or three of SEAP mentors (67%-100%) reported they used all strategies to support the diverse needs of students as learners (Table 76) except for two strategies that none reported using: integrating ideas from education literature to teach/mentor students from underrepresented groups in STEM (0%); and highlighting under-representation of women and racial/ethnic minority populations in STEM (0%). However, all three SEAP mentors reported using the following strategies: Use a variety of teaching and/or mentoring activities to meet the needs of all students (100%); Providing extra readings, activities, or learning support for students who lack essential background knowledge (100%); and Directing students to other individuals or programs for additional support as needed (100%).

Table 76. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=3)

	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 program experience	66.7%	33.3%	
	2	1	**3**
Interact with students and other personnel the same way regardless of their background	66.7%	33.3%	
	2	1	**3**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	3	0	**3**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	0.0%	100.0%	
	0	3	**3**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	100.0%	0.0%	
	3	0	**3**
Directing students to other individuals or programs for additional support as needed	100.0%	0.0%	
	3	0	**3**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	0.0%	100.0%	
	0	3	**3**

Two or three SEAP mentors (67%-100%) noted implementing all but two strategies to support students' development of collaboration and interpersonal skills (Table 77). The two strategies used by only one SEAP mentor were: having students exchange ideas with others whose backgrounds/viewpoints are different (33%); and having students give/receive constructive feedback with others (33%). All SEAP mentors, however, said they had students tell other people about their backgrounds/interests (100%).

Table 77. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=3)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	100.0%	0.0%	
	3	0	**3**
Having my student(s) explain difficult ideas to others	66.7%	33.3%	
	2	1	**3**
Having my student(s) listen to the ideas of others with an open mind	66.7%	33.3%	
	2	1	**3**

Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	33.3%	66.7%	
	1	2	**3**
Having my student(s) give and receive constructive feedback with others	33.3%	66.7%	
	1	2	**3**
Having students work on collaborative activities or projects as a member of a team	66.7%	33.3%	
	2	1	**3**
Allowing my student(s) to resolve conflicts and reach agreement within their team	66.7%	33.3%	
	2	1	**3**

A similar pattern as with the prior mentor strategies was found related to mentors use of strategies to support students' engagement in authentic STEM activities (Table 78). Two or three mentors (67%-100%) indicated they used all strategies except two: supervising students while they practice STEM research skills (33%); and encouraging students to learn collaboratively (33%). All three mentors reportedly used multiple strategies including: teaching about specific STEM subject matter (100%); having students search for technical research to support work (100%); providing students with constructive feedback (100%); and allowing students to work independently to improve self-management (100%).

Table 78. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=3)

	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%	
	3	0	**3**
Having my student(s) search for and review technical research to support their work	100.0%	0.0%	
	3	0	**3**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	66.7%	33.3%	
	2	1	**3**
Supervising my student(s) while they practice STEM research skills	33.3%	66.7%	
	1	2	**3**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	3	0	**3**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	3	0	**3**

Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	33.3%	66.7%	
	1	2	3
Encouraging students to seek support from other team members	66.7%	33.3%	
	2	1	3

Two or three SEAP mentors (67%-100%) reported using most strategies focused on supporting students' STEM educational and career pathways (Table 79). All three responding SEAP mentors indicated they: asked students about their educational/career goals (100%) and helped students build a professional network in a STEM field (100%). While only one or no SEAP mentors reported using the following strategies: helping students with their resumé, application, personal statement, and/or interview preparations (33%); discussing STEM career opportunities in private industry or academia (33%); and discussing the economic, political, ethical, and/or social context of a STEM career (0%).

Table 79. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=3)

	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%	
	3	0	3
Recommending extracurricular programs that align with students' goals	66.7%	33.3%	
	2	1	3
Recommending Army Educational Outreach Programs that align with students' goals	66.7%	33.3%	
	2	1	3
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	66.7%	33.3%	
	2	1	3
Discussing STEM career opportunities within the DoD or other government agencies	66.7%	33.3%	
	2	1	3
Discussing STEM career opportunities in private industry or academia	33.3%	66.7%	
	1	2	3
Discussing the economic, political, ethical, and/or social context of a STEM career	0.0%	100.0%	
	0	3	3
Recommending student and professional organizations in STEM to my student(s)	33.3%	66.7%	
	1	2	3
	100.0%	0.0%	

Helping students build a professional network in a STEM field	3	0	**3**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	33.3%	66.7%	
	1	2	**3**

Apprentices were also asked about the use of teaching and mentoring strategies by their mentor during SEAP (Table 80). Two-thirds or more (2 to 3) of apprentices reported their mentor used each strategy.

Table 80. SEAP Apprentice Reports of Teaching and Mentoring Strategies used by Mentors (n=3)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	100.0%	0.0%	
	3	0	**3**
Helped me understand how I can use STEM to improve my community	66.7%	33.3%	
	2	1	**3**
Used a variety of strategies to help me learn	100.0%	0.0%	
	3	0	**3**
Gave me extra support when I needed it	100.0%	0.0%	
	3	0	**3**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	100.0%	0.0%	
	3	0	**3**
Allowed me to work on a team project or activity	66.7%	33.3%	
	2	1	**3**
Helped me learn or practice a variety of STEM skills	100.0%	0.0%	
	3	0	**3**
Gave me feedback to help me improve in STEM	100.0%	0.0%	
	3	0	**3**
Talked to me about the education I need for a STEM career	66.7%	33.3%	
	2	1	**3**
Recommended Army Educational Outreach Programs that match my interests	66.7%	33.3%	
	2	1	**3**

Discussed STEM careers with the DoD or government	100.0%	0.0%	
	3	0	**3**

Mentor Strategies and Support – University-Based Programs

REAP

Three-quarters or more of REAP mentors (79%-100%) indicated implementing all strategies to help make learning activities relevant to students (Table 81). All REAP mentors noted using the following strategies: becoming familiar with their students' backgrounds and interests (100%) and giving students real-life problems to investigate/solve (100%).

Table 81. 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 program experience	100.0%	0.0%	
	14	0	**14**
Giving students real-life problems to investigate or solve	100.0%	0.0%	
	14	0	**14**
Selecting readings or activities that relate to students' backgrounds	78.6%	21.4%	
	11	3	**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	92.9%	7.1%	
	13	1	**14**
Helping students understand how STEM can help them improve their own community	78.6%	21.4%	
	11	3	**14**
Asking students to relate real-life events or activities to topics covered in apprenticeship	92.9%	7.1%	
	13	1	**14**

Nearly three-quarters or more of REAP mentors (71%-93%) noted using all strategies to support the diverse needs of students as learners (Table 82). More than 90% of REAP mentors said they: identified different learning styles their students had at the beginning of the program (93%) and used a variety of teaching/mentoring activities to meet the needs of all students (93%).

Table 82. 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 program experience	92.9%	7.1%	
	13	1	**14**
Interact with students and other personnel the same way regardless of their background	78.6%	21.4%	
	11	3	**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	78.6%	21.4%	
	11	3	**14**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	85.7%	14.3%	
	12	2	**14**
Directing students to other individuals or programs for additional support as needed	85.7%	14.3%	
	12	2	**14**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	71.4%	28.6%	
	10	4	**14**

More than three-quarters of REAP mentors (79%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills (Table 83). All reported using the following strategies: having students listen to ideas of others with an open mind (100%); having students give/receive constructive feedback (100%); and having students work on collaborative activities as a team member (100%).

Table 83. 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	92.9%	7.1%	

	13	1	**14**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	14	0	**14**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	78.6%	21.4%	
	11	3	**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**

When asked about strategies to support students' engagement in authentic STEM activities (Table 84), more than 85% of REAP mentors (86%-100%) indicated implementing all strategies. All REAP mentors said they taught about specific STEM subject matter (100%) and encouraged students to seek support from other team members (100%).

Table 84. 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	100.0%	0.0%	
	14	0	**14**
Having my student(s) search for and review technical research to support their work	92.9%	7.1%	
	13	1	**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	85.7%	14.3%	
	12	2	**14**
Providing my student(s) with constructive feedback to improve their STEM competencies	92.9%	7.1%	
	13	1	**14**
	85.7%	14.3%	

Allowing students to work independently to improve their self-management abilities	12	2	**14**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	92.9%	7.1%	
	13	1	**14**
Encouraging students to seek support from other team members	100.0%	0.0%	
	14	0	**14**

Approximately two-thirds or more of REAP mentors (64%-100%) noted trying all strategies focused on supporting students' STEM educational and career pathways (Table 85). All REAP mentors said they asked students about their educational/career goals (100%) and provided guidance about educational pathways that would prepare students for a STEM career (100%). Fewer mentors reported discussing the economic, political, ethical, and/or social context of a STEM career (64%).

Table 85. 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	100.0%	0.0%	
	14	0	**14**
Recommending extracurricular programs that align with students' goals	85.7%	14.3%	
	12	2	**14**
Recommending Army Educational Outreach Programs that align with students' goals	85.7%	14.3%	
	12	2	**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	71.4%	28.6%	
	10	4	**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	64.3%	35.7%	
	9	5	**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	92.9%	7.1%	
	13	1	**14**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	71.4%	28.6%	
	10	4	**14**

Apprentices were also asked about the use of teaching and mentoring strategies by their mentor during REAP (Table 86). Close to half or more (47%-94%) of apprentices reported strategy was implemented. The most frequently student reported strategies used by mentors include: Becoming aware of STEM in everyday life (94%); Using a variety of strategies to help them learn (94%); Giving extra support when needed (94%); Learning or practicing a variety of STEM skills (94%); and Giving feedback to improve in STEM (94%). Although students reported mentors were less likely to recommend AEOP that align with apprentices' interests (53%) or to discuss DoD STEM careers (47%).

Table 86. REAP Apprentice Reports of Teaching and Mentoring Strategies used by Mentors (n=17)

	Yes – my mentor used this strategy	**No – my mentor did not use this strategy**	**Response Total**
Helped me become aware of STEM in my everyday life	94.1%	5.9%	
	16	1	**17**
Helped me understand how I can use STEM to improve my community	88.2%	11.8%	
	15	2	**17**
Used a variety of strategies to help me learn	94.1%	5.9%	
	16	1	**17**
Gave me extra support when I needed it	94.1%	5.9%	
	16	1	**17**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	82.4%	17.6%	
	14	3	**17**
Allowed me to work on a team project or activity	82.4%	17.6%	
	14	3	**17**
Helped me learn or practice a variety of STEM skills	94.1%	5.9%	
	16	1	**17**
Gave me feedback to help me improve in STEM	94.1%	5.9%	
	16	1	**17**

Talked to me about the education I need for a STEM career	70.6%	29.4%	
	12	5	**17**
Recommended Army Educational Outreach Programs that match my interests	52.9%	47.1%	
	9	8	**17**
Discussed STEM careers with the DoD or government	47.1%	52.9%	
	8	9	**17**

HSAP

Only one HSAP mentor completed the evaluation survey. Thus, results must be interpreted with extreme caution and not seen as representative of all HSAP mentor perspectives. The one HSAP mentor completing the evaluation survey reported using all strategies (except one) to help make learning activities relevant to students (Table 87). The only strategy not employed by the HSAP mentor completing the survey was: giving students real-life problems to investigate or solve.

Table 87. Mentors Using Strategies to Establish Relevance of Learning Activities (n=1)

	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 program experience	100.0%	0.0%	
	1	0	**1**
Giving students real-life problems to investigate or solve	0.0%	100.0%	
	0	1	**1**
Selecting readings or activities that relate to students' backgrounds	100.0%	0.0%	
	1	0	**1**
Encouraging students to suggest new readings, activities, or projects	100.0%	0.0%	
	1	0	**1**
Helping students become aware of the role(s) that STEM plays in their everyday lives	100.0%	0.0%	
	1	0	**1**
Helping students understand how STEM can help them improve their own community	100.0%	0.0%	
	1	0	**1**
Asking students to relate real-life events or activities to topics covered in apprenticeship	100.0%	0.0%	
	1	0	**1**

Table 88 shows the only reporting HSAP mentor's strategies used to support the diverse needs of students as learners. This mentor used all strategies except three: integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM; identifying different learning styles of students at the beginning of the program; and interacting with students and other personnel the same way regardless of background.

Table 88. Mentors Using Strategies to Support the Diverse needs of Students as Learners (n=1)

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

Table 89 shows that the one HSAP mentor completing the evaluation survey reportedly used all strategies to support student development of collaboration and interpersonal skills.

Table 89. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=1)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	100.0%	0.0%	
	1	0	**1**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	1	0	**1**

Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	1	0	**1**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	100.0%	0.0%	
	1	0	**1**
Having my student(s) give and receive constructive feedback with others	100.0%	0.0%	
	1	0	**1**
Having students work on collaborative activities or projects as a member of a team	100.0%	0.0%	
	1	0	**1**
Allowing my student(s) to resolve conflicts and reach agreement within their team	100.0%	0.0%	
	1	0	**1**

Table 90 provides data on the one responding HSAP mentor's use of strategies to support student engagement in authentic STEM activities. This mentor reportedly used all strategies except for having students search for technical research to support their work.

Table 90. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=1)

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

Encouraging students to seek support from other team members	100.0%	0.0%	
	1	0	**1**

Table 91 shows the one HSAP completing the evaluation survey used fewer than half of the strategies to support students' STEM educational and career pathways. The three strategies this mentor reported using were: asking their student about educational/career goals; providing guidance about educational pathways that will prepare their student for a STEM career; and discussing the economic, political, ethical, and/or social context of a STEM career.

Table 91. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=1)

	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%	
	1	0	**1**
Recommending extracurricular programs that align with students' goals	0.0%	100.0%	
	0	1	**1**
Recommending Army Educational Outreach Programs that align with students' goals	0.0%	100.0%	
	0	1	**1**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	100.0%	0.0%	
	1	0	**1**
Discussing STEM career opportunities within the DoD or other government agencies	0.0%	100.0%	
	0	1	**1**
Discussing STEM career opportunities in private industry or academia	0.0%	100.0%	
	0	1	**1**
Discussing the economic, political, ethical, and/or social context of a STEM career	100.0%	0.0%	
	1	0	**1**
Recommending student and professional organizations in STEM to my student(s)	0.0%	100.0%	
	0	1	**1**
Helping students build a professional network in a STEM field	0.0%	100.0%	
	0	1	**1**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	0.0%	100.0%	
	0	1	**1**

Apprentices were also asked about the use of teaching and mentoring strategies by their mentor during HSAP (Table 92). Half or more (50%-100%) indicated all strategies were implemented by their mentors. The most frequently reported strategy used by mentors include Using a variety of learning strategies (100%); Giving extra support when needed (100%); Learning or practicing a variety of STEM skills (100%); and Giving feedback to improve in STEM (100%).

Table 92. HSAP Apprentice Reports of Teaching and Mentoring Strategies used by Mentors (n=8)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	50.0%	50.0%	
	4	4	**8**
Helped me understand how I can use STEM to improve my community	62.5%	37.5%	
	5	3	**8**
Used a variety of strategies to help me learn	100.0%	0.0%	
	8	0	**8**
Gave me extra support when I needed it	100.0%	0.0%	
	8	0	**8**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	75.0%	25.0%	
	6	2	**8**
Allowed me to work on a team project or activity	87.5%	12.5%	
	7	1	**8**
Helped me learn or practice a variety of STEM skills	100.0%	0.0%	
	8	0	**8**
Gave me feedback to help me improve in STEM	100.0%	0.0%	
	8	0	**8**
Talked to me about the education I need for a STEM career	62.5%	37.5%	
	5	3	**8**
Recommended Army Educational Outreach Programs that match my interests	50.0%	50.0%	
	4	4	**8**
Discussed STEM careers with the DoD or government	62.5%	37.5%	

	5	3	**8**

URAP

Nearly two-thirds or more (60%-90%) of URAP mentors reported that they implemented all strategies to help make learning activities relevant to students (Table 93). Strategies used most frequently were becoming familiar with their students' backgrounds and interests (90%); and encouraging students to suggest new readings, activities, or projects (90%).

Table 93. Mentors Using Strategies to Establish Relevance of Learning Activities (n=10)

	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 program experience	90.0%	10.0%	
	9	1	**10**
Giving students real-life problems to investigate or solve	80.0%	20.0%	
	8	2	**10**
Selecting readings or activities that relate to students' backgrounds	70.0%	30.0%	
	7	3	**10**
Encouraging students to suggest new readings, activities, or projects	90.0%	10.0%	
	9	1	**10**
Helping students become aware of the role(s) that STEM plays in their everyday lives	60.0%	40.0%	
	6	4	**10**
Helping students understand how STEM can help them improve their own community	70.0%	30.0%	
	7	3	**10**
Asking students to relate real-life events or activities to topics covered in apprenticeship	80.0%	20.0%	
	8	2	**10**

Half or more (50%-100%) of URAP mentors reported that they used all strategies to support the diverse needs of students as learners (Table 94). All URAP mentors noted using a variety of teaching and/or mentoring activities to meet the needs of all students (100%). Fewer mentors indicated they integrated ideas from education literature to teach/mentor students from underrepresented STEM groups (50%).

Table 94. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=10)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
	70.0%	30.0%	

Identify the different learning styles that my student (s) may have at the beginning of the program experience	7	3	**10**
Interact with students and other personnel the same way regardless of their background	60.0%	40.0%	
	6	4	**10**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	10	0	**10**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	50.0%	50.0%	
	5	5	**10**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	90.0%	10.0%	
	9	1	**10**
Directing students to other individuals or programs for additional support as needed	80.0%	20.0%	
	8	2	**10**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	70.0%	30.0%	
	7	3	**10**

More than two-thirds of URAP mentors (70%-100%) indicated implementing all strategies to support students' development of collaboration and interpersonal skills (Table 95). All mentors noted having students explain difficult ideas to others (100%).

Table 95. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=10)

	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	70.0%	30.0%	
	7	3	**10**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	10	0	**10**
Having my student(s) listen to the ideas of others with an open mind	80.0%	20.0%	
	8	2	**10**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	80.0%	20.0%	
	8	2	**10**
Having my student(s) give and receive constructive feedback with others	90.0%	10.0%	
	9	1	**10**

Having students work on collaborative activities or projects as a member of a team	90.0%	10.0%	
	9	1	**10**
Allowing my student(s) to resolve conflicts and reach agreement within their team	80.0%	20.0%	
	8	2	**10**

More than three-quarters (80%-100%) of URAP mentors reported using all strategies to support students' engagement in authentic STEM activities (Table 96). All URAP mentors said they implemented the following strategies: having students search for technical research to support their work (100%); supervising students while they practice STEM research skills (100%); allowing students to work independently to improve their self-management abilities (100%); and encouraging students to learn collaboratively (100%).

Table 96. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=10)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	80.0%	20.0%	
	8	2	**10**
Having my student(s) search for and review technical research to support their work	100.0%	0.0%	
	10	0	**10**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	80.0%	20.0%	
	8	2	**10**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	10	0	**10**
Providing my student(s) with constructive feedback to improve their STEM competencies	90.0%	10.0%	
	9	1	**10**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	10	0	**10**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	10	0	**10**
Encouraging students to seek support from other team members	90.0%	10.0%	
	9	1	**10**

Half or more of URAP mentors (50%-90%) reported using all strategies focused on supporting students' STEM educational and career pathways (Table 97) except for recommending AEOP that align with students' goals (40%). Nearly all responding URAP mentors indicated they asked students about their educational and career goals (90%).

Table 97. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=10)

	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	90.0%	10.0%	
	9	1	**10**
Recommending extracurricular programs that align with students' goals	50.0%	50.0%	
	5	5	**10**
Recommending Army Educational Outreach Programs that align with students' goals	40.0%	60.0%	
	4	6	**10**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	80.0%	20.0%	
	8	2	**10**
Discussing STEM career opportunities within the DoD or other government agencies	70.0%	30.0%	
	7	3	**10**
Discussing STEM career opportunities in private industry or academia	60.0%	40.0%	
	6	4	**10**
Discussing the economic, political, ethical, and/or social context of a STEM career	80.0%	20.0%	
	8	2	**10**
Recommending student and professional organizations in STEM to my student(s)	80.0%	20.0%	
	8	2	**10**
Helping students build a professional network in a STEM field	70.0%	30.0%	
	7	3	**10**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	70.0%	30.0%	
	7	3	**10**

Apprentices were also asked about the use of teaching and mentoring strategies by their mentor during URAP (Table 98). More than two-thirds of apprentices reported their mentors using each strategy (69%-100%) with the exception of recommending AEOP that align with apprentices' interests (38%) and discussing DoD STEM careers (38%). All apprentices noted their mentors implemented the following strategies: Used a variety of strategies to help me learn (100%); Gave me extra support when I needed it

(100%); Allowed me to work on a team project/activity (100%); Helped me learn/practice a variety of STEM skills (100%); and Gave me feedback to help me improve in STEM (100%).

Table 98. URAP Apprentice Reports of Teaching and Mentoring Strategies used by Mentors (n=16)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	75.0%	25.0%	
	12	4	**16**
Helped me understand how I can use STEM to improve my community	81.3%	18.8%	
	13	3	**16**
Used a variety of strategies to help me learn	100.0%	0.0%	
	16	0	**16**
Gave me extra support when I needed it	100.0%	0.0%	
	16	0	**16**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	75.0%	25.0%	
	12	4	**16**
Allowed me to work on a team project or activity	100.0%	0.0%	
	16	0	**16**
Helped me learn or practice a variety of STEM skills	100.0%	0.0%	
	16	0	**16**
Gave me feedback to help me improve in STEM	100.0%	0.0%	
	16	0	**16**
Talked to me about the education I need for a STEM career	68.8%	31.3%	
	11	5	**16**
Recommended Army Educational Outreach Programs that match my interests	37.5%	62.5%	
	6	10	**16**
Discussed STEM careers with the DoD or government	37.5%	62.5%	
	6	10	**16**

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 various features of their CQL experience (Table 99). Approximately three-quarters or more of CQL apprentices (73%-98%) reported being at least somewhat satisfied with all program features listed. The greatest amount of satisfaction noted by apprentices was in the following areas: amount of stipend (98%); variety of STEM topics available in CQL (98%); and timeliness of receiving stipend (94%).

Table 99. Student Satisfaction with CQL Program Features (n=52)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	11.5%	34.6%	53.8%	
	0	6	18	28	**52**
Other administrative tasks (e.g., security clearances, issuing CAC cards)	9.6%	17.3%	40.4%	32.7%	
	5	9	21	17	**52**
Communicating with your host site organizers	5.8%	1.9%	44.2%	48.1%	
	3	1	23	25	**52**
The physical location(s) of Apprenticeship Program activities	11.5%	1.9%	30.8%	55.8%	
	6	1	16	29	**52**
The variety of STEM topics available to you in the Apprenticeship Program	1.9%	0.0%	36.5%	61.5%	
	1	0	19	32	**52**
Teaching or mentoring provided during Apprenticeship Program activities	1.9%	5.8%	23.1%	69.2%	
	1	3	12	36	**52**
Amount of stipend (payment)	0.0%	1.9%	38.5%	59.6%	
	0	1	20	31	**52**
	0.0%	5.8%	19.2%	75.0%	

Timeliness of receiving stipend (payment)	0	3	10	39	**52**
Research abstract preparation requirements	9.6%	3.8%	38.5%	48.1%	
	5	2	20	25	**52**

CQL apprentices were asked about the availability of their mentors during the program (Table 100). Nearly all reported that their mentors were available at least half of the time (96%), and nearly two-thirds (62%) said their mentors were always available.

Table 100. Apprentice Reports of Availability of Mentors (n=52)

	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	3.8%	2
The mentor was available about half of the time of my project	3.8%	2
The mentor was available more than half of the time	30.8%	16
The mentor was always available	61.6%	32

CQL apprentices were also asked about their satisfaction with elements of their research experience (Table 101). More than 90% reported they were somewhat or very much satisfied with all elements. All apprentices were at least somewhat satisfied with their working relationship with their mentor (100%).

Table 101. Apprentice Satisfaction with Their Experience (n=52)

	Did not experience	Not at all	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	9.6%	90.4%	
	0	0	5	47	**52**
My working relationship with the group or team	5.8%	3.8%	17.3%	73.1%	
	3	2	9	38	**52**
The amount of time I spent doing meaningful research	0.0%	1.9%	23.1%	75.0%	
	0	1	12	39	**52**
The amount of time I spent with my research mentor	0.0%	1.9%	19.2%	78.8%	
	0	1	10	41	**52**
The research experience overall	0.0%	1.9%	15.4%	82.7%	
	0	1	8	43	**52**

An open-ended item on the questionnaire asked apprentices about their overall satisfaction with their CQL experience. All but 1 of the 51 apprentices who responded to this item had something positive to say about their experience. The apprentices who provided detailed comments about their satisfaction cited their mentors, the opportunity to network, the real-world application of their knowledge, improvements to their research skills, and the flexibility with being able to apprentice online. Apprentices said, for example,

> *"I have really appreciated the CQL program. My skills as a researcher have vastly improved...My mentor is very helpful and highly available, and I have learned a lot just from talking with her when I come in at the beginning of the day. 10/10 would recommend."* (CQL Apprentice)

> *"I absolutely loved my experience with [CQL]! My mentor and my coworkers in the building went out of their way to make me feel like part of the team and helped me grow and learn as an engineer. I felt that I was a valuable resource to my branch and that I was helping my group meet our goals. I hope that I can continue to work with them in the future."* (CQL Apprentice)

> *"CQL provided me with more real-world experience than I had hoped and allowed me to make connections I never would have been able to make otherwise. CQL also made me more interested in my area of study than I have ever been before."* (CQL Apprentice)

> *"I thought my [CQL] mentor was exceptional…I felt very supported. I am extremely thankful that my mentor…and AEOP found a way to continue this program during the pandemic. Thank you to all the staff that had to adapt the program to make sure we were able to participate this summer."* (CQL Apprentice)

> *"[In CQL] I was able to connect what I learned in my coursework…to my internship experience and... apply it ...And then I was able to take the things that I learned in my internship and apply it back to my coursework."* (CQL Apprentice)

Seven of the apprentice respondents (14%) made positive comments about their CQL experiences but also offered some caveats. These caveats included lack of opportunities for apprentices to interact with one another, lack of site and DoD orientation, difficulties with administrative details including timeliness of stipend payments and the selection process, communication from the program, difficulties in finding and funding housing, and a request to include more robust writing requirements as part of the program. For example,

> *"Overall, considering the circumstances I was pretty satisfied. There are definitely limitations due to COVID, but I think the program functioned fairly well considering it. I do think there are improvements to be made- a better introduction to [the lab] and DOD would help in establishing the direction of the program to interns, and more communication between the other students and mentors would have been useful (especially since you wouldn't see people in person)."* (CQL Apprentice)

"Overall, I really enjoyed my time at CQL. My mentors were fantastic and have inspired me to pursue further research opportunities. I hope to be able to return to [the site] in the future to continue working on the project. My principal recommendation for improvements revolves around the selection process. It was not clear at all how my application ended up at [the site], as I did not select them as my three choices. Obviously, I am extremely grateful that it did, but letting me know how that happened would be helpful. I also never heard back from any of the locations that I had selected, so that was not ideal. Lastly, a great thing about this program is that it includes programs from across the nation. In order to place the best students at the best locations, I feel it would make a lot of sense for this program to provide financial relocation assistance." (CQL Apprentice)

"Overall, I am very satisfied with my [CQL] apprenticeship experience… I think a requirement to write a paper would be much more valuable than a symposium/presentation. I am not suggesting getting rid of the presentation because it is a fun way to culminate all your work. However, in general, I feel like paper writing skills are much more important because, in STEM, you will produce many more papers than you will ever attend conferences." (CQL Apprentice)

Only one apprentice had nothing positive to say about his CQL experience. This apprentice noted that he lacked access to his mentor and that the program expectations were unclear, saying,

"I was not very satisfied with my [CQL] apprenticeship program. The is partially because of the coronavirus which has caused a lot of difficulty for me to complete my work in quarantine, losing easy access to my professor who helped guide me previously. But in addition, the expectations from me were never clear enough. I was given too much license and not enough guidance. My mentors would occasionally check in or offer help when I asked, but the original problem was the vagueness of my goals for the apprenticeship…Part of the problem is that I have never been to the CQL facility, only working on the [university] campus which has hurt communication between my Army mentors and myself. I think this experience could have been improved with a more defined set of goals and more regular technical discussions with my mentors." (CQL Apprentice)

Another open-ended questionnaire item asked apprentices to list three benefits of CQL. The 52 apprentices who responded cited a variety of benefits. The most frequently mentioned benefits (38 apprentices or 73%) were the hands-on lab experiences and STEM skills they gained. Another 27 apprentices (52%) noted that networking and/or the mentoring is a benefit of CQL. About a third or more of apprentices also cited STEM learning (18, or 35%) and career information (17, or 33%) as benefits. About 20%-25% of apprentices (10-12) cited the DoD information they gained and the opportunity to apply their learning to real-world situations as benefits of CQL. Between four and nine apprentices (8%-17%) mentioned the following as benefits of CQL:

- teamwork
- scientific communication skills (writing and presenting)
- workplace skills

- increasing motivation for or interest in STEM
- problem solving
- the stipend
- increases in their confidence

Likewise, apprentices participating in interviews were asked to comment upon the benefits of CQL. These apprentices cited the value of the real-world research experience they gained, the opportunity to apply their knowledge, the CQL mentors, the opportunity to network with DoD personnel, learning about others' research, career information, and the opportunity to improve their communication skills as meaningful benefits of CQL. Apprentices said, for example,

> *"I've learned a whole lot about how to conduct research… [CQL has] really broadened my understanding of the methods and how you go on and analyze the data afterwards."* (CQL Apprentice)

> *"[My CQL mentor] was just very helpful. Basically, the way they had me working was I had my own projects and my own space…but if I needed help, I could just basically turn around and ask my mentor, 'hey, what's going on here?' Or 'how do I approach this problem better?' And then even if she wasn't available, there were other people there who would be able to help me."* (CQL Apprentice)

> *"I have a very good relationship with my mentor, so that's been very helpful. I guess if I ever have any questions about anything I can go and ask her."* (CQL Apprentice)

> *"We listened to the other CQL students - what they were working on and their projects and just kind of getting a better understanding of what [they were working on]. That particular experience [gave me] a really good understanding of what [the site] is working on."* (CQL Apprentice)

Apprentices were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The most frequently suggested improvement among the 46 apprentices who responded (suggested by 19 apprentices, or 41%) was to provide more or better communication from the program. Another 11 apprentices (24%) suggested providing more opportunities for apprentices to interact with one another, and ten apprentices (22%) suggested improving or streamlining in-processing procedures. Nine apprentices (20%) suggested clarifying expectations, particularly for abstracts and posters. Other improvements, suggested by three to eight apprentices (7%-17%) included:

- providing more tours or events
- improvements to stipend payment including making timely payments, increasing the amount of the stipend, or providing information about who pays the stipend and the amount of the stipend
- providing more career information
- providing guidance for mentors and ensuring that mentors are accessible

- improvements to the website and/or online application
- providing more networking opportunities
- providing assistance with locating and/or funding housing
- providing more choice of projects or more information about projects at the point of application
- providing more options for the duration of the apprenticeship (e.g., extend through school year)

Apprentices participating in interviews were also asked for their opinions about how the CQL program could be improved. Their responses primarily mirrored the comments above, including requests for more clarity regarding expectations, better communication, and better in-processing. These apprentices added comments about difficulties with the online nature of the apprenticeship, suggestions for more opportunities to present their research, and a request more information about AEOP. Apprentices said, for example,

> *"I felt like we didn't really have good communication with the CQL program. There [were] times that they...requested abstracts and stuff for what we were working on, but they never sent us any follow up information on what type of documentation they would like. So, since they never did, we actually never ended up doing any of that documentation...I felt like we didn't really have any contact with the CQL program as a whole. And I'm not sure if we necessarily met their goals."* (CQL Apprentice)

> *"[An improvement to CQL would be] making sure that there's a way for the CQL apprentices and...the director or someone sort of in that kind of position to come together to sort of share their research and what's going on in their respective fields."* (CQL Apprentice)

> *"The remote aspect [of CQL] was difficult where sometimes being in constant contact would be very difficult and staying up to date on exactly what was expected of me or what was going on was a bit difficult. I think the most important [improvement] for me would be more clear goals of the project from the outset because I think there were sometimes where I was not really sure what the purpose of what I was doing was or where exactly I was working towards... I felt like my work was not as targeted as it could be... I think a clear set of…short-term goals and long-term goals would be useful."* (CQL Apprentice)

CQL mentors were also asked about their satisfaction with program features (Table 102). Half or more of responding mentors (50%-83%) reported being at least somewhat satisfied with all program features except for research abstract preparation requirements (33%); half of CQL mentors (50%) reported having not experienced these requirements. Areas of mentor reported greatest satisfaction (somewhat or very much) were amount of stipends for apprentices (83%); communication with program organizers (83%); application/registration process (83%); and other administrative tasks (83%).

Table 102. Mentor Satisfaction with CQL Program Features (n=6)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	16.7%	0.0%	0.0%	33.3%	50.0%	
	1	0	0	2	3	**6**
Other administrative tasks (in-processing, network access, etc.)	16.7%	0.0%	0.0%	50.0%	33.3%	
	1	0	0	3	2	**6**
Communicating with Rochester Institute of Technology (RIT)	33.3%	0.0%	0.0%	16.7%	50.0%	
	2	0	0	1	3	**6**
Communicating with program organizers	16.7%	0.0%	0.0%	16.7%	66.7%	
	1	0	0	1	4	**6**
Support for instruction or mentorship during program activities	33.3%	0.0%	0.0%	50.0%	16.7%	
	2	0	0	3	1	**6**
Amount of stipends for apprentices (payment)	16.7%	0.0%	0.0%	16.7%	66.7%	
	1	0	0	1	4	**6**
Timeliness of stipend payment to apprentices	33.3%	0.0%	0.0%	16.7%	50.0%	
	2	0	0	1	3	**6**
Research abstract preparation requirements	50.0%	16.7%	0.0%	16.7%	16.7%	
	3	1	0	1	1	**6**
Research presentation process	50.0%	0.0%	0.0%	33.3%	16.7%	
	3	0	0	2	1	**6**

CQL mentors were also asked to respond to open-ended items asking for their opinions about the program. While only three mentors responded, all made positive comments about the program. Two mentors said,

> *"I have had a very rewarding experience with [CQL] and I enjoy helping to develop young talent."* (CQL Mentor)
>
> *Overall, the [CQL] program went well, and I plan on participating next year. This past summer was interesting, given everything that was going on, and we were able to adapt a lab-based internship into a virtual one."* (CQL Mentor)

One of the mentors added as a caveat that more outreach and information from the program would have been helpful, saying, *"If we weren't already aware of the summer student programs, it would have been difficult to get students. It would be nice if students actually reached out to us or at least we have a list of students to choose from. Most people in our organization that end up with several students each year tend to do so through their own connections, not the AEOP programs."* (CQL Mentor)

Another open-ended item asked mentors to identify the three most important strengths of CQL. The six mentors who responded noted several program strengths. The most frequently mentioned strengths, mentioned by three mentors each, were the STEM and research skills and experience apprentices receive and apprentices' opportunities to network. Two mentors also cited the quality and diversity of CQL applicants as a strength and two cited the program's flexibility as a strength of CQL. Other strengths, each mentioned by one mentor, included the stipend, the opportunity for students to apply their learning to real-world situations, and students' opportunity to build their resumes.

Mentors participating in interviews also commented on the benefits of CQL, both to apprentices and to themselves These mentors noted that strengths of the program for students include career information, research experience, and the opportunity to gain research skills. Mentors commented that benefits they experience from participating in CQL included the satisfaction of inspiring students to pursue STEM careers, the help they received with research projects, and the broadening of their perspectives they experience from mentoring. Mentors said, for example,

"[CQL] was great. Our intern was really really smart…I wasn't exactly sure how it was going to work cause he's never taken the programming classes that we were going to use, but he's been really great at sort of figuring things out on his own with some basic guidance and he's doing really well." (CQL Mentor)

"[My CQL apprentice is able to] apply technical skills and engineering skills to actual projects…he's getting the real project experience working with real customers and actually interacting with those customers as well...He gets to build that kind of a foundation of people skills…It's kind of a transition between the classroom to the real-world application, to a real job, a real profession." (CQL Mentor)

Several mentors participating in phone interviews also commented on their experiences with mentoring apprentices online. These mentors made positive comments such as "pleasantly surprised by how well it's going" and noted that mentors are "more reachable than before." Mentors noted that apprentices were finding ways to network with each other online and noted that a potential benefit of the online format is the opportunity to extend apprenticeships throughout the school year. One mentor did note, however, that it was more challenging in the online format to assist apprentices having difficulties with their work.

Mentors were also asked in an open-ended questionnaire item to identify three ways in which CQL could be improved. The five mentors who responded made a range of suggestions. The most frequently mentioned suggestions (each mentioned by two mentors) were to increase the program's outreach or publicity and to improve communication from the program. Other improvements, each mentioned by one mentor, included providing training for mentors, recruiting applicants with better lab skills, providing apprentices with housing assistance, and increasing the diversity of participants.

Mentors participating in phone interviews were asked for their suggestions about how the CQL program could better reach underserved or underrepresented populations. These mentors suggested sending AEOP representatives to career events and job fairs, providing funding for housing, developing relationships with university career departments, and conducting targeted outreach to organizations that serve underrepresented and minority populations.

Mentors participating in interviews offered a variety of suggestion for program improvement. These mentors suggested extending the program throughout the school year, expanding the disciplinary reach of CQL to include social science disciplines that utilize computational research, and having the AEOP create a central repository for housing information to which apprentices could provide information that could be accessed by other apprentices. One mentor suggested that the program and AEOP generally improve its outreach, saying,

> *"I don't believe AEOP reaches out to the community. They're not actively outreaching. They're passively doing outreach by posting a website."* (CQL Mentor)

CQL apprentices were asked to report on their input into the design of their projects (Table 103). Two apprentices (4%) reported independently designing their entire project. Slightly over a third (37%) of apprentices said they had some input or choice in project design. Half (50%) indicated being assigned a project by their mentors.

Table 103. Apprentice Input on Design of Their Project (n=52)

	Response Percent	Response Total
I did not have a project	1.9%	1
I was assigned a project by my mentor	50.0%	26
I worked with my mentor to design a project	11.5%	6
I had a choice among various projects suggested by my mentor	17.4%	9
I worked with my mentor and members of a research team to design a project	7.7%	4
I designed the entire project on my own	3.8%	2
I worked on various projects for other mentors	7.7%	4

Apprentices were also asked about their participation in research groups (Table 104). Approximately two-thirds of apprentices reported working near others during CQL but on their own projects (64%). Few (19%) worked alone or with only their research mentor. Approximately 17% of apprentices worked in a group on the same project collaboratively.

Table 104. Apprentice Participation in a Research Group (n=52)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	19.2%	10
I worked with others in a shared laboratory or other space, but we worked on different projects	15.4%	8
I worked alone on my project and I met with others regularly for general reporting or discussion	17.3%	9
I worked alone on a project that was closely connected with projects of others in my group	30.8%	16
I worked with a group who all worked on the same project	17.3%	9

SEAP

Apprentices were asked how satisfied they were with various features of the SEAP program (Table 105). Two or three of SEAP apprentices (67%-100%) reported being at least somewhat satisfied with all program features. All three apprentices reported being at least somewhat satisfied with more than half of the features listed, including the following: applying for the program (100%); the variety of STEM topics available (100%); the teaching/mentoring provided (100%); amount of the stipend (100%); and the timeliness of receiving the stipend (100%).

Table 105. Student Satisfaction with SEAP Program Features (n=3)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Communicating with your host site organizers	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
The physical location(s) of Apprenticeship Program activities	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
The variety of STEM topics available to you in the Apprenticeship Program	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**

Amount of stipend (payment)	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Timeliness of receiving stipend (payment)	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Research abstract preparation requirements	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**

Apprentices were asked about their SEAP mentor's availability (Table 106). All three apprentices reported their mentor was always available (100%).

Table 106. Apprentice Reports of Availability of Mentors (n=3)

	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	0%	0
The mentor was available more than half of the time	0%	0
The mentor was always available	100%	3

SEAP apprentices were asked about their satisfaction with various elements of their research experience (Table 107). All three SEAP apprentices reported being at least somewhat satisfied with each experience except for one item. The working relationship with the group/team left only two of the three apprentices (67%) at least somewhat satisfied.

Table 107. Apprentice Satisfaction with Their Experience (n=3)

	Did not experience	Not at all	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
My working relationship with the group or team	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
The amount of time I spent doing meaningful research	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
The amount of time I spent with my research mentor	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**

The research experience overall	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**

SEAP apprentices were asked to comment on their overall satisfaction with their apprenticeship experiences in an open-ended questionnaire item. All three responding apprentices made positive comments. These apprentices said,

> *"Overall, I was very satisfied with my [SEAP] experience. My mentor was always happy to provide assistance and discuss ideas with me. I felt respected, and I felt like I was really contributing to the team. I also gained confidence in my computer programming skills."* (SEAP Apprentice)

> *"I really enjoyed [SEAP]. It has been the best research experience I have ever had. I learned so much about a fascinating topic and had a great mentor who was always available to help. I got to present to and interact with several other researcher scientists. I am even going to continue my research during the school year because I had such a positive experience."* (SEAP Apprentice)

One apprentice made positive comments but offered the caveat that he was not taught the skills necessary for the work in his apprenticeship. This apprentice said,

> *"I had a lot of fun but felt lost most of the time because I was expected to be familiar with code. I expected to be taught a bit more, but in the end, I don't think I really learned anything. I just became familiar with the topic and learned how to follow tutorials. However, it was fun to work with an actual professional."* (SEAP Apprentice)

Because all apprentices interviewed participated in fully online apprenticeships, they were asked to comment on their experience with the online format. All apprentices noted that they had ultimately had good experiences with their online apprenticeships and most commented favorably on their access to their mentors. One apprentice described not having to find housing as a distinct benefit of the online format. For example, apprentices described their experience as follows:

> *"Absolutely wonderful… I never feel like I'm left out of the loop…I don't feel like there are any barriers despite not seeing these people in person."* (SEAP Apprentice)

> *"it's still easy to communicate with my mentor whenever I need to…We do weekly Zoom calls, and on-the-phone calls, twice a week as well."* (SEAP Apprentice)

> *"[I have] many ways to contact [my mentor] if I ever need to ask questions."* (SEAP Apprentice)

Only one apprentice described any challenges to the online format. This apprentice noted that she had to install software on her home computer for her apprenticeship work and had difficulties with this task.

In another open-ended questionnaire item, SEAP apprentices were asked to name three benefits of SEAP. The three apprentices who responded cited a variety of benefits. The most frequently cited benefits were gaining experience in real-world application of STEM (mentioned by all three apprentices). Two apprentices cited gaining specific STEM skills as a benefit. Other benefits, each mentioned by one apprentice included career information, confidence, the mentors, the opportunity to interact with other apprentices, and the opportunity to gain workplace skills.

Apprentices participating in interviews cited the same benefits of participating in SEAP. These apprentices said, for example,

> *"I've also had the opportunity to meet other youth like myself. The program does a wonderful job of having all the interns - despite us not seeing each other in person - meet virtually and talk and learn...The program offers a lot of different ways for us to learn more, conduct some research but also connect with others and get a better idea of what military research looks like."* (SEAP Apprentice)

> *"One of the biggest benefits was being able to still do hands on work. My project makes it easier to do work away from the lab, but my mentor also tried to make it available to me to be able to continue trying to do a big part of my project on my own."* (SEAP Apprentice)

> "*The biggest benefit is experience in research because I really want to go into research in college and after college as a career."* (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 three apprentices who responded offered a range of suggestions, none mentioned by more than one apprentice. Suggested improvements included the following:

- providing a more transparent process for payment of stipends
- improving communication from the program
- clarifying the expectations for posters and abstracts
- providing opportunities to tour labs
- providing more opportunities to see others' work
- accommodating different apprentice skill levels
- improving the mentoring and teaching

Most SEAP apprentices participating in the interviews had no suggestions for improvements. One of the two apprentices who made suggestions indicated that she would prefer an on-site experience to the virtual apprenticeship. The other apprentice suggested providing more opportunities to work with apprentices in different departments in order to learn about others' research.

The three SEAP mentors who completed the evaluation survey were also asked about their satisfaction with various program components (Table 108). Two or three of the responding mentors (67%-100%) reported being at least somewhat satisfied with all features except for the following: communicating with RIT (67% did not experience); timeliness of stipend pay (67% did not experience); support for instruction during program activities (33% did not experience); and research presentation process (33% did not experience). All three responding SEAP mentors were at least somewhat satisfied with their communication with program organizers (100%).

Table 108. Mentor Satisfaction with SEAP Program Features (n=3)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	33.3%	0.0%	33.3%	33.3%	
	0	1	0	1	1	**3**
Other administrative tasks (in-processing, network access, etc.)	0.0%	0.0%	33.3%	33.3%	33.3%	
	0	0	1	1	1	**3**
Communicating with Rochester Institute of Technology (RIT)	66.7%	0.0%	0.0%	0.0%	33.3%	
	2	0	0	0	1	**3**
Communicating with program organizers	0.0%	0.0%	0.0%	66.7%	33.3%	
	0	0	0	2	1	**3**
Support for instruction or mentorship during program activities	33.3%	0.0%	33.3%	0.0%	33.3%	
	1	0	1	0	1	**3**
Amount of stipends for apprentices (payment)	33.3%	0.0%	0.0%	33.3%	33.3%	
	1	0	0	1	1	**3**
Timeliness of stipend payment to apprentices	66.7%	0.0%	0.0%	0.0%	33.3%	
	2	0	0	0	1	**3**
Research abstract preparation requirements	0.0%	0.0%	33.3%	33.3%	33.3%	
	0	0	1	1	1	**3**
Research presentation process	33.3%	0.0%	33.3%	0.0%	33.3%	
	1	0	1	0	1	**3**

Mentors were also asked to respond to an open-ended questionnaire item asking them to comment on their overall satisfaction with SEAP. The one mentor who responded to this item commented positively about the program administration, saying, *"I am very satisfied with AEOP Apprenticeship Program and understand that the success of this program starts with the hard work and efforts by those running the program. Your hard work allows us to focus our attention on mentoring the next-generation of STEM professionals."* (SEAP Mentor)

The mentor interviewed commented favorably upon the online format of SEAP in 2020, saying he was "pleasantly surprised" by how well it went. This mentor reported using Microsoft Teams for daily meetings and added that apprentices were able to contact their mentors easily throughout the day. This mentor reported that his lab had intentionally provided ways for apprentices to connect with one another. He described this as follows:

"I have a collaboration space where...all our interns are in one space. Then our mentors come in and work with the students. I find that if you put all the interns in one place, they get to network with each other, they help each other." (SEAP Mentor)

In another open-ended questionnaire item, mentors were asked to identify the three most important strengths of SEAP. The two mentors who responded noted a variety of strengths, none mentioned more than once. These mentors commented positively about the variety of AEOP overall, the ease of the apprentice selection process, the program's minimal administrative demands, the uniqueness of the opportunity for high school students, apprentices' exposure to real-world research experiences, and apprentices' opportunities to network.

The one mentor interviewed cited the information students receive that can guide their college academic decisions and the career information they receive as strengths of SEAP for apprentices. This mentor also noted that he benefits from the experience of inspiring students to pursue STEM. This mentor said,

"[SEAP is] all about developing and inspiring students to continue in STEM. I tell other mentors this too, it's like, 'If you are volunteering to mentor a student, it doesn't mean that they're necessarily going to help you advance your research. It is you who are going to advance their understanding, and that they have potential contribution to the future workforce.'" (SEAP Mentor)

Mentors were also asked in a questionnaire item to suggest three ways in which SEAP could be improved for future participants. The one mentor who responded suggested coordinating with other labs and holding weekly research seminars. The SEAP mentor interviewed pointed out the difficulty of hosting minor apprentices in the lab when asked about program improvements, noting that his lab requires adults working with youth to have a youth protection clearance. He noted that he would be more likely to host SEAP apprentices under the age of 18 if apprenticeships were online. This mentor described the difficulties as follows:

"Because they are minors, it's very, very difficult [to host SEAP apprentices]. It puts a lot of burden on our mentors. We have to get additional clearances, youth protection clearances...They have to

be attached to the mentor at all times. We have to clear the bathrooms for them...Long story short, it's burdensome. We can't watch them. It's not babysitting, we just can't watch them all the time. Last year, we tried bringing a SEAP student that was under 18, and the poor kid ended up spending most of his time at the STEM Center." (SEAP Mentor)

SEAP apprentices were asked to report on their project design input (Table 109). No apprentices reported independently designing their entire project. However, two of the three apprentices responding (67%) indicated they had choice among various projects suggested by their mentor. One SEAP apprentice (33%) said they were assigned a project by their mentor.

Table 109. Apprentice Input on Design of Their Project (n=3)

	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	33.3%	1
I worked with my mentor to design a project	0%	0
I had a choice among various projects suggested by my mentor	66.7%	2
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	0%	0

Apprentices were asked about research group participation (Table 110). While two of the three apprentices (67%) reported working alone but meeting or being connected with others, one apprentice (33%) indicated they worked alone or only with their research mentor.

Table 110. Apprentice Participation in a Research Group (n=3)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	33.3%	1
I worked with others in a shared laboratory or other space, but we worked on different projects	0%	0
I worked alone on my project and I met with others regularly for general reporting or discussion	33.3%	1
I worked alone on a project that was closely connected with projects of others in my group	33.3%	1
I worked with a group who all worked on the same project	0%	0

Program Features and Satisfaction – University-Based Programs

REAP

Apprentices were asked about their satisfaction level with various REAP program features (Table 111). More than half of REAP apprentices (53%-100%) noted being at least somewhat satisfied with all program features listed except one – physical location, which 59% did not experience. All REAP apprentices reported being very much satisfied with their amount of stipend pay (100%).

Table 111. Apprentice Satisfaction with REAP Program Features (n=17)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Other administrative tasks (e.g., security clearances, issuing CAC cards)	47.1%	0.0%	5.9%	47.1%	
	8	0	1	8	**17**
Communicating with your host site organizers	0.0%	0.0%	5.9%	94.1%	
	0	0	1	16	**17**
The physical location(s) of Apprenticeship Program activities	58.8%	0.0%	5.9%	35.3%	
	10	0	1	6	**17**
The variety of STEM topics available to you in the Apprenticeship Program	11.8%	0.0%	41.2%	47.1%	
	2	0	7	8	**17**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Amount of stipend (payment)	0.0%	0.0%	0.0%	100.0%	
	0	0	0	17	**17**
Timeliness of receiving stipend (payment)	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
Research abstract preparation requirements	0.0%	0.0%	35.3%	64.7%	
	0	0	6	11	**17**

REAP apprentices were asked about their mentor availability (Table 112). All apprentices reported that their mentors were available more than half of the time (100%), and more than three-quarters (88%) reported that their mentors were always available.

Table 112. Apprentice Reports of Availability of Mentors (n=17)

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	0%	0
The mentor was available more than half of the time	11.8%	2
The mentor was always available	88.2%	15

Almost all REAP apprentices (94%-100%) reported being at least somewhat satisfied with all components of their research experience (Table 113). All REAP apprentices (100%) reported being at least somewhat satisfied with all components except their working relationship with the group/team (94%).

Table 113. Apprentice Satisfaction with Their Experience (n=17)

	Did not experience	Not at all	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	5.9%	94.1%	
	0	0	1	16	**17**
My working relationship with the group or team	5.9%	0.0%	29.4%	64.7%	
	1	0	5	11	**17**
The amount of time I spent doing meaningful research	0.0%	0.0%	17.6%	82.4%	
	0	0	3	14	**17**
The amount of time I spent with my research mentor	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**
The research experience overall	0.0%	0.0%	11.8%	88.2%	
	0	0	2	15	**17**

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 17 apprentices who responded to this question made positive comments. Apprentices who elaborated upon their satisfaction mentioned their learning, the STEM skills they developed, the mentoring they received, gaining career information, and the opportunity to develop communication skills as sources of their satisfaction. Apprentices said, for example, "*Overall, I greatly enjoyed [REAP]. I feel like I had a unique opportunity to learn things that my peers in high school wouldn't be able to learn until they were in college. I feel like my mentor did an excellent job teaching me about the research project my group completed. I am glad she chose the project for us to complete because the project included high-level concepts but wasn't too hard to understand. This experience helped me finally decide what I want to pursue in college and is the most realistic for my future career.*" (REAP Apprentice)

"I greatly enjoyed [REAP]. At first, I had reservations because I've never done research in general, but my mentor helped us all assimilate into the process and explained each step. Even though I didn't understand some of the more mathematical concepts, both my mentor and my peers helped when I was struggling. I also got experience in research and connections with STEM mentors…. Overall, this program exceeded my expectations, and I would definitely say I was satisfied." (REAP Apprentice)

Three apprentices made positive comments but included some caveats. These caveats included a comment about feeling overwhelmed and stressed and two comments expressing a wish that the program had been held in person rather than virtually. For example,

"Overall, I'm satisfied with my experience at [REAP]. Of course, if it was in person, it would have been better/ more in depth but I think it was really good for the situation. I learned a lot about the field of study and was able to experience the education process required to pursue such a career. I also gained new skills that I can use in the future and an interest in stem careers." (REAP Apprentice)

"Overall, I found it very stressful, but also useful. I was fairly overwhelmed a lot of the time, but that in itself was a useful experience, as I will be more prepared for similar feelings in college and work. I learned a lot and became much better at managing stress and heavy workloads. I would say I am fairly satisfied." (REAP Apprentice)

Apprentices participating in phone interviews also commented on their satisfaction with the virtual format of REAP. Those apprentices who provided feedback on the virtual format all made positive comments, although the consensus was that they would have liked to complete their apprenticeships in person. Apprentices made comments such as "it's going great" and "I'm enjoying it" in reference to the virtual format of the program. Although one apprentice indicated that she missed seeing her peers in person, she noted that the use of technology tools such as Slack kept her feeling connected to peers and mentors. This apprentice also noted that her REAP mentor held a minimum of two Zoom calls daily as well as communication through Slack and noted that "we're always in touch." Another apprentice noted that the apprenticeship was "more complicated" because of the technology platform used but added that it was going well overall and that his apprenticeship experience was "better than being at school."

Apprentices were also asked in an open-ended questionnaire item to list three benefits of participating in REAP. The 17 apprentices who responded cited a variety of benefits. The most frequently mentioned benefit was the career and/or college information apprentices gained during their apprenticeship (ten apprentices, or 59%). Nine apprentices (53%) noted that STEM learning was a benefit and seven (41%) noted each of the following benefits: gaining specific STEM skills or research skills; gaining real-world, hands-on experience; and networking with professors and mentors. Five apprentices (29%) cited an increased interest in or motivation for STEM as a benefit, and two apprentices (12%) mentioned teamwork and increases in their confidence as benefits of 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, specific STEM skills they acquired, and the opportunity to network with peers and mentors were benefits. These apprentices added that developing workplace skills, having fun, and having a structure to their summer schedules were benefits of participating in REAP. Apprentices said, for example,

> *"It's very intriguing to wake up every day and learn something new. I feel like I'm that excited to learn about whatever is in the STEM."* (REAP Apprentice)

> *"I found this as a really great opportunity for me to expand my research skills and learn more about research in general. I thought it was really cool that I could be paired with college professors. I've learned so much about how research is used in real life and how college professors do research."* (REAP Apprentice)

> *"We've actually had the opportunity to interact with the CEOs of [a] company and provide suggestions for them how to improve their program. That's been great [for] me. I've learned a lot of other things."* (REAP Apprentice)

> *"I feel like I've learned a lot [in REAP]. I've also learned how to work well with others. Working in groups is a struggle for me sometimes. My group, we really learned to communicate well together and to collaborate. I learned how to do proper scientific research."* (REAP Apprentice)

> *"My parents are from Guatemala. In my daily life, I don't actually meet a lot of people with Hispanic heritage. That's been missing.... [REAP] gave me the opportunity to make connections within an affinity group that I belong to that, in my regular life, I haven't really had the opportunity to have."* (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 15 apprentices who responded suggested a wide variety of potential program improvements, although none were mentioned by more than four apprentices (27%). The most frequently mentioned improvements, each mentioned by four apprentices, were to provide more interaction with other students; to provide more teaching or learning resources; and to improve communication from the program, including more timely communication and providing clearer instructions and guidelines. Three apprentices (20%) mentioned providing more topics and holding the program in person as ways to improve the program. Two apprentices (13%) suggested providing more interactions with mentors as an improvement and improving the website or application. No other improvement was mentioned by more than one apprentice (e.g., more hands-on content, larger stipend, more AEOP information, record online lessons).

Apprentices participating in phone interviews were also asked about potential program improvements. Most of these apprentices did not suggest improvements but made comments such as “having it back in person would be great.” The five apprentices who suggested improvements mentioned providing clearer information from the program about expectations, increasing interaction between apprentices or providing more opportunities for teamwork, providing information about topics and projects at the point of application, and providing more outreach. These apprentices said, for example,

> *“When I received the email, they didn't say what we were going to be learning…When I signed up, it was just very broad. It was an internship for STEM. I was confused as to what we're doing. I feel just more information [would be an improvement].”* (REAP Apprentice)
>
> *“When I was applying to REAP, I wasn't able to see which project I was going to be working on. I was only able to see the university. It would've been helpful [to see the project].”* (REAP Apprentice)
>
> *“[An improvement to REAP would be] a little more clarity in what was expected as the final deliverable, mostly for the students, but also for the guiding teachers...our advisor had a little bit of difficulty figuring out what exactly was expected of us.”* (REAP Apprentice)
>
> *“It would be cool to spread this information [about REAP] more…It would be interesting to a lot of students in my school. I wanted to talk to them about it. They had no idea what it was...Maybe send emails to teachers, and they can send it to their students.”* (REAP Apprentice)
>
> *“We got an email from the people from REAP saying we were going to have to write an abstract. A lot of us co-wrote it and we didn't hear anything about turning in an abstract.”* (REAP Apprentice)

REAP mentors were also asked questions about their satisfaction with program features (Table 114). Approximately two-thirds or more of mentors (64%-93%) noted they were at least somewhat satisfied with all features on the evaluation survey. The aspect REAP mentors were most satisfied (somewhat or very much) with was the research abstract preparation requirements (93%).

Table 114. Mentor Satisfaction with REAP Program Features (n=14)

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

Mentors were also asked to respond to open-ended items asking for their opinions about the program. Only eight mentors responded to an item asking them about their overall satisfaction with REAP, however seven of those had something positive to say. Mentors' comments focused on apprentices' learning and the fact that the program serves underrepresented students. One mentor said, for example,

> *"We are satisfied with our overall participation in the AEOP REAP program…Despite having to work remotely due to COVID, both apprentices learned research techniques and conducted work that contribute to larger ongoing projects in the lab…We look forward to continue being [a] REAP site and potentially participating in other AEOP programs in the future."* (REAP Mentor)

Two mentors made positive comments about REAP but also offered caveats. These caveats focused on the virtual format of the program and a request that the program include information about the types of research projects available at the point of application. These mentors said, *"COVID was exceptionally difficult, it was hard to work several hours each day via computer. However, when I think of the time that these great students could have lost by not participating, I'm glad we went forward. The project did have to take a big turn to go Virtual, but that drove me into a space where I had to learn along with the students, which is not always the case. The questions I asked were not as 'well baked' as usual, but I now have an added dimension of thought to work with…This program has a significant impact on students in my area, and by the program focusing on under-represented students, the impact is made even greater."* (REAP Mentor)

"Overall, everything went extremely well! We had a fabulous experience remotely hosting our two REAP apprentices this summer. Our greatest struggle is during the application process because the applicants aren't aware of the type of research we do. If they had the opportunity to know more about the type of STEM research conducted at each site, I think it would be better for helping applicants find excellent fits. Thank you!" (REAP Mentor)

One mentor did not make any positive comments about REAP, commenting that "this year personal interaction was very difficult. I'm hoping next year will be better."

One mentor who participated in a phone interview commented upon the virtual format of REAP. This mentor noted that he felt there was overall less interaction and less hands-on content, but that the apprenticeship went fairly well since their research is software-based.

Mentors were asked in an open-ended questionnaire item to identify the three most important strengths of REAP. The 14 mentors who responded cited a variety of program strengths. The most frequently cited strength was apprentices' opportunity to participate in real-life research (mentioned by eight mentors, or 57%). Six mentors (43%) mentioned STEM learning and students' exposure to STEM generally as a program strength, and five (36%) mentioned teamwork and the program stipends as strengths of REAP. Two mentors (14%) cited apprentices' opportunities to gain problem-solving skills as a benefit. No other benefit was mentioned by more than one mentor (e.g., program administrators, engagement of underserved students, the application process, apprentices' opportunities to connect with peers).

REAP mentors participating in phone interviews were asked to comment on the strengths of the program. Students' exposure to STEM and career information were cited as benefits for students, and the opportunity to work with high school students and practice mentoring skills was cited as benefits for mentors. For example,

"[REAP] will help [apprentices] to understand how we do [research] in real-life circumstances…It might inspire them also to pursue this kind of research." (REAP Mentor)

The 13 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 suggestion (5 mentors or 38%) focused on stipends, including suggestions for providing larger mentor and student stipends. Another four mentors (31%) suggested providing more time for recruiting, interviewing, and/or placing students in apprenticeships. Three mentors (23%) suggested each of the following improvements: having more involvement by sponsoring agencies (Battelle and the DoD) in the program. having students give presentations or write papers, providing more information about sites and projects at the point of application, and expanding the program to serve more students. Other improvements, mentioned by one or two mentors included providing more funding for supplies, having sites collaborate, streamlining communication, and providing more marketing tools.
One mentor participating in a phone interview also suggested that students be given information at application to choose the type of research they would be engaged in. He said,

> *"[An improvement to REAP would be to] have an option for students to choose what research they want to pursue during this apprentice program. Also, if they have an option to interact with a mentor beforehand, it will help both the mentors and supervisors and also the students to work better throughout the program. It will produce a better result in the end."* (REAP Mentor)

REAP apprentices reported on their project design input (Table 115). No apprentices independently designed their entire project. Slightly over half (53%) of apprentices reported having some input or choice in project design. Approximately 47% indicated that their mentor assigned them a project.

Table 115. Apprentice Input on Design of Their Project (n=17)

Choice	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	47.1%	8
I worked with my mentor to design a project	17.6%	3
I had a choice among various projects suggested by my mentor	11.8%	2
I worked with my mentor and members of a research team to design a project	23.5%	4
I designed the entire project on my own	0%	0
I worked on various projects for other mentors	0%	0

Apprentices indicated how they participated in research groups during REAP in response to a survey item (Table 116). Nearly half of REAP apprentices (47%) reported either working in a group on the same project or working on their own project in a shared space or closely connected with others. Only one apprentice (6%) said they worked alone or only with their research mentor.

Table 116. Apprentice Participation in a Research Group (n=17)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	5.9%	1

I worked with others in a shared laboratory or other space, but we worked on different projects	5.9%	1
I worked alone on my project and I met with others regularly for general reporting or discussion	35.3%	6
I worked alone on a project that was closely connected with projects of others in my group	5.9%	1
I worked with a group who all worked on the same project	47.0%	8

HSAP

Apprentices were asked about their satisfaction with HSAP program features (Table 117). Approximately two-thirds or more of HSAP apprentices (63%-100%) reported that they were at least somewhat satisfied with all program features listed. Features all HSAP apprentices reported being most satisfied with (somewhat or very much) included: applying or registering for the program (100%); the variety of STEM topics available (100%); the teaching/mentoring provided (100%); and the amount of the stipend (100%).

Table 117. Apprentice Satisfaction with HSAP Program Features (n=8)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**
Other administrative tasks (e.g., security clearances, issuing CAC cards)	37.5%	0.0%	25.0%	37.5%	
	3	0	2	3	**8**
Communicating with your host site organizers	12.5%	0.0%	25.0%	62.5%	
	1	0	2	5	**8**
The physical location(s) of Apprenticeship Program activities	37.5%	0.0%	25.0%	37.5%	
	3	0	2	3	**8**
The variety of STEM topics available to you in the Apprenticeship Program	0.0%	0.0%	50.0%	50.0%	
	0	0	4	4	**8**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**
Amount of stipend (payment)	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**
	0.0%	25.0%	25.0%	50.0%	

Timeliness of receiving stipend (payment)	0	2	2	4	**8**
Research abstract preparation requirements	12.5%	12.5%	37.5%	37.5%	
	1	1	3	3	**8**

Apprentices reported on the availability of their HSAP mentors (Table 118). All apprentices reported that their mentors were available more than half of the time (100%), and more than three-quarters (88%) reported their mentors were always available.

Table 118. Apprentice Reports of Availability of Mentors (n=8)

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	0%	0
The mentor was available more than half of the time	12.5%	1
The mentor was always available	87.5%	7

All HSAP apprentices (100%) indicated they were somewhat or very much satisfied with all elements of their research experience about which they were asked on the evaluation survey (Table 119). All apprentices were "very much" satisfied with their working relationship with their mentors.

Table 119. Apprentice Satisfaction with Their Experience (n=8)

	Did not experience	Not at all	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	0.0%	100.0%	
	0	0	0	8	**8**
My working relationship with the group or team	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**
The amount of time I spent doing meaningful research	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
The amount of time I spent with my research mentor	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**
The research experience overall	0.0%	0.0%	12.5%	87.5%	
	0	0	1	7	**8**

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

> *"I enjoyed [HSAP] very much. I learned skills and information that I would not have learned otherwise."* (HSAP Apprentice)

> *"I was very satisfied with [HSAP]. Even though the program has ended, I am able to continue the work that I have begun with my mentor and further the research done in the field."* (HSAP Apprentice)

One of the responding apprentices responded positively, but offered a caveat, noting that his experience would have been better if he had been able to contribute to a publishable paper. This apprentice said,

> *"Overall, I'm quite satisfied with my experience because of its independence and what I learned. One major improvement would be if I could help publish a paper, but otherwise this was a very positive experience."* (HSAP Apprentice)

Apprentices participating in phone interviews also commented positively on their experience with the virtual format of their apprenticeships. Some apprentices noted that their work was primarily computational, which lent itself well to the online format. Three of the apprentices noted that communication was more difficult virtually than in person, but most felt that their mentors were accessible. One apprentice commented that the virtual format did not accommodate interactions between apprentices well and that she would have liked more time for interactions between students and faculty and between students. As one apprentice noted,

> *"Having the apprenticeship online was obviously way, way better than not having it at all. I think if it were in person, it would have been easier for communication purposes. Also, everyone would have been able to make more progress, more quickly, just because in person communication is a lot more efficient." (HSAP Apprentice)*

In another open-ended item, apprentices were asked to list three benefits of HSAP. The eight apprentices who responded cited a variety of benefits. The most frequently mentioned benefit (mentioned by seven, or 88%) was the STEM skills and research skills apprentices gained. Five apprentices cited their STEM learning as a benefit, and three commented that the college and career information they received and the opportunity to connect with other students were benefits. Two apprentices cited the opportunity to work independently and the fun or interesting nature of the apprenticeship as benefits. No other benefit was mentioned by more than one apprentice (e.g., adapting to a new situation, problem-solving, confidence, the stipend).

Apprentices participating in interviews echoed these themes and also commented on the career information they gained, the seminars provided, and the writing and presentation skills they developed. One apprentice said, for example,

> *"[A benefit of HSAP] is just gaining some research skills and some general STEM knowledge. In the first couple of weeks of the program, we were in a learning stage where our mentors were giving us lectures and assignments related to some basic STEM stuff.... The next thing, which I think is probably the most valuable, is the research experience all the HSAP students get...Those were really unique experiences and I'm really grateful for that opportunity. It's rare to have the opportunity to work on something that's cutting edge like that. I'm pretty grateful for that."* (HSAP Apprentice)

HSAP apprentices were also asked, in an open-ended questionnaire item, to indicate three ways that the program could be improved. The eight apprentices who responded provided a variety of suggestions, however the most frequently mentioned suggestions had to do with communication from the program (mentioned by 4 apprentices, or 50%), including more communication and clearer abstract requirements. Three apprentices (38%) suggested allowing more time for applying STEM skills (e.g., coding, research) rather than mathematics instruction or other training. Two apprentices suggested having more seminars or speakers, and more input into the project design or more choices of topics. No other improvement was mentioned by more than one apprentice (e.g., larger network of professionals, teach presentation skills, larger stipend, more regular online meetings, more requirements for prerequisite skills).

Apprentices participating in interviews were also asked to suggest program improvements. Apprentices suggested having apprentices begin their research sooner, providing more opportunities for collaboration between students, and exposing apprentices to more than one professor's research. Apprentices said, for example,

> *"We did a lot of training. The first six weeks, with my particular program, we did a lot of almost lecture things, like, "Here's how you do this. Here's background information." I loved all that, because I love to learn. These last couple of weeks has been quickly trying to do our own research on our own project…Maybe implementing us choosing that and going through that a little sooner, so there's a more balance between our own research and still learning things from our mentors."* (HSAP Apprentice)

> *"I proposed to the faculty to have more collaboration between students, but they weren't able to incorporate that into the program. I feel like collaboration would have been better. After meeting in the morning for two hours, we just left and went back to our own little worlds. It would have been nice to talk and get to know the other students as well."* (HSAP Apprentice)

With the exception of two items, the one HSAP mentor responding to the evaluation survey indicated being somewhat or very much satisfied with program features (Table 120). This mentor indicated they had not experienced communication with RIT and he was only "a little" satisfied with the research presentation process.

Table 120. Mentor Satisfaction with HSAP Program Features (n=1)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Other administrative tasks (in-processing, network access, etc.)	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Communicating with Rochester Institute of Technology (RIT)	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
Communicating with program organizers	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Support for instruction or mentorship during program activities	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Amount of stipends for apprentices (payment)	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Timeliness of stipend payment to apprentices	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
Research abstract preparation requirements	0.0%	0.0%	0.0%	100.0%	0.0%	
	0	0	0	1	0	**1**
Research presentation process	0.0%	0.0%	100.0%	0.0%	0.0%	
	0	0	1	0	0	**1**

The one mentor who responded to the evaluation survey responded positively when asked about his satisfaction with HSAP. This mentor cited apprentices' learning, their ability to experience and understand research, and the confidence apprentices gained as sources of his satisfaction. This mentor said,

> *"The program this Summer 2020 was successful in introducing the concept of a `neural network' from a mathematical and coding perspective. Since the program was online, it involved more presentation on the part of the PI, as it was not easy to collaborate in real time. However, the students discussed their projects and assignments offline in teams via zoom or through slack, and*

I was pleased to see their progress. At the end, I felt there was real gain for them to see how a topic could be approached from a research point of view. I do think the students in finishing their high school senior year will take confidence from their participation and apply it to their future studies. I really enjoyed meeting virtually with the students 3 times a week for 6 weeks. I also feel the program in this time of Covid-19 helped serve as a way to advance when other in-person activities were cancelled. I would like to try again next summer, as an in-person program, and see how the increased communication will help with project goals. As it is, they were able to write a neural network from scratch, understanding the algorithm mathematically, and implementing in python. This was nontrivial." (HSAP Mentor)

Mentors who participated in phone interviews responded positively about the virtual format of HSAP for 2020. One mentor provided some specific details about his online mentoring strategies, saying that he created a virtual research syllabus, used virtual meeting tools such as WebEx, and held seminars each morning, allowing students to work independently in the afternoon. Another mentor commented,

"It was definitely a learning experience both for us, faculty, as well as the students…We ended up doing a pretty good mixture of having the students work in pairs as well as with their mentors and then having meetings with the entire group at least once a week"

Creating connections between students was the main challenge mentors cited regarding the online format. For example, one mentor said,

"The biggest challenge with [the virtual format of HSAP] is that, at least for our first time doing this, it was somewhat unavoidable that the students spent quite a bit of time working independently. This was definitely a challenge. Our students did rise to that challenge pretty well. On the positive side, we came up with some ways to have them interact more online. At our site, we had each student meeting online one on one with their mentors once a week. They met with their mentor's research group once a week in a lab meeting. Then we met all together with all the HSAP and URAP students from the site on Fridays, and we had career development workshops...I would leave the meeting, and I would leave the students in the WebEx chat so they could chat amongst themselves and build rapport as a cohort."

Mentors were asked to list three program strengths in another open-ended questionnaire item. The responding mentor listed the AEOP support for research, the website, and the ease of the application process as strengths of HSAP. Mentors participating in interviews noted benefits of HSAP both for apprentices and for themselves. These mentors commented that HSAP benefits apprentices by exposing them to STEM research, encouraging them to consider STEM careers, developing STEM skills, exposing them to academic settings. Mentors also commented that students' STEM learning generally is a benefit of the program. For example, *"[HSAP apprentices] enhanced their not only mathematical skill but computational skill, programming skills as well. Sometimes, they can also contribute to our research project. We had one student that coauthored a paper with us, which was published. We probably will have another student coauthor a paper this year as well."* (HSAP Mentor)

"I think these students in the future will definitely remember this experience. I think they learn more efficiently than they [do] in the school year for four years." (HSAP Mentor)

Mentors were asked in a questionnaire item about their suggestions for program improvement. The responding mentor suggested including more students if apprenticeships continue online and offering the apprenticeship course simultaneously with HSAP.

Mentors participating in phone interviews were also asked to suggest ways HSAP could be improved. These mentors suggested providing virtual seminars to connect apprentices across the country, expanding the program to include more students, creating a hybrid virtual/in person program, providing stipends for graduate student mentors, ensuring that sites receive information from the program in a timely fashion, and clarifying expectations for abstracts. For example,

"I think like my main suggestion would be to make sure the sites get all the information that they need to proceed with the program well in advance. The timeline was super short this year, so we had to gear up very quickly. The other thing was we heard that the students were supposed to prepare written abstracts at the end of the summer, but it was a little bit unclear what was the purpose of those. Where were they going to be sent? Who was going to read them, or what was the venue? More communication about what the expectations for that capstone assignment are would be good." (HSAP Mentor)

HSAP apprentices reported on their project design input (Table 121). One apprentice (13%) reported independently designing their entire project, and half (51%) indicated they had some input or choice in project design. Slightly over a third of apprentices (38%) reported they were assigned a project by their mentors.

Table 121. Apprentice Input on Design of Their Project (n=8)

Choice	Response Percent	Response Total
I did not have a project	0%	0
I was assigned a project by my mentor	37.5%	3
I worked with my mentor to design a project	12.5%	1
I had a choice among various projects suggested by my mentor	25.0%	2
I worked with my mentor and members of a research team to design a project	12.5%	1
I designed the entire project on my own	12.5%	1

I worked on various projects for other mentors	0%	0

In terms of research group participation during HSAP (Table 122), three-quarters of apprentices (75%) reported working alone but in close proximity to others. The other quarter (25%) indicated they worked with a group on the same project.

Table 122. Apprentice Participation in a Research Group (n=8)

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	0%	0
I worked alone on my project and I met with others regularly for general reporting or discussion	25.0%	2
I worked alone on a project that was closely connected with projects of others in my group	50.0%	4
I work with a group who all worked on the same project	25.0%	2

URAP

Apprentices were asked to rate their level of satisfaction with various URAP program features (Table 123). Three-quarters or more of URAP apprentices (75%-100%) reported being at least somewhat satisfied with all program features listed except for physical location (50% did not experience, 50% somewhat/very much satisfied). Features that all apprentices were satisfied with were the application/registration for program (100%) and the variety of STEM topics available (100%).

Table 123. Apprentice Satisfaction with URAP Program Features (n=16)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	50.0%	50.0%	
	0	0	8	8	**16**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	25.0%	0.0%	50.0%	25.0%	
	4	0	8	4	**16**
Communicating with your host site organizers	12.5%	0.0%	25.0%	62.5%	
	2	0	4	10	**16**
The physical location(s) of Apprenticeship Program activities	50.0%	0.0%	12.5%	37.5%	
	8	0	2	6	**16**
	0.0%	0.0%	25.0%	75.0%	

The variety of STEM topics available to you in the Apprenticeship Program	0	0	4	12	**16**
Teaching or mentoring provided during Apprenticeship Program activities	6.3%	0.0%	6.3%	87.5%	
	1	0	1	14	**16**
Amount of stipend (payment)	6.3%	0.0%	25.0%	68.8%	
	1	0	4	11	**16**
Timeliness of receiving stipend (payment)	12.5%	12.5%	12.5%	62.5%	
	2	2	2	10	**16**
Research abstract preparation requirements	6.3%	0.0%	56.3%	37.5%	
	1	0	9	6	**16**

Apprentices reported on their URAP mentors' availability (Table 124). Nearly all apprentices indicated that their mentors were available at least half of the time (94%), and more than two-thirds (69%) responded that their mentors were always available.

Table 124. Apprentice Reports of Availability of Mentors (n=16)

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	6.3%	1
The mentor was available about half of the time of my project	6.3%	1
The mentor was available more than half of the time	18.7%	3
The mentor was always available	68.7%	11

All responding URAP apprentices reported high levels of satisfaction (somewhat or very much) for each aspect of their research experience (Table 125).

Table 125. Apprentice Satisfaction with Their Experience (n=16)

	Did not experience	Not at all	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	12.5%	87.5%	
	0	0	2	14	**16**
My working relationship with the group or team	0.0%	0.0%	6.3%	93.8%	
	0	0	1	15	**16**

The amount of time I spent doing meaningful research	0.0%	0.0%	12.5%	87.5%	
	0	0	2	14	**16**
The amount of time I spent with my research mentor	0.0%	0.0%	12.5%	87.5%	
	0	0	2	14	**16**
The research experience overall	0.0%	0.0%	0.0%	100.0%	
	0	0	0	16	**16**

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 16 who provided responses to this question made positive comments about their URAP experiences. Apprentices who provided details cited mentioned their learning and acquisition of STEM skills, their mentors, the opportunity to network, being able to work as part of a team, and the opportunity to present as sources of their satisfaction. Apprentices made the following comments, for example:

> *"Overall, I enjoy my experience [URAP]; it is an experience that I hope everyone could have at least once. With the Apprenticeship Program, I was able to work with a knowledgeable mentor in the exciting field of machine learning and in a communicative team. Throughout my experience, I learned the joy and struggle of doing research, met several STEM researchers, and was ultimately inspired to further my education."* (URAP Apprentice)

> *"I enjoyed my experience with [URAP]! I was able to learn a lot, including writing, presenting, and other technical STEM skills. I was able to communicate with my mentor every day, sometimes multiple times a day, and participate in professional meetings with other researchers. I also got the chance to present my research to a symposium and also to a conference. I was given a lot of opportunities through the Apprenticeship Program to learn and develop skills."* (URAP Apprentice)

> *"I was extremely satisfied with my experience. I learned a lot about working together with a team on research and I learned a lot about computational sciences. I look forward to connecting with the team after the apprenticeship and to how the project will go."* (URAP Apprentice)

Two apprentices made positive comments about the program but also offered caveats. These caveats were focused on pandemic-related issues such as delays in funding and work changes, and lack of communication from the program and AEOP. These apprentices said,

> *"Overall, I have been satisfied with my experience. A lot of the issues I saw (funding delayed, work changes, timelines) were all related to the pandemic, and I think that given everything this program went about as smoothly as could be expected. I think that my mentor did a great job adapting to the online setup and providing us with a reasonable, useful, and interesting project*

that could be completed remotely. I would definitely complete this program again (hopefully in person)."(URAP Apprentice)

"Really enjoyed the lab, never heard much from URAP or AEOP personnel though." (URAP Apprentice)

Apprentices participating in phone interviews also commented upon their satisfaction with the virtual format of the program. All apprentices made positive comments about the online format, and many expressed gratitude that they were able to complete their apprenticeships and appreciation for their mentors' work in transitioning the program to a virtual format. While most apprentices noted that they would have preferred to complete their apprenticeships on site, they reported feeling engaged with the research process. Apprentices said, for example,

"[I have] still have been having a lot of communication and contact with my [URAP] mentor and the entire lab. I've still been able to engage with the lab environment. Maybe not in the most traditional way that would happen, if this happened last year, but I think I've still been engaging with the lab and learning a lot about the whole research process and what goes behind it." (URAP Apprentice)

"[The virtual format of URAP was] really good...Honestly, coming off of half of the semester of online classes, my expectations were not too high, but it's been really nice." (URAP Apprentice)

The ability to communicate regularly with mentors and be able to ask questions was a theme of apprentices' comments. For example, apprentices commented,

"My mentor has been quite phenomenal for me. He is just been on top of everything. He responds to questions and emails very, very quick. The transition online for him, I think, has been very seamless." (URAP Apprentice)

"[A regular meeting schedule made it easy for me to just be there and be aware of what's happening. Instead of doing everything by myself, I had my group to ask questions [to] and be present." (URAP Apprentice)

Likewise, another apprentice reported that he participated in a "very pleasant" video chat once each week and "communicated through email extensively." One apprentice noted that he found advantages in the online format, commenting,

"I liked the accessibility of having everything online as you can communicate and receive feedback from your mentor anytime, anywhere." (URAP Apprentice)

One apprentice noted that he had difficulty asking questions and difficulty connecting with other members of his research team. This apprentice suggested that having more contact with his mentor and team by video would have improved his experience.

Apprentices were asked in another open-ended questionnaire item to list three benefits of URAP. The 16 apprentices who responded mentioned a variety of benefits. The most frequently cited benefit, mentioned by 11 apprentices (69%) was the value of the networking opportunities and their relationships with their mentors. Ten apprentices (63%) cited the research experience and skills they gained as a benefit while seven (44%) cited their STEM learning generally. Four apprentices (25%) commented upon the career information they received and three (19%) commented that the stipend was a benefit of URAP. Two apprentices (13%) mentioned each of the following as benefits: communication skills, technical or professional writing skills, increases in motivation for or interest in STEM, and connections to peers. No other benefit was mentioned by more than one apprentice (e.g., teamwork, problem solving, presentation skills).

URAP apprentices participating in interviews were also asked to reflect on the benefits of participation in URAP. Participants' comments echoed the themes mentioned above. These apprentices also noted the value of the personalized attention they received in the program, opportunities to work independently, the preparation for graduate school the program provided, and the perseverance they developed. Apprentices said, for example,

> *"I definitely learned a lot about how a lot of research actually is the planning aspect of it and the analysis aspect of it...Even though I might not be able to in the lab, I do genuinely think my understanding of… concepts has definitely increased. Week after week, I am learning something new."* (URAP Apprentice)
>
> *"The biggest benefit would be that I can, hopefully, begin a network with the DoD and with the AEOP Program. I get to put it on my resume, which is something that I value. I get to discuss in further research of what I'm doing."* (URAP Apprentice)
>
> *"I learned how to deal with conducting mostly independent work, while also collaborating with others...I also learned a lot of scientific presenting and writing skills… and certainly got more interested in a future career in this area."* (URAP Apprentice)
>
> *It's been really cool being a part of URAP. I feel like they've been genuinely more interested in the students who are participating than a lot of different research or programs tend to be."* (URAP Apprentice)

Apprentices were also asked in an open-ended question to list three ways in which URAP could be improved. The 16 apprentices who responded offered a variety of suggestions for improvement. The most frequently mentioned improvements were related to communication with the program (mentioned by 7 apprentices, or 44%), and included suggestions for more frequent communication and more communication about guidelines and requirements. Five apprentices (31%) suggested that the program provide more career information, and four (25%) suggested providing more interactions between apprentices. Three apprentices (19%) suggested providing ways for apprentices to share their work with others or for apprentices to learn about others' research and three suggested improvements to the stipend (paying in a timely manner, paying it bi-weekly, and providing clarity about the stipend). Two apprentices (13%) suggested each of the following: more communication with mentors, more time for research (less training), and providing more structure to apprentices' research. No other improvement was mentioned by more than one apprentice (e.g., more opportunities to network with DoD, more AEOP information, more research topics to choose from).

Apprentices participating in interviews were also asked for their ideas about how URAP could be improved. Six of these apprentices had no suggestions. Those that made suggestions commented on the following:

- emailing a list of AEOP webinars in advance so that apprentices can plan, and emailing changes in webinar topics in advance
- providing more group activities or opportunities for collaboration
- providing more interaction with other mentors and participants
- allowing more time for research, or a longer program
- providing more career information
- providing an orientation course "describing details or ways to fully optimize their URAP experience and their internship/apprenticeship."

Apprentices' comments indicated that they placed primary value on being connected to both their mentors and other apprentices. As one apprentice said,

> *"I would like it more if there was more group activities. Or, where there were more options where other participants could work together to produce a project, or presentation, or something like that."* (URAP Apprentice)

More than three-quarters of URAP mentors (80%-90%) indicated they were at least somewhat satisfied with all program components they experienced (Table 126) except for communicating with RIT (60% somewhat or very much satisfied, 40% had not experienced). Program features mentors reported being most satisfied with (somewhat or very much) were the timeliness of stipend payment to apprentices (90%); research abstract preparation requirements (90%); and research presentation process (90%).

Table 126. Mentor Satisfaction with URAP Program Features (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	20.0%	0.0%	0.0%	20.0%	60.0%	
	2	0	0	2	6	**10**
Other administrative tasks (in-processing, network access, etc.)	20.0%	0.0%	0.0%	30.0%	50.0%	
	2	0	0	3	5	**10**
Communicating with Rochester Institute of Technology (RIT)	40.0%	0.0%	0.0%	30.0%	30.0%	
	4	0	0	3	3	**10**
Communicating with program organizers	20.0%	0.0%	0.0%	20.0%	60.0%	
	2	0	0	2	6	**10**
Support for instruction or mentorship during program activities	20.0%	0.0%	0.0%	30.0%	50.0%	
	2	0	0	3	5	**10**
Amount of stipends for apprentices (payment)	10.0%	0.0%	10.0%	30.0%	50.0%	
	1	0	1	3	5	**10**
Timeliness of stipend payment to apprentices	10.0%	0.0%	0.0%	10.0%	80.0%	
	1	0	0	1	8	**10**
Research abstract preparation requirements	10.0%	0.0%	0.0%	30.0%	60.0%	
	1	0	0	3	6	**10**
Research presentation process	10.0%	0.0%	0.0%	50.0%	40.0%	
	1	0	0	5	4	**10**

Like apprentices, URAP mentors were asked to reflect on their overall satisfaction with URAP in an open-ended questionnaire item. All eight mentors who responded made positive comments about their satisfaction with URAP. Mentors expressed satisfaction with the quality of the URAP apprentices, the mentoring experience generally, the career information apprentices received, apprentices' learning, and the apprentice stipend. For example,

> *"AEOP provided funds to work with talented students that helped further the broader research goals. The teaching and interaction with students helped hone our ideas, and we ended up learning from the students as well."* (URAP Mentor)

> *"Generally speaking, I am very satisfied with [the URAP] apprenticeship program. It is a great opportunity for undergraduate students to gain real-world research experience. It also helps*

motivate undergraduate students in their decision making of future career development." (URAP Mentor)

"I think that this was a great program for the undergraduate researcher. It also allowed for flexibility in how we mentored the students, with good guidelines on how to best mentor my research student." (URAP Mentor)

Mentors participating in phone interviews who commented on the virtual format of URAP were positive about the experience. These mentors noted a variety of ways they engaged with students, including holding daily or biweekly meetings, giving students regular feedback, and having daily discussions using videoconferencing. One mentor noted that the biggest challenge was formulating ways for apprentices to interact with one another online. As one mentor said,

"This summer, I'm glad that we were able to do anything at all. In the end, it turned out pretty decent." (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 ten mentors who responded was apprentices' exposure to research and the research experience they gain (mentioned by 5 mentors, or 50%). Three mentors (30%) noted that the opportunity to work with talented students was a strength of URAP, and three commented on the value to students of participating in a DoD program and receiving information about the DoD. Two mentors (20%) cited each of the following as strengths of URAP: the mentoring opportunity, the program's focus on undergraduate students, collaborative learning, and apprentice stipends). No other strength was mentioned by more than one mentor (e.g., apprentices' opportunity to develop workplace skills, developing scientific communication skills, minimal reporting requirements).

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 resume builder, the opportunity to gain 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 apprentices'] mathematical skills and their programming skills, computer science knowledge [were] enhanced a great deal during this two or three months period of time." (URAP Mentor)

"[Benefits of URAP are] the communication with a graduate student-professor in the college, in the universities and also, the peer communication." (URAP Mentor)

"[URAP] is very directly related to what [apprentices are] studying in their majors. It's more immediately useful and applicable for them...For example, I think some of the students whose

majors were in physics or engineering and had taken a lot of coursework and knew a lot of the theory, this was their first time doing a research project or something where they got to see the results of what they were working on and getting to develop their problem solving skills...and then also gaining familiarity with research and giving them that perspective on, 'Do I want to continue on in grad school? Would I like to do some type of research work after I graduate?'" (URAP Mentor)

"In terms of personal and professional growth, thinking capability, how to work with others, people in multidisciplinary teams, how to improve their communication or presentation skills, [URAP] is really important if someone wants to go to academia or industry. Within these few weeks I see significant improvement in each student." (URAP Mentor)

Mentors also noted that URAP had benefits for them personally. Mentors cited the satisfaction they gain from seeing apprentices accomplish their goals, the assistance apprentices provide in the lab, the opportunity to work with talented students, and the challenge of identifying productive activities for apprentices' online work. One mentor commented on the synergistic benefits of URAP, saying,

"I can assign a small task from my research to the students. They will work on that small task. In one way, they will practice their knowledge and learn the real-hand experience in research. In the other hand, if they are successful, they can also accomplish a research goal that is part of my life, so I can also benefit from their accomplishment." (URAP Mentor)

The questionnaire also asked mentors to note three ways in which URAP could be improved for future participants. The seven mentors who responded offered a wide variety of suggestions, none mentioned by more than two mentors. The most frequently mentioned improvements were to provide more outreach or advertising to increase the number of applicants, to provide opportunities for apprentices to present their research, and to extend the program's length (e.g., through the school year). No other improvement was suggested by more than one mentor (e.g., provide a summary of all AEOP students' projects, connect students to DoD labs or industry, provide financial assistance with moving expenses and/or travel, increase interaction between students, higher apprentice stipend, provide mentor stipend).

Mentors participating in interviews were also asked to share their ideas about ways that URAP could be improved. These mentors suggested offering more seminars for apprentices, providing information about DoD fellowship opportunities, featuring alumni on social media, beginning the application process sooner, communicating more effectively about apprentices' abstracts, extending the program throughout the school year, providing an early orientation for apprentices, providing more outreach to increase the pool of applicants, and creating hybrid apprenticeships. For example, mentors said,

"[The application and registration process] should be done by March. [Then apprentices will] know that they are recruited, and they are in the program at least two months before, so they plan, and not [at] the last minute…All the communications, all the paperwork, everything should be completed by middle of March." (URAP Mentor)

"I would like the duration of the program to be longer rather than having four weeks or five weeks, which will not actually help them to explore a lot. At least two months program would actually benefit students. If you're thinking about research, you cannot learn research or do research in two weeks or three weeks." (URAP Mentor)

"This year, I only have one candidate… [An improvement would be] If we have [a larger] number of…undergraduate student candidates I can select from. If the ARO will give us the demographic information. We can also encourage underrepresented minority students to join." (URAP Mentor)

URAP apprentices reported on their project design input level (Table 127). While approximately a third of apprentices (31%) were assigned their project by their mentor, more than two-thirds of apprentices indicated they had some level of choice or design responsibility (69%).

Table 127. Apprentice Input on Design of Their Project (n=16)

Choice	Response Percent	Response Total
I did not have a project	0.%	0
I was assigned a project by my mentor	31.3%	5
I worked with my mentor to design a project	18.8%	3
I had a choice among various projects suggested by my mentor	37.4%	6
I worked with my mentor and members of a research team to design a project	12.5%	2
I designed the entire project on my own	0%	0
I worked on various projects for other mentors	0%	0

Apprentices were also asked about their participation in research groups during URAP (Table 128). Half of apprentices (50%) said they worked alone but nearby others in terms of workspace, and only one (6%) reported working entirely alone or only with their mentor. Close to half of apprentices (44%) indicated they worked with a group on the same project.

Table 128. Apprentice Participation in a Research Group (n=16)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	6.3%	1
I worked with others in a shared laboratory or other space, but we work on different projects	6.3%	1
I worked alone on my project and I met with others regularly for general reporting or discussion	25.0%	4
I worked alone on a project that was closely connected with projects of others in my group	18.7%	3
I work with a group who all worked on the same project	43.7%	7

7

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 noted multiple sources that helped them to learn about AEOP (Table 129). The most frequently selected sources of information (selected by more than a third of apprentices) were: someone who works with the DoD (42%); someone who works with the program (38%); and past participants of the program (38%). CQL mentors were also asked how they learned about AEOP (Table 130). Half (50%) reported that they learned about AEOP from a past participant.

Table 129. How Apprentices Learned About AEOP (n=45)*

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	15.6%	7
AEOP on Facebook, Twitter, Instagram, or other social media	0.0%	0
School or university newsletter, email, or website	11.1%	5
Past participant of program	37.8%	17
Friend	13.3%	6
Family Member	17.8%	8
Someone who works at the school or university I attend	28.9%	13
Someone who works with the program	37.8%	17

Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	42.2%	19
Community group or program	0%	0
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

Table 130. How Mentors Learned About AEOP (n=6)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	0%	0
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	16.7%	1
An email or newsletter from school, university, or a professional organization	16.7%	1
Past participant	50.0%	3
A student	0%	0
A colleague	16.7%	1
My supervisor or superior	16.7%	1
An AEOP site host or director	0%	0
Workplace communications	33.3%	2
Someone who works with the Department of Defense (Army, Navy, Air Force)	0%	0
Other, (specify):	0%	0

Factors motivating apprentices to participate in CQL varied widely (Table 131). The most frequently selected motivators were related to apprentice educational interests and learning, including the following: the desire to learn something new/interesting (58%); interest in STEM (56%); and the desire to expand laboratory/research skills (53%).

Table 131. Factors Motivating Apprentices to Participate in CQL (n=45)*

	Response Percent	Response Total
Teacher or professor encouragement	15.6%	7
An academic requirement or school grade	4.4%	2
Desire to learn something new or interesting	57.8%	26
The mentor(s)	44.4%	20
Building college application or résumé	24.4%	11

Networking opportunities	44.4%	20
Interest in science, technology, engineering, or mathematics (STEM)	55.6%	25
Interest in STEM careers with the Army	42.2%	19
Having fun	24.4%	11
Earning stipends or awards for doing STEM	20.0%	9
Opportunity to do something with friends	8.9%	4
Opportunity to use advanced laboratory technology	40.0%	18
Desire to expand laboratory or research skills	53.3%	24
Learning in ways that are not possible in school	40.0%	18
Serving the community or country	42.2%	19
Exploring a unique work environment	24.4%	11
Figuring out education or career goals	37.8%	17
Seeing how school learning applies to real life	26.7%	12
Recommendations of past participants	11.1%	5
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

CQL apprentices participating in interviews 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 that their college or university required cooperative learning experiences, while others cited the need to make money and the opportunity to explore options for working with the DoD.

Mentors were asked how apprentices were recruited for CQL (Table 132). Half of mentors (50%) noted they believed it was through either application from RIT/AEOP or through their colleague(s) in their workplace.

Table 132. Mentor Reports of Recruitment Strategies (n=6)

	Response Percent	Response Total
Applications from Rochester Institute of Technology (RIT) or the AEOP	50.0%	3
Personal acquaintance(s) (friend, family, neighbor, etc.)	33.3%	2
Colleague(s) in my workplace	50.0%	3
K-12 schoolteacher(s) outside of my workplace	0%	0
University faculty outside of my workplace	16.7%	1
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)	16.7%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	16.7%	1
STEM or STEM Education conference(s) or event(s)	16.7%	1
Organization(s) that serve underserved or underrepresented populations	16.7%	1
The student contacted me (the mentor) about the program	16.7%	1
I do not know how student(s) were recruited for CQL	0%	0
Other, (specify):	16.7%	1

SEAP

SEAP apprentices noted multiple sources of information about AEOP (Table 133). The most frequently selected sources of information (selected by two of the three apprentices completing the survey) were the AEOP website (67%) and friends (67%). SEAP mentors were also asked how they learned about AEOP (Table 134). All three responding mentors (100%) indicated they learned about AEOP from past participants.

Table 133. How Participants Learned About AEOP (n=3)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	66.7%	2
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	0%	0
Past participant of program	0%	0
Friend	66.7%	2
Family Member	33.3%	1
Someone who works at the school or university I attend	0%	0
Someone who works with the program	33.3%	1
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	33.3%	1
Community group or program	0%	0
Choose Not to Report	0%	0

Table 134. How Mentors Learned About AEOP (n=3)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	0%	0
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	33.3%	1
Past participant	100%	3
A student	0%	0
A colleague	0%	0
My supervisor or superior	33.3%	1
An AEOP site host or director	0%	0
Workplace communications	33.3%	1
Someone who works with the Department of Defense (Army, Navy, Air Force)	33.3%	1
Other, (specify):	0%	0

SEAP apprentices were asked what factors motivated them to participate in their program. (Table 135). Motivators selected most frequently (two or three apprentices) for participating in SEAP were related to their educational interests and learning: interest in STEM (100%); the desire to learn something new/interesting (67%); and learning in ways not possible in school (67%).

Table 135. Factors Motivating Apprentices to Participate in SEAP (n=3)

	Response Percent	Response Total
Teacher or professor encouragement	0%	0
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	66.7%	2
The mentor(s)	0%	0
Building college application or résumé	0%	0
Networking opportunities	0%	0
Interest in science, technology, engineering, or mathematics (STEM)	100%	3
Interest in STEM careers with the Army	0%	0
Having fun	0%	0
Earning stipends or awards for doing STEM	0%	0

Opportunity to do something with friends	0%	0
Opportunity to use advanced laboratory technology	33.3%	1
Desire to expand laboratory or research skills	33.3%	1
Learning in ways that are not possible in school	66.7%	2
Serving the community or country	33.3%	1
Exploring a unique work environment	33.3%	1
Figuring out education or career goals	0%	0
Seeing how school learning applies to real life	0%	0
Recommendations of past participants	0%	0
Choose Not to Report	0%	0

Apprentices participating in interviews were asked about their reasons for participating in SEAP. These apprentices noted their interest in research, the opportunity to gain research experience, participating as a part of a required school internship, and one student reported being encouraged to apply by a mentor who she had worked with previously.

SEAP mentors were asked how they believed their apprentices were recruited for the program (Table 136). All three mentors did not agree on any one strategy, but two of the three (67%) reported it was because of applications to RIT/AEOP.

Table 136. Mentor Reports of Strategies Used to Recruit Apprentices (n = 3)

	Response Percent	Response Total
Applications from Rochester Institute of Technology (RIT) or the AEOP	66.7%	2
Personal acquaintance(s) (friend, family, neighbor, etc.)	0%	0
Colleague(s) in my workplace	0%	0
K-12 school teacher(s) outside of my workplace	33.3%	1
University faculty outside of my workplace	0%	0
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)	0%	0
Communication(s) generated by a university or faculty (newsletter, email blast, website)	0%	0
STEM or STEM Education conference(s) or event(s)	0%	0
Organization(s) that serve underserved or underrepresented populations	0%	0
The student contacted me (the mentor) about the program	0%	0

I do not know how student(s) were recruited for CQL	33.3%	1
Other, (specify):	0%	0

How Participants Found out About AEOP – University-Based Programs

REAP

REAP apprentices mentioned numerous ways they learned about AEOP (Table 137). Three sources were noted by nearly a third or more of apprentices: the AEOP website (38%); past participant (31%); and family member (33%). Mentors were also asked how they learned about AEOP (Table 138). While a variety of sources were noted, half (50%) mentioned the AEOP website.

Table 137. How Apprentices Learned about AEOP (n=16)*

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	37.5%	6
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	25.0%	4
Past participant of program	31.3%	5
Friend	18.8%	3
Family Member	31.3%	5
Someone who works at the school or university I attend	12.5%	2
Someone who works with the program	18.8%	3
Someone who works with the Department of Defense (Army, Navy,	0%	0
Community group or program	0%	0
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

Table 138. How Mentors Learned about AEOP (n=14)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	50.0%	7
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	14.3%	2
A student	0%	0

A colleague	21.4%	3
My supervisor or superior	21.4%	3
An AEOP site host or director	0%	0
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	21.4%	3
Other, (specify):	7.1%	1

Apprentices indicated factors that motivated them to participate in REAP (Table 139). Half or more of apprentices reported motivators related to their personal educational interests and learning: interest in STEM (81%) and the desire to expand laboratory/research skills (50%).

Table 139. Factors Motivating Apprentices to Participate in REAP (n=16)*

Choice	Response Percent	Response Total
Teacher or professor encouragement	12.5%	2
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	37.5%	6
The mentor(s)	12.5%	2
Building college application or résumé	25.0%	4
Networking opportunities	12.5%	2
Interest in science, technology, engineering, or mathematics (STEM)	81.3%	13
Interest in STEM careers with the Army	12.5%	2
Having fun	6.3%	1
Earning stipends or awards for doing STEM	12.5%	2
Opportunity to do something with friends	0%	0
Opportunity to use advanced laboratory technology	31.3%	5
Desire to expand laboratory or research skills	50.0%	8
Learning in ways that are not possible in school	37.5%	6
Serving the community or country	18.8%	3
Exploring a unique work environment	25.0%	4
Figuring out education or career goals	18.8%	3
Seeing how school learning applies to real life	6.3%	1
Recommendations of past participants	0%	0
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

The REAP apprentices who participated in interviews also cited their desire for learning and hands-on research experiences as motivators for their participation. These apprentices added that the opportunity to gain information to guide their choices in college courses and the opportunity to have fun motivated them to participate. One apprentice said, for example,

> *"I continuously want to learn. Especially during this time when the school is closed, I want to be prepared going in, not only for next year, but when I start college. I hope that the information I learned will help prepare me."* (REAP Apprentice)

Mentors were asked how they believed their apprentices were recruited for REAP (Table 140). The most commonly reported recruitment strategy was through applications from RIT/AEOP (71%). Slightly over a third (36%) of mentors also noted K-12 teachers outside of their workplace as an influential source.

Table 140. Mentor Reports of Recruitment Strategies (n=14)

Choice	Response Percent	Response Total
Applications from Rochester Institute of Technology (RIT) or the AEOP	71.4%	10
Personal acquaintance(s) (friend, family, neighbor, etc.)	14.3%	2
Colleague(s) in my workplace	7.1%	1
K-12 school teacher(s) outside of my workplace	35.7%	5
University faculty outside of my workplace	0%	0
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)	7.1%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	21.4%	3
STEM or STEM Education conference(s) or event(s)	0%	0
Organization(s) that serve underserved or underrepresented populations	14.3%	2
The student contacted me (the mentor) about the program	21.4%	3
I do not know how student(s) were recruited for the program	21.4%	3
Other, (specify):	0%	0

HSAP

HSAP apprentices mentioned multiple ways that they had learned about AEOP (Table 141). The two most frequently selected sources, selected by half of apprentices (50%), were the AEOP website and someone who works at the school they attend.

Table 141. How Apprentices Learned About AEOP (n=8)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	50.0%	4
AEOP on Facebook, Twitter, Instagram, or other social media	0.0%	0
School or university newsletter, email, or website	25.0%	2
Past participant of program	0.0%	0
Friend	0.0%	0
Family Member	0.0%	0
Someone who works at the school or university I attend	50.0%	4
Someone who works with the program	12.5%	1
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.0%	0
Community group or program	0.0%	0
Choose Not to Report	0.0%	0

Mentors were also asked how they learned about AEOP (Table 142). Only one mentor responded to this item and he reported that he learned about AEOP from a supervisor and an AEOP site host/director.

Table 142. How Mentors Learned About AEOP (n=1)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	0%	0
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	0%	0
An email or newsletter from school, university, or a professional organization	0%	0
Past participant	0%	0
A student	0%	0
A colleague	0%	0
My supervisor or superior	100%	1
An AEOP site host or director	100%	1
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	0%	0
Other, (specify):	0%	0

HSAP apprentices reported factors that motivated them to participate in their program (Table 143). The most commonly noted motivators were related to apprentices' educational interests and learning.

Approximately two-thirds or more of apprentices selected interest in STEM (75%), the desire to learn something new/interesting (63%); and the desire to expand laboratory/research skills (63%) as motivating factors for their participation in HSAP.

Table 143. Factors Motivating Apprentice Participation in HSAP (n=8)

Choice	Response Percent	Response Total
Teacher or professor encouragement	12.5%	1
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	62.5%	5
The mentor(s)	12.5%	1
Building college application or résumé	12.5%	1
Networking opportunities	0%	0
Interest in science, technology, engineering, or mathematics (STEM)	75.0%	6
Interest in STEM careers with the Army	12.5%	1
Having fun	0%	0
Earning stipends or awards for doing STEM	0%	0
Opportunity to do something with friends	0%	0
Opportunity to use advanced laboratory technology	0%	0
Desire to expand laboratory or research skills	62.5%	5
Learning in ways that are not possible in school	25.0%	2
Serving the community or country	37.5%	3
Exploring a unique work environment	25.0%	2
Figuring out education or career goals	12.5%	1
Seeing how school learning applies to real life	0%	0
Recommendations of past participants	0%	0
Choose Not to Report	0%	0

Apprentices participating in interviews reported learning about HSAP primarily either through personal connections (e.g., a father's coworker) or from online searches. These apprentices cited their interest in STEM, the desire to participate in hands-on research, the opportunity to gain information for college major decisions, the desire for a productive summer activity, and the opportunity to make connections in the Army and university as motivators for participating in HSAP. Apprentices said, for example,

> *"I liked how it was through the army, but it was also partnering with a university, and that I could get that experience with working with professors and with other college or graduate students all in one experience."* (HSAP Apprentice)

Mentors were asked how they believed apprentices were recruited for HSAP (Table 144). The one responding mentor reported four recruitment strategies: applications from RIT/AEOP; K-12 teachers outside of their workplace; informational materials sent to K-12 schools outside their workplace; and communications generated by a K-12 school or teacher.

Table 144. Mentor Reports of Recruitment Strategies (n=1)

Choice	Response Percent	Response Total
Applications from Rochester Institute of Technology (RIT) or the AEOP	100%	1
Personal acquaintance(s) (friend, family, neighbor, etc.)	0%	0
Colleague(s) in my workplace	0%	0
K-12 school teacher(s) outside of my workplace	100%	1
University faculty outside of my workplace	0%	0
Informational materials sent to K-12 schools or Universities outside of my workplace	100%	1
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	100%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	0%	0
STEM or STEM Education conference(s) or event(s)	0%	0
Organization(s) that serve underserved or underrepresented populations	0%	0
The student contacted me (the mentor) about the program	0%	0
I do not know how student(s) were recruited for the program	0%	0
Other, (specify):	0%	0

URAP

URAP apprentices selected multiple sources from which they had learned about AEOP (Table 145). Nearly all apprentices selected someone who works at the school/university they attend (83%). A quarter of the responding apprentices (25%) also indicated that they had learned about AEOP from someone who works with the program.

Table 145. How Apprentices Learned About AEOP (n=12)*

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0%	0
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0

School or university newsletter, email, or website	16.7%	2
Past participant of program	16.7%	2
Friend	16.7%	2
Family Member	0%	0
Someone who works at the school or university I attend	83.3%	10
Someone who works with the program	25.0%	3
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	8.3%	1
Community group or program	8.3%	1
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

Mentors were also asked how they learned about AEOP (Table 146). The two most commonly selected responses were their supervisor/superior (30%) and someone who works with the DoD (30%).

Table 146. How Mentors Learned About AEOP (n=10)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) website	20.0%	2
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	0%	0
An email or newsletter from school, university, or a professional organization	0%	0
Past participant	20.0%	2
A student	10.0%	1
A colleague	20.0%	2
My supervisor or superior	30.0%	3
An AEOP site host or director	20.0%	2
Workplace communications	0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force)	30.0%	3
Other, (specify):	10.0%	1

URAP apprentices reported on factors that motivated them to participate in their program (Table 147). The most commonly reported motivators for participating in URAP were related to apprentices' personal educational interests and learning. Half or more of apprentices noted they were motivated to participate in URAP because of a desire to learn something new/interesting (58%) and an interest in STEM (50%).

Table 147. Factors Motivating Apprentice Participation in URAP (n=12)*

Choice	Response Percent	Response Total
Teacher or professor encouragement	41.7%	5
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	58.3%	7
The mentor(s)	0%	0
Building college application or résumé	8.3%	1
Networking opportunities	16.7%	2
Interest in science, technology, engineering, or mathematics (STEM)	50.0%	6
Interest in STEM careers with the Army	16.7%	2
Having fun	8.3%	1
Earning stipends or awards for doing STEM	0%	0
Opportunity to do something with friends	0%	0
Opportunity to use advanced laboratory technology	33.3%	4
Desire to expand laboratory or research skills	41.7%	5
Learning in ways that are not possible in school	25.0%	3
Serving the community or country	0%	0
Exploring a unique work environment	8.3%	1
Figuring out education or career goals	33.3%	4
Seeing how school learning applies to real life	8.3%	1
Recommendations of past participants	0%	0
Choose Not to Report	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

Apprentices participating in interviews were also asked about why they chose to participate in URAP. These apprentices' responses also focused primarily on the value of the research experience and networking. Apprentices said, for example,

> *"I wanted to do it because I get to work along with scientists, and engineers, and do research. That struck my interests."* (URAP Apprentice)

> *"I thought that maybe it would be a helpful experience for me to get more involved in the research aspect [of my major], since I want to know more about research techniques, and what kind of qualities you should have in order to participate in any type of research work."* (URAP Apprentice)

Mentors were asked how they believed apprentices were recruited for URAP (Table 148). More than a third of mentors chose the following three recruitment strategies: colleagues in their workplace (50%); applications from RIT/AEOP (40%); and communications generated by a university or faculty (40%).

Table 148. Mentor Reports of Recruitment Strategies (n=10)

Choice	Response Percent	Response Total
Applications from Rochester Institute of Technology (RIT) or the AEOP	40.0%	4
Personal acquaintance(s) (friend, family, neighbor, etc.)	20.0%	2
Colleague(s) in my workplace	50.0%	5
K-12 school teacher(s) outside of my workplace	10.0%	1
University faculty outside of my workplace	20.0%	2
Informational materials sent to K-12 schools or Universities outside of my workplace	10.0%	1
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	10.0%	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	40.0%	4
STEM or STEM Education conference(s) or event(s)	10.0%	1
Organization(s) that serve underserved or underrepresented populations	20.0%	2
The student contacted me (the mentor) about the program	30.0%	3
I do not know how student(s) were recruited for the program	10.0%	1
Other, (specify):	10.0%	1

Previous Program Participation & Future Interest – Overall

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

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

CQL

Table 149 shows CQL apprentice reports of previous participation in AEOP. Nearly half (47%) noted they had never participated in any AEOP. Smaller proportions indicated having participated in the following programs: CQL (33%), GEMS (11%), and SEAP (9%). Some CQL respondents (18%) said they had participated other STEM programs.

Table 149. Previous Participation in AEOP Programs (n=45)*

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)	11.1%	5
Unite	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	8.9%	4
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	33.3%	15
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	46.7%	21
Other STEM Program	17.8%	8

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

CQL apprentices were asked about their interest in participating in future AEOP (Table 150). Approximately three-quarters or more of apprentices were at least somewhat interested in participating in CQL again (85%) and SMART (71%). Half (50%) indicated they were at least somewhat interested in NDSEG, and more than a third were similarly interested in URAP (42%) and the GEMS NPM program (37%).

Table 150. Student Interest in Future AEOP Programs (n=52)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	1.9%	13.5%	17.3%	67.3%	
	1	7	9	35	**52**
Undergraduate Research Apprenticeship Program (URAP)	34.6%	23.1%	17.3%	25.0%	
	18	12	9	13	**52**
	21.2%	7.7%	26.9%	44.2%	

Science Mathematics, and Research for Transformation (SMART) College Scholarship	11	4	14	23	**52**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	42.3%	7.7%	13.5%	36.5%	
	22	4	7	19	**52**
GEMS Near Peer Mentor Program	42.3%	21.2%	13.5%	23.1%	
	22	11	7	12	**52**

Mentors were asked which AEOP they discussed directly with CQL apprentices. Table 151 shows the only two AEOP discussed were CQL (83%) and SMART (50%).

Table 151. Mentors Explicitly Discussing AEOP with Apprentices (n=6)

	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)	83.3%	16.7%	
	5	1	**6**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	6	**6**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	6	**6**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	50.0%	50.0%	
	3	3	**6**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	6	**6**
I discussed AEOP with my student(s) but did not discuss any specific program	16.7%	83.3%	
	1	5	**6**

SEAP

Table 152 shows SEAP apprentice reported previous participation in AEOP. All three survey respondents indicated they had never participated in any AEOP.

Table 152. Previous Participation in AEOP Programs (n=3)

Choice	Response Percent	Response Total
Camp Invention	0%	0
eCYBERMISSION	0%	0
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	0%	0
Unite	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	100%	3
Other STEM Program	0%	0

SEAP apprentices were asked about their level of interest related to future AEOP participation (Table 153). Two general patterns were found in the results. Either two of three participants reported being at least somewhat interested in participating in the AEOP (CQL – 67%, URAP – 67%, SMART – 67%) or two of three respondents reported having never heard of the program (NDSEG – 67%, GEMS NPM – 67%).

Table 153. Student Interest in Future AEOP Programs (n=3)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Undergraduate Research Apprenticeship Program (URAP)	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	66.7%	0.0%	0.0%	33.3%	
	2	0	0	1	**3**

GEMS Near Peer Mentor Program	66.7%	0.0%	0.0%	33.3%	
	2	0	0	1	**3**

Mentors were asked which AEOP they discussed directly with their SEAP apprentices. Table 154 shows that either all three (100%) or two of the three (67%) SEAP mentor survey participants reported they did not discuss any specific AEOP with their apprentices. Two of three responding mentors (67%), did, however, note discussing AEOP in general with their SEAP apprentices.

Table 154. Mentors Explicitly Discussing AEOP with Apprentices (n=3)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	0.0%	100.0%	
	0	3	**3**
High School Apprenticeship Program (HSAP)	0.0%	100.0%	
	0	3	**3**
College Qualified Leaders (CQL)	33.3%	66.7%	
	1	2	**3**
Unite	0.0%	100.0%	
	0	3	**3**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	3	**3**
Research and Engineering Apprenticeship Program (REAP)	0.0%	100.0%	
	0	3	**3**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	3	**3**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	33.3%	66.7%	
	1	2	**3**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	3	**3**
I discussed AEOP with my student(s) but did not discuss any specific program	66.7%	33.3%	
	2	1	**3**

Previous Program Participation & Future Interest – University-Based Programs

REAP

Table 155 shows REAP apprentice reported previous participation in AEOP. Half (50%) noted they had not previously participated in any AEOP. Smaller proportions indicated having participated in the following programs: Unite (25%) and GEMS (6%). Some REAP respondents (13%) said they had participated other STEM programs.

Table 155. Apprentice Participation in AEOP Programs (n=16)*

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)	6.3%	1
Unite	25.0%	4
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	6.3%	1
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%	8
Other STEM Program	12.5%	2

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

REAP apprentices were also asked to report on their level of future AEOP participation interest (Table 156). More than half of apprentices indicated they were at least somewhat interested in participating in GEMS NPM (53%), CQL (53%), NDSEG (59%), SMART (71%), and URAP (82%).

Table 156. Apprentice Interest in Future AEOP Programs (n=17)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	41.2%	5.9%	5.9%	47.1%	
	7	1	1	8	**17**
Undergraduate Research Apprenticeship Program (URAP)	17.6%	0.0%	5.9%	76.5%	
	3	0	1	13	**17**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	29.4%	0.0%	11.8%	58.8%	
	5	0	2	10	**17**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	35.3%	5.9%	17.6%	41.2%	
	6	1	3	7	**17**
GEMS Near Peer Mentor Program	47.1%	0.0%	29.4%	23.5%	
	8	0	5	4	**17**

Mentors were asked which AEOP they discussed with their REAP apprentices. Table 157 shows at least half of mentors reported discussing the following specific AEOP with apprentices: URAP (64%), HSAP (57%), SMART (57%), and NDSEG (57%). Additionally, nearly three-quarters (71%) of mentors said they discussed AEOP in general.

Table 157. Mentors Explicitly Discussing AEOP with Students (n=14)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
GEMS Near Peer Mentor Program	42.9%	57.1%	
	6	8	**14**
High School Apprenticeship Program (HSAP)	57.1%	42.9%	
	8	6	**14**
Junior Science and Humanities Symposium (JSHS)	42.9%	57.1%	
	6	8	**14**
College Qualified Leaders (CQL)	35.7%	64.3%	
	5	9	**14**
Unite	35.7%	64.3%	
	5	9	**14**

Gains in the Education of Mathematics and Science (GEMS)	42.9%	57.1%	
	6	8	**14**
Science and Engineering Apprenticeship Program (SEAP)	42.9%	57.1%	
	6	8	**14**
Undergraduate Research Apprenticeship Program (URAP)	64.3%	35.7%	
	9	5	**14**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	57.1%	42.9%	
	8	6	**14**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	57.1%	42.9%	
	8	6	**14**
I discussed AEOP with my student(s) but did not discuss any specific program	71.4%	28.6%	
	10	4	**14**

HSAP

Table 158 shows HSAP apprentice reports of their previous participation in AEOP. Three-quarters (75%) reported they had never participated in any AEOP. A quarter (25%) had participated in Camp Invention previously, and a small proportion indicated having participated in HSAP previously (13%).

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

Choice	Response Percent	Response Total
Camp Invention	25.0%	2
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)	12.5%	1
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	75.0%	6
Other STEM Program	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

HSAP apprentices were also asked to indicate their level of interest in participating in future AEOP (Table 159). Except for CQL (39%) and GEMS NPM (39%), half or more of apprentices reported being at least somewhat interested in the other AEOP (50%-88%). At the same time, half or more of HSAP apprentices reported having never heard of most AEOP (NDSEG – 50%, GEMS NPM – 63%, CQL – 63%).

Table 159. Apprentice Interest in Future AEOP Programs (n=8)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	62.5%	0.0%	0.0%	37.5%	
	5	0	0	3	**8**
Undergraduate Research Apprenticeship Program (URAP)	12.5%	0.0%	37.5%	50.0%	
	1	0	3	4	**8**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	25.0%	12.5%	0.0%	62.5%	
	2	1	0	5	**8**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	50.0%	0.0%	12.5%	37.5%	
	4	0	1	3	**8**
GEMS Near Peer Mentor Program	62.5%	0.0%	0.0%	37.5%	
	5	0	0	3	**8**

Mentors were asked which AEOP they discussed directly with their apprentices during HSAP (Table 160). The one HSAP mentor who responded to the evaluation survey indicated they only discussed HSAP.

Table 160. Mentors Explicitly Discussing AEOP with Apprentices (n=1)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Unite	0.0%	100.0%	
	0	1	**1**
High School Apprenticeship Program (HSAP)	100.0%	0.0%	
	1	0	**1**

Junior Science and Humanities Symposium (JSHS)	0.0%	100.0%	
	0	1	**1**
College Qualified Leaders (CQL)	0.0%	100.0%	
	0	1	**1**
Gains in the Education of Mathematics and Science (GEMS)	0.0%	100.0%	
	0	1	**1**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	1	**1**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	100.0%	
	0	1	**1**
Science and Engineering Apprenticeship Program (SEAP)	0.0%	100.0%	
	0	1	**1**
Research and Engineering Apprenticeship Program (REAP)	0.0%	100.0%	
	0	1	**1**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	0.0%	100.0%	
	0	1	**1**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	1	**1**
I discussed AEOP with my student(s) but did not discuss any specific program	0.0%	100.0%	
	0	1	**1**

URAP

Table 161 shows URAP apprentice reports of their previous participation in AEOP. Nearly all (92%) responded they had never participated in any AEOP. Only one respondent indicated they had previously participated in JSHS (8%).

Table 161. Previous Participation in AEOP Programs (n=12)*

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)	8.3%	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	91.7%	11
Other STEM Program	0%	0

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

URAP apprentices were also asked to report their level of interest in future AEOP participation (Table 162). Most apprentices were interested in participating in URAP again (94%) and over 40% were interested in SMART (44%). Half of more of apprentices said they had not heard of all programs other than URAP: CQL (69%), GEMS-NPM (63%), NDSEG (63%), and SMART (50%).

Table 162. Apprentice Interest in Future AEOP Programs (n=16)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	68.8%	6.3%	12.5%	12.5%	
	11	1	2	2	**16**
Undergraduate Research Apprenticeship Program (URAP)	0.0%	6.3%	25.0%	68.8%	
	0	1	4	11	**16**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	50.0%	6.3%	18.8%	25.0%	
	8	1	3	4	**16**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	62.5%	6.3%	6.3%	25.0%	
	10	1	1	4	**16**
GEMS Near Peer Mentor Program	62.5%	12.5%	12.5%	12.5%	
	10	2	2	2	**16**

URAP mentors were asked which AEOP they discussed directly with their apprentices (Table 163). A majority of mentors (70%) reported speaking with their apprentices about URAP (70%), and two mentors (20%) discussed SMART and NDSEG with apprentices. Another 40% had discussed AEOP generally, but without reference to any specific program. Large proportions of mentors reported not discussing the other AEOP with their apprentices (60%-100%).

Table 163. Mentors Explicitly Discussing AEOP with Apprentices (n=10)

	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)	0.0%	100.0%	
	0	10	**10**
GEMS Near Peer Mentor Program	0.0%	100.0%	
	0	10	**10**
Undergraduate Research Apprenticeship Program (URAP)	70.0%	30.0%	
	7	3	**10**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	20.0%	80.0%	
	2	8	**10**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	20.0%	80.0%	
	2	8	**10**
I discussed AEOP with my student(s) but did not discuss any specific program	40.0%	60.0%	
	4	6	**10**

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

A goal of all AEOP 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 164 and 165 show that a large proportion of CQL apprentices (96%) reported learning about at least one STEM job/career and most (81%) reported learning about three or more general STEM careers. Similarly, a large proportion of apprentices (94%) indicated they learned about at least one DoD STEM job/career, with fewer (63%) learning about three or more STEM careers in the Army or DoD.

Table 164. Number of STEM Jobs/Careers Apprentices Learned About During CQL (n=52)

	Response Percent	Response Total
None	3.8%	2
1	7.7%	4
2	7.7%	4
3	36.5%	19
4	9.7%	5
5 or more	34.6%	18

Table 165. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During CQL (n=52)

	Response Percent	Response Total
None	5.8%	3
1	13.5%	7
2	17.3%	9
3	19.2%	10
4	7.7%	4
5 or more	36.5%	19

Apprentices participating in interviews indicated that being on-site at Army labs, information from their mentors, and learning about other CQL apprentices' projects were influential factors in their awareness and understanding of Army and DoD STEM careers. Apprentices said, for example,

> *"Because of my time working in the branch that I did… [I learned] a lot about like what it can be like and what you can work on as an electrical engineer for the military. And it's something that I want to pursue now, after graduation, when before I wasn't necessarily thinking defense was for me."* (CQL Apprentice)

> *"Before I got this [CQL apprenticeship], I'd started thinking about working for the military as an engineer and this is the best taste, I could have got of it. And it really shows you how everything*

works. They're very welcoming and I remember at the beginning we had a meeting…I got to meet everyone in different branches and everything, and it was really cool and then throughout the [apprenticeship] you learn how everything works." (CQL Apprentice)

"We were able interact with other people's mentors and we were able to interact with the interns themselves. So, through that, we were able to get a better sense of what each intern was working on." (CQL Apprentice)

Mentors' comments in interviews also highlighted the value of the career information apprentices gained from being on site at an Army lab. Mentors noted, however, that they had not received information about careers or how to expose apprentices to careers from the program. These mentors suggested providing an AEOP seminar that included careers, providing information to mentors that they can use to launch discussions with apprentices, and educating apprentices about the Army's organization and the range of career fields in the Army. CQL apprentices held extremely positive opinions about DoD researchers and research with more than 95% agreeing to all statements (Table 166).

Table 166. Student Opinions about DoD Researchers and Research (n=52)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.9%	1.9%	25.0%	71.2%	
	1	1	13	37	**52**
DoD researchers develop new, cutting edge technologies	1.9%	1.9%	30.8%	65.4%	
	1	1	16	34	**52**
DoD researchers solve real-world problems	3.8%	0.0%	25.0%	71.2%	
	2	0	13	37	**52**
DoD research is valuable to society	1.9%	1.9%	28.8%	67.3%	
	1	1	15	35	**52**

SEAP

Tables 167 and 168 show that all three responding SEAP apprentices (100%) indicated learning about at least one STEM job/career, and that two (67%) reported learning about three or more general STEM careers. Similarly, all apprentices (100%) reported learning about at least one DoD STEM job/career, and two (67%) reported learning about three or more Army or DoD STEM jobs or careers.

Table 167. Number of STEM Jobs/Careers Apprentices Learned About During SEAP (n=3)

	Response Percent	Response Total
None	0%	0
1	0%	0
2	33.3%	1
3	0%	0
4	0%	0
5 or more	66.7%	2

Table 168. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During SEAP (n=3)

	Response Percent	Response Total
None	0%	0
1	0%	0
2	33.3%	1
3	33.3%	1
4	0%	0
5 or more	33.3%	1

SEAP apprentices participating in interviews 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 that hosted their apprenticeships. In particular, apprentices cited their mentors, other researchers at the sites, online meetings, and research symposia as sources of information rather than information they received from the program. Apprentices said, for example,

> *"[The site has] meetings for all the interns every week or so, sometimes twice a week, where we go over lessons. We get to meet different people who are involved in the research. We meet active military who are studying and doing research. We meet contractors who are civilians who are also doing research. We meet students who are doing graduate studies here, pursuing other programs. It gives the students a great overview of the different ways you can get involved in the military here by being an active military member or just being a contractor and a civilian who works at bases. It does a great job of addressing the different paths and avenues in a very subtle way. We get to meet all these different people and talk to them about how they do their work and learn more about this."* (SEAP Apprentice)

> *"[We learn about STEM careers from] a symposium at the end of the SEAP internship - at the end of the summer where we look at other people's projects. We also see how they connect to different areas of the Department of Defense. We see their mentors and the work that they do, those different types of STEM careers."* (SEAP Apprentice)

SEAP apprentices held extremely positive opinions about DoD researchers and research with all three responding apprentices (100%) strongly agreeing with each statement in Table 169.

Table 169. Student Opinions about DoD Researchers and Research (n=3)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
DoD researchers solve real-world problems	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
DoD research is valuable to society	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**

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

REAP

Tables 170 and 171 show that all REAP apprentices (100%) indicated learning about at least one STEM job/career, and approximately two-thirds (65%) learned about three or more STEM careers in general. Much smaller proportions of apprentices (53%), however, reported learning about at least one DoD STEM job/career, and even fewer (24%) noted learning about three or more Army or DoD STEM jobs/careers.

Table 170. Number of STEM Jobs/Careers Apprentices Learned About During REAP (n=17)

Choice	Response Percent	Response Total
None	0%	0
1	11.8%	2
2	23.5%	4
3	17.6%	3
4	11.8%	2
5 or more	35.3%	6

Table 171. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During REAP (n=17)

Choice	Response Percent	Response Total

None	47.1%	8
1	11.8%	2
2	17.6%	3
3	17.6%	3
4	0%	0
5 or more	5.9%	1

Most REAP apprentices participating in phone interviews indicated that they had not learned about STEM careers in the DoD during their apprenticeships, although they had learned about STEM careers in general. Those that indicated they had learned about careers cited their mentors or professors and invited speakers as sources of general STEM career information. REAP apprentices held extremely positive perspectives toward DoD researchers and research with all or nearly all (94%-100%) expressing agreement with each item in Table 172.

Table 172. Apprentice Opinions about DoD Researchers and Research (n=17)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	29.4%	70.6%	
	0	0	5	12	**17**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	29.4%	70.6%	
	0	0	5	12	**17**
DoD researchers solve real-world problems	0.0%	0.0%	29.4%	70.6%	
	0	0	5	12	**17**
DoD research is valuable to society	0.0%	5.9%	35.3%	58.8%	
	0	1	6	10	**17**

HSAP

Tables 173 and 174 show all HSAP apprentices (100%) indicated they learned about at least one STEM job/career, while only approximately a third (38%) noted learning about three or more general STEM careers. Three-quarters of apprentices (75%) reported learning about at least one DoD STEM job/career, and a quarter (25%) said they learned about three or more Army or DoD STEM jobs/careers.

Table 173. Number of STEM Jobs/Careers Apprentices Learned About During HSAP (n=8)

Choice	Response Percent	Response Total
None	0%	0

1	25.0%	2
2	37.5%	3
3	0%	0
4	25.0%	2
5 or more	12.5%	1

Table 174. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During HSAP (n=8)

Choice	Response Percent	Response Total
None	25.0%	2
1	50.0%	4
2	0%	0
3	25.0%	2
4	0%	0
5 or more	0%	0

Only two of the HSAP apprentices participating in phone interviews reported learning about careers specifically within the Army or DoD during their apprenticeships, although all apprentices indicated that they had been exposed to STEM career connections more generally during their apprenticeships. The apprentices who had received information about DoD STEM careers cited their mentors and webinars that featured DoD researchers as speakers as sources of information. One apprentice said, for example,

> *"[The seminars included] actual researchers from the Navy lab or from different public-sector labs across the country. They would come to speak about their educational path and how they got into a Department of Defense position."* (HSAP Apprentice)

One apprentice noted that she learned about DoD STEM careers indirectly, by discussing with her mentor DoD applications of the research project she worked on. This apprentice said,

> *"[HSAP] students were exposed to a lot of connections between the research and the interests of the Army and the Army Research Office."* HSAP Apprentice)

Those who had received more general STEM career information cited their mentors as sources of information. HSAP mentors all reported that their apprentices received information about STEM careers in the Army or DoD. Mentors reported that this information was provided by seminars, through information provided by the program that mentors passed on to students, and through defense applications of research projects. One mentor suggested that webinars are an effective means of exposing apprentices to career information.

HSAP apprentices expressed extremely positive opinions about DoD researchers and research with all (100%) agreeing with each item in Table 175.

Table 175. Apprentice Opinions about DoD Researchers and Research (n=8)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	8
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	8
DoD researchers solve real-world problems	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	8
DoD research is valuable to society	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	8

URAP

Tables 176 and 177 show a large proportion of URAP apprentices (81%) indicated learning about at least one STEM job/career, and approximately a third (31%) said they learned about three or more STEM careers in general. Considerably fewer apprentices (31%) reported learning about at least one DoD STEM job/career, and none (0%) noted learning about three or more Army or DoD STEM jobs/careers.

Table 176. Number of STEM Jobs/Careers Learned About During URAP (n=16)

Choice	Response Percent	Response Total
None	18.8%	3
1	12.4%	2
2	37.5%	6
3	25.0%	4
4	0%	0
5 or more	6.3%	1

Table 177. Number of DoD STEM Jobs/Careers Learned About During URAP (n=16)

Choice	Response Percent	Response Total
None	68.8%	11
1	12.4%	2

2	18.8%	3
3	0%	0
4	0%	0
5 or more	0%	0

Ten of the URAP apprentices participating in phone interviews had not learned about STEM careers within the DoD during their apprenticeships. The five who reported that they had learned about these careers noted that they received this information from their mentors and through seminars and invited speakers. Two noted that their primary exposure to these careers was through DoD applications of their research projects.

Four of the six mentors interviewed reported that their apprentices received information about STEM careers within the DoD during their URAP apprenticeships. These mentors cited newsletters and information from the program, seminars offered by the mentors, and the connections between the research projects and applications within the DoD as sources of information.

URAP apprentices expressed extremely positive opinions about DoD researchers and research with all (100%) agreeing with each item in Table 178.

Table 178. Apprentice Opinions about DoD Researchers and Research (n=16)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	68.8%	31.3%	
	0	0	11	5	**16**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	56.3%	43.8%	
	0	0	9	7	**16**
DoD researchers solve real-world problems	0.0%	0.0%	50.0%	50.0%	
	0	0	8	8	**16**
DoD research is valuable to society	0.0%	0.0%	50.0%	50.0%	
	0	0	8	8	**16**

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 in various 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 4 = "Much more likely". Apprentice averages across all items were computed. Composite scores were used to test for 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 grade level. However, there was a significant difference by program setting, with apprentices housed at a university setting reporting a greater likelihood compared to Army research lab apprentices (effect size is medium with d = 0.501).[27]

CQL

Nearly all apprentices (89%-100%) reported they were more likely or much more likely to engage in all STEM activities after CQL participation (Table 179). All apprentices (100%) said they were more or much more likely to work on a STEM project or experiment in a university or professional setting. Composite scores were used to compare apprentice future STEM engagement by Underserved classification and specific variables that make up Underserved. Differences were not found in likelihood of future STEM engagement by overall Underserved classification or specific variables investigated.

Table 179. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=52)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	1.9%	0.0%	76.9%	21.2%	
	1	0	40	11	52
Tinker (play) with a mechanical or electrical device	1.9%	3.8%	65.4%	28.8%	
	1	2	34	15	52
Work on solving mathematical or scientific puzzles	1.9%	1.9%	67.3%	28.8%	
	1	1	35	15	52
Use a computer to design or program something	1.9%	9.6%	48.1%	40.4%	
	1	5	25	21	52

[26] Likelihood to Engage in STEM Practices Activities (10 items) Cronbach's alpha reliability = 0.804.

[27] Independent Samples *t*-test for Future STEM engagement by program setting: $t(94)=2.43$, $p=0.017$.

Talk with friends or family about STEM	0.0%	5.8%	50.0%	44.2%	
	0	3	26	23	**52**
Mentor or teach other students about STEM	0.0%	1.9%	53.8%	44.2%	
	0	1	28	23	**52**
Help with a community service project related to STEM	0.0%	1.9%	59.6%	38.5%	
	0	1	31	20	**52**
Participate in a STEM camp, club, or competition	1.9%	7.7%	59.6%	30.8%	
	1	4	31	16	**52**
Take an elective (not required) STEM class	0.0%	5.8%	55.8%	38.5%	
	0	3	29	20	**52**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	40.4%	59.6%	
	0	0	21	31	**52**

Apprentice educational aspirations after completing CQL are presented in Table 180. All (100%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's (38%) or terminal degree (37%) in their field.

Table 180. Apprentice Education Aspirations After CQL (n=52)

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)	13.5%	7
Get more education after college	11.5%	6
Get a master's degree	38.4%	20
Get a Ph.D.	21.2%	11
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	5.8%	3
Get a combined M.D. / Ph.D.	7.7%	4
Get another professional degree (law, business, etc.)	1.9%	1

SEAP

Either all three or two of three SEAP apprentices responding to the evaluation survey (67%-100%) indicated they were more likely or much more likely to engage in each STEM activity listed after their SEAP experience (Table 181). Composite scores were used unable to be used for comparing subgroups of students due to the low sample size.

Table 181. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=3)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	100.0%	0.0%	
	0	0	3	0	**3**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	100.0%	0.0%	
	0	0	3	0	**3**
Use a computer to design or program something	0.0%	0.0%	0.0%	100.0%	
	0	0	0	3	**3**
Talk with friends or family about STEM	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Mentor or teach other students about STEM	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
Help with a community service project related to STEM	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Participate in a STEM camp, club, or competition	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
Take an elective (not required) STEM class	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**

When asked their formal education aspirations, all three responding SEAP apprentices (100%) reported wanting to at least earn a bachelor's degree (Table 182). While none (0%) reported wanting to finish their higher education with a master's degree, all three (100%) reported a desire to earn a terminal degree in their field.

Table 182. Apprentice Education Aspirations After SEAP (n=3)

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)	0%	0
Get more education after college	0%	0
Get a master's degree	0%	0
Get a Ph.D.	33.3%	1
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	33.3%	1
Get a combined M.D. / Ph.D.	33.3%	1
Get another professional degree (law, business, etc.)	0%	0

Interest & Future Engagement in STEM – University-Based Programs

REAP

More than 85% of apprentices (88%-100%) reported being more likely or much more likely to engage in all STEM activities after REAP (Table 183). All REAP apprentices (100%) noted an increased likelihood of participating in the following activities: working on solving mathematical or scientific puzzles; using a computer to design/program somethings; helping with a community service project related to STEM; and working on a STEM project/experiment in a university/professional setting. Composite scores were used to compare apprentice future STEM engagement by Underserved classification and specific variables that make up Underserved. No differences were found in future STEM engagement by overall Underserved classification or specific variables.

Table 183. Change in Likelihood Apprentice Will Engage in STEM Activities Outside of School (n=17)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	5.9%	35.3%	58.8%	
	0	1	6	10	**17**
Tinker (play) with a mechanical or electrical device	0.0%	5.9%	23.5%	70.6%	
	0	1	4	12	**17**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	35.3%	64.7%	
	0	0	6	11	**17**

Use a computer to design or program something	0.0%	0.0%	41.2%	58.8%	
	0	0	7	10	**17**
Talk with friends or family about STEM	5.9%	0.0%	47.1%	47.1%	
	1	0	8	8	**17**
Mentor or teach other students about STEM	0.0%	11.8%	41.2%	47.1%	
	0	2	7	8	**17**
Help with a community service project related to STEM	0.0%	0.0%	47.1%	52.9%	
	0	0	8	9	**17**
Participate in a STEM camp, club, or competition	0.0%	5.9%	23.5%	70.6%	
	0	1	4	12	**17**
Take an elective (not required) STEM class	0.0%	5.9%	17.6%	76.5%	
	0	1	3	13	**17**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	29.4%	70.6%	
	0	0	5	12	**17**

All REAP apprentices (100%) said they wanted to earn at least a bachelor's degree after participating in their program. Many indicated a desire to earn a master's degree (29%) or terminal degree (59%) in their field (Table 184).

Table 184. Apprentice Education Aspirations After REAP (n=17)

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)	11.8%	2
Get more education after college	0%	0
Get a master's degree	29.4%	5
Get a Ph.D.	29.4%	5
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	11.8%	2
Get a combined M.D. / Ph.D.	17.6%	3
Get another professional degree (law, business, etc.)	0%	0

HSAP

All or nearly all HSAP apprentices (88%-100%) reported being more likely or much more likely to engage in all STEM activities after participating in HSAP (Table 185). All apprentices reported that they were more likely or much more likely to participate in each activity with the exception of watching or reading non-fiction STEM (88%) and talking with friends/family about STEM (88%). Composite scores could not be used to assess for group differences because the sample size was too small.

Table 185. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=8)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	12.5%	62.5%	25.0%	
	0	1	5	2	**8**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	75.0%	25.0%	
	0	0	6	2	**8**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Use a computer to design or program something	0.0%	0.0%	50.0%	50.0%	
	0	0	4	4	**8**
Talk with friends or family about STEM	0.0%	12.5%	50.0%	37.5%	
	0	1	4	3	**8**
Mentor or teach other students about STEM	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**
Help with a community service project related to STEM	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Participate in a STEM camp, club, or competition	0.0%	0.0%	50.0%	50.0%	
	0	0	4	4	**8**
Take an elective (not required) STEM class	0.0%	0.0%	50.0%	50.0%	
	0	0	4	4	**8**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	37.5%	62.5%	
	0	0	3	5	**8**

All HSAP apprentices (100%) reported wanting to at least earn a bachelor's degree. Many indicated a desire to earn a master's degree (13%) or terminal degree (75%) in their field (Table 186).

Table 186. Apprentice Education Aspirations After HSAP (n=8)

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)	12.5%	1
Get more education after college	0%	0
Get a master's degree	12.5%	1
Get a Ph.D.	25.0%	2
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	12.5%	1
Get a combined M.D. / Ph.D.	37.5%	3
Get another professional degree (law, business, etc.)	0%	0

URAP

All or nearly all URAP apprentices (94%-100%) indicated that after participating in URAP they were more likely to engage with all activities about which they were asked (Table 187). The only activity for which less than 100% of apprentices reported increased likelihood of engagement was participating in a STEM camp, club, or competition (94%). Composite scores were used to compare apprentice future STEM engagement by Underserved classification and specific variables that make up Underserved. Statistical differences were found in future STEM engagement by gender (females reporting higher likelihood) and socioeconomic status (low-SES reporting higher likelihood) (effect sizes are large: d = 1.57 for each).[19] There were also significant differences found by overall Underserved status with Underserved apprentices reporting greater likelihood of future engagement (effect size is large with d = 2.03).[20]

Table 187. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=16)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	0.0%	93.8%	6.3%	
	0	0	15	1	**16**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	62.5%	37.5%	
	0	0	10	6	**16**

[19] Independent Samples *t*-test for Future STEM Engagement: Gender – $t(14)=2.93$, $p=.011$; SES – $t(14)=2.93$, $p=.011$.

[20] Independent Samples *t*-test for Future STEM Engagement by Underserved status: $t(14)=3.79$, $p=.002$.

Work on solving mathematical or scientific puzzles	0.0%	0.0%	75.0%	25.0%	
	0	0	12	4	**16**
Use a computer to design or program something	0.0%	0.0%	31.3%	68.8%	
	0	0	5	11	**16**
Talk with friends or family about STEM	0.0%	0.0%	43.8%	56.3%	
	0	0	7	9	**16**
Mentor or teach other students about STEM	0.0%	0.0%	50.0%	50.0%	
	0	0	8	8	**16**
Help with a community service project related to STEM	0.0%	0.0%	68.8%	31.3%	
	0	0	11	5	**16**
Participate in a STEM camp, club, or competition	0.0%	6.3%	50.0%	43.8%	
	0	1	8	7	**16**
Take an elective (not required) STEM class	0.0%	0.0%	68.8%	31.3%	
	0	0	11	5	**16**
Work on a STEM project or experiment in a university or professional setting	0.0%	0.0%	25.0%	75.0%	
	0	0	4	12	**16**

All URAP apprentices (100%) reported aspiring to earn at least a bachelor's degree. Many said they desired to earn a master's degree (44%) or terminal degree (44%) in their field (Table 188).

Table 188. Apprentice Education Aspirations After URAP (n=16)

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)	12.5%	2
Get more education after college	0%	0
Get a master's degree	43.7%	7
Get a Ph.D.	37.5%	6
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	6.3%	1
Get a combined M.D. / Ph.D.	0%	0
Get another professional degree (law, business, etc.)	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 AEOP.

Resources – Army Laboratory-Based Programs

CQL

Apprentices were asked about the impact of AEOP resources on their awareness of DoD STEM careers (Table 189). Two-thirds or more of apprentices reported the following four resources as somewhat or very much impactful: the AEOP website (65%); presentations shared in program (71%); participation in CQL (88%); and the CQL mentors (96%). More than half of CQL apprentices said they had not experienced AEOP resources such as the ARO website (56%) and AEOP on social media (65%).

Table 189. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=52)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	21.2%	13.5%	51.9%	13.5%	
	11	7	27	7	**52**
AEOP on Facebook, Twitter or other social media	65.4%	23.1%	7.7%	3.8%	
	34	12	4	2	**52**
Army Research Office (ARO) website	55.8%	17.3%	21.2%	5.8%	
	29	9	11	3	**52**
AEOP printed materials	40.4%	17.3%	38.5%	3.8%	
	21	9	20	2	**52**
My Apprenticeship Program mentor	1.9%	1.9%	32.7%	63.5%	
	1	1	17	33	**52**
Presentations or information shared in the Apprenticeship Program	19.2%	9.6%	32.7%	38.5%	
	10	5	17	20	**52**
Participation in the Apprenticeship Program	7.7%	3.8%	26.9%	61.5%	
	4	2	14	32	**52**

Mentors were also asked how useful certain resources were for introducing apprentices to DoD STEM careers (Table 190). Mentors were most likely to rate participation in CQL (83%), the AEOP website (67%), AEOP program administration (50%), and invited speakers (50%) as at least somewhat useful resources. All other resources were not experienced by more than half of responding CQL mentors.

Table 190. Usefulness of Resources on Exposing Students to DoD STEM Careers (n=6)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	33.3%	0.0%	0.0%	33.3%	33.3%	
	2	0	0	2	2	**6**
AEOP on Facebook, Twitter, Pinterest or other social media	66.7%	0.0%	0.0%	16.7%	16.7%	
	4	0	0	1	1	**6**
AEOP printed materials	66.7%	16.7%	0.0%	16.7%	0.0%	
	4	1	0	1	0	**6**
AEOP Program administrator or site coordinator	50.0%	0.0%	0.0%	33.3%	16.7%	
	3	0	0	2	1	**6**
Invited speakers or "career" events	50.0%	0.0%	0.0%	16.7%	33.3%	
	3	0	0	1	2	**6**
Participation in program	16.7%	0.0%	0.0%	0.0%	83.3%	
	1	0	0	0	5	**6**

Apprentices were asked which resources impacted their awareness of the various AEOP (Table 191). Apprentices reported the following four resources as particularly impactful (somewhat or very much): participation in CQL (98%), CQL mentors (96%), the AEOP website (83%), and presentations shared in CQL (75%). More than half of responding apprentices had not experienced AEOP on social media (65%).

Table 191. Impact of Resources on Student Awareness of AEOP (n=52)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	7.7%	9.6%	55.8%	26.9%	
	4	5	29	14	**52**
AEOP on Facebook, Twitter or other social media	65.4%	21.2%	9.6%	3.8%	
	34	11	5	2	**52**
AEOP printed materials	46.2%	13.5%	30.8%	9.6%	
	24	7	16	5	**52**

My Apprenticeship Mentor	0.0%	3.8%	26.9%	69.2%	
	0	2	14	36	**52**
Presentations or information shared through the Apprenticeship Program	19.2%	5.8%	44.2%	30.8%	
	10	3	23	16	**52**
Participation in the Apprenticeship Program	1.9%	0.0%	38.5%	59.6%	
	1	0	20	31	**52**

Mentors were also asked how useful various resources were in exposing apprentices to AEOP (Table 192). All mentors reported CQL participation (100%) was at least somewhat useful, followed by AEOP program administrators (67%) and the AEOP website (67%). Most mentors said they did not experience AEOP printed materials (67%) or AEOP on social media (67%) as resources for exposing apprentices to AEOP.

Table 192. Usefulness of Resources on Exposing Students to AEOP (n=6)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	33.3%	0.0%	0.0%	33.3%	33.3%	
	2	0	0	2	2	**6**
AEOP on Facebook, Twitter, Pinterest or other social media	66.7%	0.0%	0.0%	16.7%	16.7%	
	4	0	0	1	1	**6**
AEOP printed materials	66.7%	16.7%	0.0%	16.7%	0.0%	
	4	1	0	1	0	**6**
AEOP Program administrator or site coordinator	33.3%	0.0%	0.0%	50.0%	16.7%	
	2	0	0	3	1	**6**
Invited speakers or "career" events	50.0%	0.0%	0.0%	16.7%	33.3%	
	3	0	0	1	2	**6**
Participation in the program	0.0%	0.0%	0.0%	16.7%	83.3%	
	0	0	0	1	5	**6**

SEAP

Apprentices were asked about the impact of AEOP resources on their awareness of DoD STEM careers (Table 193). Two-thirds of apprentices (two individuals) reported that the following resources were somewhat to very much useful for this purpose: the AEOP website (67%); presentations shared in the program (67%); participation in SEAP (67%); and SEAP mentors (67%).

Table 193. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=3)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
AEOP on Facebook, Twitter or other social media	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
Army Research Office (ARO) website	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
AEOP printed materials	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
My Apprenticeship Program mentor	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
Presentations or information shared in the Apprenticeship Program	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
Participation in the Apprenticeship Program	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**

Mentors were also asked how useful certain resources were for introducing apprentices to DoD STEM careers (Table 194). All mentors selected participating in SEAP (100%) as a useful resource, followed by the AEOP website (67%) and AEOP program administrators (67%). All three responding mentors reported having not experienced AEOP social media or AEOP printed materials for this purpose.

Table 194. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=3)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	33.3%	0.0%	0.0%	0.0%	66.7%	
	1	0	0	0	2	**3**
AEOP on Facebook, Twitter, Pinterest or other social media	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
AEOP printed materials	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
	33.3%	0.0%	0.0%	33.3%	33.3%	

AEOP Program administrator or site coordinator	1	0	0	1	1	**3**
Invited speakers or "career" events	66.7%	0.0%	0.0%	33.3%	0.0%	
	2	0	0	1	0	**3**
Participation in program	0.0%	0.0%	0.0%	33.3%	66.7%	
	0	0	0	1	2	**3**

Apprentices were asked which resources impacted their awareness of the various AEOP (Table 195). Again, the three responding apprentices reported four sources as particularly impactful (somewhat or very much): participation in SEAP (67%), SEAP mentors (67%), the AEOP website (67%), and presentations shared in SEAP (100%).

Table 195. Impact of Resources on Student Awareness of AEOP (n=3)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	33.3%	0.0%	33.3%	33.3%	
	1	0	1	1	**3**
AEOP on Facebook, Twitter or other social media	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
AEOP printed materials	33.3%	33.3%	0.0%	33.3%	
	1	1	0	1	**3**
My Apprenticeship Mentor	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
Presentations or information shared through the Apprenticeship Program	0.0%	0.0%	33.3%	66.7%	
	0	0	1	2	**3**
Participation in the Apprenticeship Program	0.0%	33.3%	0.0%	66.7%	
	0	1	0	2	**3**

Mentors were also asked how useful various resources were in exposing apprentices to AEOP (Table 196). All three responding mentors reported SEAP participation (100%) was at least somewhat useful, followed by AEOP program administrators (67%). All three mentors reported that they did not experience AEOP printed materials (67%) or AEOP on social media (67%) as resources for exposing apprentices to AEOP.

Table 196. Usefulness of Resources for Exposing Students to AEOP (n=3)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total

Army Educational Outreach Program (AEOP) website	33.3%	0.0%	33.3%	33.3%	0.0%	
	1	0	1	1	0	**3**
AEOP on Facebook, Twitter, Pinterest or other social media	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
AEOP printed materials	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
AEOP Program administrator or site coordinator	0.0%	0.0%	33.3%	33.3%	33.3%	
	0	0	1	1	1	**3**
Invited speakers or "career" events	66.7%	0.0%	33.3%	0.0%	0.0%	
	2	0	1	0	0	**3**
Participation in the program	0.0%	0.0%	0.0%	66.7%	33.3%	
	0	0	0	2	1	**3**

Resources – University-Based Programs

REAP

Apprentices were asked about the impact of AEOP resources on their awareness of DoD STEM careers (Table 197). Two-thirds or more of apprentices reported that the following resources were somewhat or very much impactful: participation in REAP (94%); REAP mentors (82%); the AEOP website (82%); and presentations shared in REAP (65%). More than half of REAP apprentices said they had not experienced AEOP resources such as the ARO website (59%) and AEOP on social media (59%).

Table 197. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=17)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	5.9%	11.8%	35.3%	47.1%	
	1	2	6	8	**17**
AEOP on Facebook, Twitter or other social media	58.8%	35.3%	5.9%	0.0%	
	10	6	1	0	**17**
Army Research Office (ARO) website	58.8%	23.5%	11.8%	5.9%	
	10	4	2	1	**17**
AEOP printed materials	35.3%	23.5%	17.6%	23.5%	

	6	4	3	4	**17**
My Apprenticeship Program mentor	0.0%	17.6%	23.5%	58.8%	
	0	3	4	10	**17**
Presentations or information shared in the Apprenticeship Program	17.6%	17.6%	17.6%	47.1%	
	3	3	3	8	**17**
Participation in the Apprenticeship Program	0.0%	5.9%	29.4%	64.7%	
	0	1	5	11	**17**

Mentors were also asked how useful certain resources were for introducing apprentices to DoD STEM careers (Table 198). Mentors were most likely to rate participation in REAP (86%), the AEOP website (86%), AEOP program administration (57%), and AEOP printed materials (50%) as at least somewhat useful resources. All other resources were not experienced by more than half of responding CQL mentors.

Table 198. Usefulness of Resources for Exposing Students 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	7.1%	0.0%	7.1%	14.3%	71.4%	
	1	0	1	2	10	**14**
AEOP on Facebook, Twitter, Pinterest or other social media	64.3%	7.1%	7.1%	14.3%	7.1%	
	9	1	1	2	1	**14**
AEOP printed materials	42.9%	0.0%	7.1%	21.4%	28.6%	
	6	0	1	3	4	**14**
AEOP Program administrator or site coordinator	28.6%	0.0%	14.3%	7.1%	50.0%	
	4	0	2	1	7	**14**
Invited speakers or "career" events	64.3%	0.0%	7.1%	7.1%	21.4%	
	9	0	1	1	3	**14**
Participation in program	0.0%	7.1%	7.1%	14.3%	71.4%	
	0	1	1	2	10	**14**

Apprentices were asked which resources impacted their awareness of the various AEOP (Table 199). Two-thirds or more of REAP apprentices (65%-100%) indicated all resources were at least somewhat impactful except for AEOP social media (6% useful, 65% did not experience). All apprentices (100%) said participation in REAP was at least somewhat impactful.

Table 199. Impact of Resources on Apprentice Awareness of AEOP (n=17)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	5.9%	5.9%	17.6%	70.6%	
	1	1	3	12	**17**
AEOP on Facebook, Twitter or other social media	64.7%	29.4%	5.9%	0.0%	
	11	5	1	0	**17**
AEOP printed materials	35.3%	0.0%	35.3%	29.4%	
	6	0	6	5	**17**
My Apprenticeship Mentor	0.0%	11.8%	11.8%	76.5%	
	0	2	2	13	**17**
Presentations or information shared through the Apprenticeship Program	5.9%	0.0%	29.4%	64.7%	
	1	0	5	11	**17**
Participation in the Apprenticeship Program	0.0%	0.0%	5.9%	94.1%	
	0	0	1	16	**17**

Mentors were also asked how useful various resources were in exposing apprentices to AEOP (Table 200). Nearly all mentors reported that REAP participation (93%) and the AEOP website (93%) were at least somewhat useful. Additionally, at least half indicated AEOP program administrators (57%) and AEOP printed materials (67%) were at least somewhat useful for this purpose. Most mentors said they did not experience AEOP on social media (64%) or invited speakers (64%) as resources for exposing apprentices to AEOP.

Table 200. Usefulness of Resources for Exposing Students to AEOP (n=14)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	7.1%	21.4%	71.4%	
	0	0	1	3	10	**14**
AEOP on Facebook, Twitter, Pinterest or other social media	64.3%	7.1%	7.1%	7.1%	14.3%	
	9	1	1	1	2	**14**
AEOP printed materials	35.7%	0.0%	14.3%	14.3%	35.7%	
	5	0	2	2	5	**14**
AEOP Program administrator or site coordinator	28.6%	0.0%	14.3%	7.1%	50.0%	
	4	0	2	1	7	**14**

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Invited speakers or "career" events	64.3%	7.1%	7.1%	7.1%	14.3%	
	9	1	1	1	2	**14**
Participation in the program	0.0%	0.0%	7.1%	14.3%	78.6%	
	0	0	1	2	11	**14**

HSAP

Apprentices were asked about the impact of AEOP resources on their awareness of DoD STEM careers (Table 201). Half or more of apprentices reported the following resources as somewhat or very much impactful: the AEOP website (50%); presentations shared in program (63%); HSAP mentors (75%); and participation in HSAP (88%). More than half of HSAP apprentices said they had not experienced AEOP resources such as the ARO website (63%), AEOP printed materials (75%), and AEOP on social media (75%).

Table 201. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=8)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	25.0%	25.0%	25.0%	25.0%	
	2	2	2	2	**8**
AEOP on Facebook, Twitter or other social media	75.0%	12.5%	0.0%	12.5%	
	6	1	0	1	**8**
Army Research Office (ARO) website	62.5%	12.5%	12.5%	12.5%	
	5	1	1	1	**8**
AEOP printed materials	62.5%	25.0%	0.0%	12.5%	
	5	2	0	1	**8**
My Apprenticeship Program mentor	12.5%	12.5%	50.0%	25.0%	
	1	1	4	2	**8**
Presentations or information shared in the Apprenticeship Program	25.0%	12.5%	37.5%	25.0%	
	2	1	3	2	**8**
Participation in the Apprenticeship Program	12.5%	0.0%	50.0%	37.5%	
	1	0	4	3	**8**

Table 202 shows the one responding HSAP mentor indicated he had only experienced AEOP website as a useful resource for exposing apprentices to DoD STEM careers. He reported having not experienced any of the other resources for this purpose.

Table 202. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=1)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
AEOP on Facebook, Twitter, Pinterest or other social media	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
AEOP printed materials	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
AEOP Program administrator or site coordinator	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
Invited speakers or "career" events	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
Participation in program	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**

Apprentices were asked which resources impacted their awareness of the various AEOP (Table 203). Again, large proportions of apprentices reported the following four sources as particularly impactful (somewhat or very much): participation in HSAP (100%), HSAP mentors (100%), the AEOP website (100%), and presentations shared in HSAP (63%). Half or more of responding apprentices had not experienced AEOP on social media (88%) or AEOP printed materials (50%).

Table 203. Impact of Resources on Apprentice Awareness of AEOP (n=8)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	25.0%	75.0%	
	0	0	2	6	**8**
AEOP on Facebook, Twitter or other social media	87.5%	0.0%	0.0%	12.5%	
	7	0	0	1	**8**
AEOP printed materials	50.0%	25.0%	0.0%	25.0%	
	4	2	0	2	**8**

My Apprenticeship Mentor	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
Presentations or information shared through the Apprenticeship Program	25.0%	12.5%	37.5%	25.0%	
	2	1	3	2	**8**
Participation in the Apprenticeship Program	0.0%	0.0%	50.0%	50.0%	
	0	0	4	4	**8**

Mentors were also asked how useful various resources were in their efforts to expose apprentices to AEOP (Table 204). The one responding mentor indicated the AEOP website and participation in HSAP were very much useful for this purpose. All other resources were not experienced by this mentor for this purpose.

Table 204. Useful Resources for Exposing Apprentices to AEOP (n=1)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**
AEOP on Facebook, Twitter, Pinterest or other social media	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
AEOP printed materials	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
AEOP Program administrator or site coordinator	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
Invited speakers or "career" events	100.0%	0.0%	0.0%	0.0%	0.0%	
	1	0	0	0	0	**1**
Participation in the program	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	1	**1**

URAP

Apprentices were asked about the impact of AEOP resources on their awareness of DoD STEM careers (Table 205). Approximately two-thirds of apprentices reported the following resources as somewhat or very much impactful: the AEOP website (63%); URAP mentors (63%); and participation in URAP (69%). Half or more of URAP apprentices said they had not experienced AEOP resources such as AEOP on social media (69%) and AEOP printed materials (50%) for this purpose.

Table 205. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=16)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	18.8%	18.8%	50.0%	12.5%	
	3	3	8	2	**16**
AEOP on Facebook, Twitter or other social media	68.8%	18.8%	12.5%	0.0%	
	11	3	2	0	**16**
Army Research Office (ARO) website	43.8%	12.5%	37.5%	6.3%	
	7	2	6	1	**16**
AEOP printed materials	50.0%	12.5%	31.3%	6.3%	
	8	2	5	1	**16**
My Apprenticeship Program mentor	18.8%	18.8%	50.0%	12.5%	
	3	3	8	2	**16**
Presentations or information shared in the Apprenticeship Program	37.5%	18.8%	31.3%	12.5%	
	6	3	5	2	**16**
Participation in the Apprenticeship Program	18.8%	12.5%	50.0%	18.8%	
	3	2	8	3	**16**

Mentors were asked how useful certain resources were for introducing apprentices to DoD STEM careers (Table 206). Mentors were most likely to rate participation in URAP (70%) and the AEOP website (70%) as at least somewhat useful resources. The following resources were not experienced by more than half of responding URAP mentors: invited speakers (70%) and AEOP on social media (60%).

Table 206. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	20.0%	0.0%	10.0%	10.0%	60.0%	
	2	0	1	1	6	**10**
AEOP on Facebook, Twitter, Pinterest or other social media	60.0%	0.0%	10.0%	10.0%	20.0%	
	6	0	1	1	2	**10**
AEOP printed materials	40.0%	10.0%	10.0%	0.0%	40.0%	
	4	1	1	0	4	**10**
	30.0%	0.0%	20.0%	0.0%	50.0%	

AEOP Program administrator or site coordinator	3	0	2	0	5	**10**
Invited speakers or "career" events	70.0%	0.0%	10.0%	10.0%	10.0%	
	7	0	1	1	1	**10**
Participation in program	20.0%	0.0%	10.0%	0.0%	70.0%	
	2	0	1	0	7	**10**

Apprentices were asked which resources impacted their awareness of the various AEOP (Table 207). Half or more reported the following four resources as particularly impactful (somewhat or very much): URAP mentors (100%); the AEOP website (94%); participation in URAP (81%); and presentations shared in URAP (50%). More than half of responding apprentices had not experienced AEOP on social media (69%) or AEOP printed materials (56%).

Table 207. Impact of Resources on Apprentice Awareness of AEOP (n=16)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	6.3%	50.0%	43.8%	
	0	1	8	7	**16**
AEOP on Facebook, Twitter or other social media	68.8%	18.8%	6.3%	6.3%	
	11	3	1	1	**16**
AEOP printed materials	56.3%	6.3%	37.5%	0.0%	
	9	1	6	0	**16**
My Apprenticeship Mentor	0.0%	0.0%	43.8%	56.3%	
	0	0	7	9	**16**
Presentations or information shared through the Apprenticeship Program	31.3%	18.8%	43.8%	6.3%	
	5	3	7	1	**16**
Participation in the Apprenticeship Program	6.3%	12.5%	50.0%	31.3%	
	1	2	8	5	**16**

Mentors were also asked how useful various resources were in exposing apprentices to AEOP (Table 208). More than half of mentors reported URAP participation (80%) was at least somewhat useful, followed by the AEOP website (60%). Most mentors said they did not experience invited speakers (70%) or AEOP on social media (60%) as resources for exposing apprentices to AEOP.

Table 208. Usefulness of Resources for Exposing Apprentices to AEOP (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	20.0%	0.0%	20.0%	20.0%	40.0%	
	2	0	2	2	4	**10**
AEOP on Facebook, Twitter, Pinterest or other social media	60.0%	0.0%	10.0%	20.0%	10.0%	
	6	0	1	2	1	**10**
AEOP printed materials	40.0%	10.0%	10.0%	20.0%	20.0%	
	4	1	1	2	2	**10**
AEOP Program administrator or site coordinator	30.0%	0.0%	20.0%	10.0%	40.0%	
	3	0	2	1	4	**10**
Invited speakers or "career" events	70.0%	0.0%	20.0%	0.0%	10.0%	
	7	0	2	0	1	**10**
Participation in the program	10.0%	0.0%	10.0%	10.0%	70.0%	
	1	0	1	1	7	**10**

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 AEOP in the future, and their awareness of and interest in STEM careers.

Overall Impact – Level and Setting Comparisons

All apprentices were asked to provide 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 for 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 overall impact were found by grade level or program setting.

CQL

[30] Overall Program Impact (7 items) Cronbach's alpha reliability = 0.832.

Approximately 70% or more of apprentices (69%-96%) agreed that CQL contributed in some way to each impact listed in Table 209. Areas of greatest impact were increased confidence in STEM knowledge, skills, and abilities (96%) and a greater appreciation of DoD STEM research (90%). The overall impacts composite variable was used to test for differences in overall Underserved classification and among subgroups of apprentices; no significant differences were found.

Table 209. Apprentice Opinions of CQL Impacts (n=52)

	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	0.0%	3.8%	67.3%	28.8%	
	0	2	35	15	**52**
I am more interested in participating in STEM activities outside of school requirements	1.9%	13.5%	51.9%	32.7%	
	1	7	27	17	**52**
I am more interested in taking STEM classes in school	7.7%	23.1%	53.8%	15.4%	
	4	12	28	8	**52**
I am more interested in earning a STEM degree	7.7%	21.2%	55.8%	15.4%	
	4	11	29	8	**52**
I am more interested in pursuing a career in STEM	7.7%	21.2%	48.1%	23.1%	
	4	11	25	12	**52**
I have a greater appreciation of Army or DoD STEM research	5.8%	3.8%	34.6%	55.8%	
	3	2	18	29	**52**
I am more interested in pursuing a STEM career with the Army or DoD	13.5%	7.7%	36.5%	42.3%	
	7	4	19	22	**52**

SEAP

Two or three of the responding SEAP apprentices (67%-100%) agreed that SEAP contributed in some way to each impact listed in Table 210. Areas of greatest impact (all three agreed) were more interested in participating in STEM activities outside of school requirements (100%) and a greater appreciation of DoD STEM research (100%). The SEAP survey sample was too small to use the Overall Impacts composite variable to assess for statistical differences between groups.

Table 210. Apprentice Opinions of SEAP Impacts (n=3)

	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	33.3%	0.0%	0.0%	66.7%	
	1	0	0	2	**3**
I am more interested in participating in STEM activities outside of school requirements	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
I am more interested in taking STEM classes in school	0.0%	33.3%	33.3%	33.3%	
	0	1	1	1	**3**
I am more interested in earning a STEM degree	0.0%	33.3%	66.7%	0.0%	
	0	1	2	0	**3**
I am more interested in pursuing a career in STEM	0.0%	33.3%	66.7%	0.0%	
	0	1	2	0	**3**
I have a greater appreciation of Army or DoD STEM research	0.0%	0.0%	66.7%	33.3%	
	0	0	2	1	**3**
I am more interested in pursuing a STEM career with the Army or DoD	33.3%	0.0%	66.7%	0.0%	
	1	0	2	0	**3**

Overall Impact – University-Based Program

REAP

More than half of REAP apprentices (59%-100%) agreed that REAP contributed in some way to each impact listed in Table 211. The greatest area of impact, with all apprentices agreeing, was feeling more confident in their STEM knowledge, skills, and abilities (100%). The overall impacts composite variable was used to test for differences in overall Underserved classification and among subgroups of apprentices; no significant differences were found.

Table 211. Apprentice Opinions of REAP Impacts (n=17)

	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%	0.0%	70.6%	29.4%	
	0	0	12	5	**17**
I am more interested in participating in STEM activities outside of school requirements	5.9%	11.8%	52.9%	29.4%	
	1	2	9	5	**17**
I am more interested in taking STEM classes in school	5.9%	17.6%	47.1%	29.4%	
	1	3	8	5	**17**
I am more interested in earning a STEM degree	0.0%	17.6%	52.9%	29.4%	
	0	3	9	5	**17**
I am more interested in pursuing a career in STEM	0.0%	17.6%	52.9%	29.4%	
	0	3	9	5	**17**
I have a greater appreciation of Army or DoD STEM research	0.0%	17.6%	29.4%	52.9%	
	0	3	5	9	**17**
I am more interested in pursuing a STEM career with the Army or DoD	29.4%	11.8%	23.5%	35.3%	
	5	2	4	6	**17**

HSAP

Approximately two-thirds or more (63%-100%) of HSAP apprentices agreed that the program contributed in some way to each impact listed in Table 212. All apprentices said HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%) and gave them a greater appreciation of Army/DoD STEM research (100%). The HSAP survey sample was too small to use the Overall Impacts composite variable to assess for statistical differences between groups.

Table 212. Apprentice Opinions of HSAP Impacts (n=8)

	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%	87.5%	12.5%	
	0	0	7	1	**8**
	12.5%	25.0%	62.5%	0.0%	

I am more interested in participating in STEM activities outside of school requirements	1	2	5	0	**8**
I am more interested in taking STEM classes in school	12.5%	25.0%	62.5%	0.0%	
	1	2	5	0	**8**
I am more interested in earning a STEM degree	12.5%	25.0%	62.5%	0.0%	
	1	2	5	0	**8**
I am more interested in pursuing a career in STEM	12.5%	25.0%	62.5%	0.0%	
	1	2	5	0	**8**
I have a greater appreciation of Army or DoD STEM research	0.0%	0.0%	62.5%	37.5%	
	0	0	5	3	**8**
I am more interested in pursuing a STEM career with the Army or DoD	12.5%	12.5%	37.5%	37.5%	
	1	1	3	3	**8**

URAP

Nearly 70% or more (69%-100%) of URAP apprentices agreed the program contributed in some way to each impact listed in Table 213. All apprentices reported that participating in URAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%). No statistical differences were found in the Overall Impacts composite variable by overall Underserved status or individual demographic variables.

Table 213. Apprentice Opinions of URAP Impacts (n=16)

	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%	0.0%	68.8%	31.3%	
	0	0	11	5	**16**
I am more interested in participating in STEM activities outside of school requirements	0.0%	12.5%	75.0%	12.5%	
	0	2	12	2	**16**
I am more interested in taking STEM classes in school	0.0%	31.3%	68.8%	0.0%	
	0	5	11	0	**16**
	0.0%	25.0%	62.5%	12.5%	

I am more interested in earning a STEM degree	0	4	10	2	**16**
I am more interested in pursuing a career in STEM	0.0%	18.8%	62.5%	18.8%	
	0	3	10	3	**16**
I have a greater appreciation of Army or DoD STEM research	18.8%	0.0%	50.0%	31.3%	
	3	0	8	5	**16**
I am more interested in pursuing a STEM career with the Army or DoD	18.8%	6.3%	50.0%	25.0%	
	3	1	8	4	**16**

8

8 | AEOP Summer Course Evaluation

Course Description

In light of the COVID-19 pandemic, a significant number of AEOP high school participants were displaced from the AEOP apprenticeship programs for high school students (REAP, SEAP, and HSAP). To address the 2020 summer programming gap, the Rochester Institute of Technology provided a virtual four-week (July 20 - August 14) credit-bearing course for 104 displaced high school apprentices.

The course, *Science in the Real World: Finding Your Voice*, engaged participants around themes connected to the AEOP goal of creating a STEM literate citizenry. Students explored the concepts and effects of science and technology on society, looked at how science and technology have affected and been affected by our values, and thought about how we know what we know in science and engineering (metacognition) as they completed hands-on experiments. As a supplement to the course, students participated in a seminar series featuring speakers related to course topics, STEM research areas, and Army/DoD laboratories. Virtual college and career readiness skill-building workshops were also provided. Twelve undergraduate students (past AEOP apprenticeship participants and RIT undergraduates in STEM) served as near-peer mentors and teaching assistants within the course experience. Students and near-peer mentors were provided with all course related materials and were awarded an educational stipend upon completion of the course.

Successful summer course participants earned two units of transcript credit at RIT. The course aimed to equip students with an understanding of the culture of science and engineering, an appreciation for doing STEM in the public interest (including knowledge of government research labs), exposure to high-need areas of STEM research, a deepened understanding of the process of producing scientific knowledge, and an increased preparedness for college and careers in STEM.

Enrollment

The apprenticeship course served 104 students. Of these students, 54 were displaced REAP students, 17 were displaced HSAP students, and 31 were displaced SEAP students. Two additional students who had not applied to apprenticeship programs were also accepted for the course.

Demographic data for the 102 students who were displaced from apprenticeships are provided in Table 214. Nearly three quarters of students were female (74.5%) and just over a quarter (25.5%) were male. The most frequently reported race ethnicity was Asian (45%) followed by Black or African American (27%), White (11%), and Hispanic or Latino (10%). Most students (68%) attended suburban schools, and most (56%) were in the 11th grade. Less than a third (29%) received free or reduced-price school lunches (FARMS). Most students in the course (71%) spoke English as their first language, and relatively few (19%) would be first generation college attenders. Nearly three-quarters (73%) of students met the AEOP definition of underserved or underrepresented (Underserved).

Table 214. 2020 AEOP Summer Course Student Participant Profile

Demographic Category		
Respondent Gender (n=102)		
Female	76	74.5%
Male	26	25.5%
Choose not to report	0	0%
Respondent Race/Ethnicity (n=102)		
Asian	46	45.0%
Black or African American	27	26.5%
Hispanic or Latino	10	9.8%
Native American or Alaska Native	1	1.0%
Native Hawaiian or Other Pacific Islander	0	0%
White	11	10.8%
More than one race	4	3.9%
Other race or ethnicity	1	1.0%
Choose not to report	2	2.0%
School Location (n=102)		
Urban (city)	21	20.6%
Suburban	69	67.6%
Rural (country)	9	8.8%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	1	1.0%
Other	1	1.0%
Choose not to report	1	1.0%
Grade Level (n=102)		
9th Grade	12	11.8%
10th grade	25	24.5%

11th grade	57	55.9%
12th grade	8	7.8%
Free or Reduced Price Lunch Recipient (n=102)		
Yes	29	28.5%
No	70	68.6%
Choose not to report	3	2.9%
English is First Language (n=102)		
Yes	72	70.6%
No	29	28.4%
Choose not to report	1	1.0%
One parent/guardian graduated from college (n=102)		
Yes	80	78.5%
No	19	18.6%
Choose not to report	3	2.9%
Underserved Classification (n=102)		
Yes	74	72.5%
No	27	26.5%
Missing or Insufficient Data	1	1.0%

Note: 104 students participated in the AEOP summer course. Two students were not registered in CVENT and thus demographics are reported for 102 students.

AEOP Summer Course Evaluation Plan

So that outcomes from the summer course could be compared with other AEOP, the evaluation questionnaire used for apprenticeship programs was adapted for use in the summer course. The questionnaire is provided in Appendix D.

Table 215 shows a sample of 36 participants out of the 104 students enrolled completed the evaluation survey. This provided a participation rate of approximately 35%. The margin of error (noted in the table) is larger than generally considered acceptable, indicating that the survey sample may not be representative of population of students who participated in the summer course.

Table 215. 2020 AEOP Summer Course Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence
Students	36	104	34.6%	±13.27%

Respondent Demographics

Demographic information collected from the 36 evaluation survey respondents is summarized in Table 216. More females (72%) completed the survey compared to males (19%). A majority of students reported being Asian (36%) or White (19%). Most students reported being in the upper high school level (senior –

67%, junior – 19%). Students reported either attending a suburban (61%) or urban (14%) school. Most students said they did not earn free/reduced lunch (72%), spoke English as a first language (58%), and had at least one parent who had graduated from college (69%). Slightly under two-thirds of survey respondents (64%) met the AEOP criteria for Underserved status. These demographic data are similar to those of overall enrolled participants, although slightly fewer respondents met the AEOP criteria for Underserved and somewhat more were White than in the overall population of students enrolled in the course.

Table 216. 2020 AEOP Summer Course Student Survey Respondent Profile		
Demographic Category		
Respondent Gender (n=36)		
Female	26	72.3%
Male	7	19.4%
Missing	3	8.3%
Respondent Race/Ethnicity (n=36)		
Asian	13	36.1%
Black or African American	3	8.3%
Hispanic or Latino	2	5.6%
Native American or Alaska Native	1	2.8%
Native Hawaiian or Other Pacific Islander	0	0.0%
White	7	19.4%
More than one race	1	2.8%
Other race or ethnicity	0	0%
Choose not to report	0	0%
Missing	9	25.0%
School Location (n=36)		
Urban (city)	5	13.9%
Suburban	22	61.1%
Rural (country)	5	13.9%
Frontier or tribal School	0	0%
DoDDS/DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Other	0	0%

Choose not to report	1	2.8%
Missing	3	8.3%
Grade Level (n=36)		
9th Grade	0	0%
10th grade	4	11.1%
11th grade	7	19.4%
12th grade	24	66.7%
College Senior	1	2.8%
Free or Reduced Price Lunch Recipient (n=36)		
Yes	7	21.9%
No	23	71.8%
Choose not to report	2	6.3%
English is First Language (n=36)		
Yes	21	58.4%
No	12	33.3%
Choose not to report	0	0%
Missing	3	8.3%
One parent/guardian graduated from college (n=36)		
Yes	25	69.4%
No	6	16.7%
Choose not to report	2	5.6%
Missing	3	8.3%
Underserved Classification (n=36)		
Yes	23	63.9%
No	9	25.0%
Missing or Insufficient Data	4	11.1%

STEM Knowledge and 21st Century Skills

Approximately 70% of students or more (70%-95%) reported either medium or large gains in every area of STEM knowledge on the survey (Table 217). The area with the largest knowledge gain was students' knowledge of research processes, ethics, and rules for conduct in STEM (95%). STEM knowledge gain composites were used to test for differential impacts by overall Underserved classification and across demographic subgroups of apprentices. No differences were found by overall Underserved classification. There were, however, significant differences in STEM knowledge by first generation status (first generation students reporting greater gains; effect size is medium with d = 0.789) and ELL status (ELL students reporting greater gains; effect size is large with d = 1.02).[21]

[21] Independent Samples *t*-test for STEM Knowledge: First Generation Status – $t(34)=2.30$, $p=.028$; ELL Status – $t(34)=2.97$, $p=.005$.

Table 217. Student Report of Impacts on STEM Knowledge (n=36)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	2.8%	27.8%	41.7%	27.8%	
	1	10	15	10	**36**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	5.6%	27.8%	66.7%	
	0	2	10	24	**36**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	16.7%	41.7%	41.7%	
	0	6	15	15	**36**
Knowledge of what everyday research work is like in STEM	8.3%	13.9%	36.1%	41.7%	
	3	5	13	15	**36**

More than half of students reported high levels (medium to large) of 21st Century skills gains (58%-97%) across survey items, except for one, as a result of participating in their program (Table 218). The one item for which less than half of students reported strong gains was creating media products (17% - medium/large gains). Three items for which nearly all participants reported at least medium gains were: communicating clearly (94%); evaluating others' evidence, arguments, and beliefs (95%); and collaborating with others effectively in diverse teams (97%). Composites from the 21st Century skills section of the questionnaire were used to test for differential impacts by overall Underserved status and subgroups; none were found.

Table 218. Student Report of Impacts on 21st Century Skills (n=36)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	2.8%	19.4%	36.1%	41.7%	
	1	7	13	15	**36**
Working creatively with others	5.6%	22.2%	33.3%	38.9%	
	2	8	12	14	**36**
Using my creative ideas to make a product	8.3%	33.3%	36.1%	22.2%	
	3	12	13	8	**36**
Thinking about how systems work and how parts interact with each other	11.1%	16.7%	33.3%	38.9%	
	4	6	12	14	**36**
Evaluating others' evidence, arguments, and beliefs	0.0%	5.6%	30.6%	63.9%	
	0	2	11	23	**36**

Solving problems	0.0%	25.0%	41.7%	33.3%	
	0	9	15	12	**36**
Communicating clearly (written and oral) with others	0.0%	5.6%	33.3%	61.1%	
	0	2	12	22	**36**
Collaborating with others effectively and respectfully in diverse teams	2.8%	0.0%	33.3%	63.9%	
	1	0	12	23	**36**
Interacting effectively in a respectful and professional manner	0.0%	13.9%	27.8%	58.3%	
	0	5	10	21	**36**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	2.8%	19.4%	44.4%	33.3%	
	1	7	16	12	**36**
Using and managing data accurately, creatively, and ethically	0.0%	22.2%	38.9%	38.9%	
	0	8	14	14	**36**
Analyzing media (news) - understanding points of view in the media	2.8%	16.7%	25.0%	55.6%	
	1	6	9	20	**36**
Creating media products like videos, blogs, social media	52.8%	30.6%	8.3%	8.3%	
	19	11	3	3	**36**
Use technology as a tool to research, organize, evaluate, and communicate information	8.3%	25.0%	33.3%	33.3%	
	3	9	12	12	**36**
Adapting to change when things do not go as planned	8.3%	16.7%	27.8%	47.2%	
	3	6	10	17	**36**
Incorporating feedback into my work effectively	0.0%	13.9%	33.3%	52.8%	
	0	5	12	19	**36**
Setting goals and utilizing time wisely	5.6%	25.0%	30.6%	38.9%	
	2	9	11	14	**36**
Working independently and completing tasks on time	5.6%	16.7%	38.9%	38.9%	
	2	6	14	14	**36**
Taking initiative and doing work without being told to	5.6%	27.8%	36.1%	30.6%	
	2	10	13	11	**36**
	2.8%	25.0%	41.7%	30.6%	

Prioritizing, planning, and managing projects to achieve completion	1	9	15	11	**36**
Producing results - sticking with a task until it is finished	5.6%	16.7%	38.9%	38.9%	
	2	6	14	14	**36**
Leading and guiding others in a team or group	11.1%	27.8%	36.1%	25.0%	
	4	10	13	9	**36**
Being responsible to others - thinking about the larger community	8.3%	16.7%	33.3%	41.7%	
	3	6	12	15	**36**

STEM Identity and Confidence

Approximately three-quarters or more of students (72%-95%) reported medium or large gains on all items associated with STEM identity (Table 219). Nearly all students reported at least medium gains in a desire to build relationships with mentors who work in STEM (95%). STEM identity composite scores were used to evaluate differences by overall Underserved status and demographic variables contributing to Underserved. No significant differences existed by overall Underserved classification or demographics investigated.

Table 219. Student Report of Impacts on STEM Identity (n=36)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	16.7%	8.3%	36.1%	38.9%	
	6	3	13	14	**36**
Interest in pursuing a STEM career	5.6%	22.2%	33.3%	38.9%	
	2	8	12	14	**36**
Sense of accomplishing something in STEM	0.0%	25.0%	30.6%	44.4%	
	0	9	11	16	**36**
Feeling prepared for more challenging STEM activities	0.0%	16.7%	33.3%	50.0%	
	0	6	12	18	**36**
Confidence to try out new ideas or procedures on my own in a STEM project	2.8%	13.9%	27.8%	55.6%	
	1	5	10	20	**36**
Desire to build relationships with mentors who work in STEM	2.8%	2.8%	27.8%	66.7%	
	1	1	10	24	**36**

Program Features and Satisfaction

Students were asked about their motivation for taking the course (Table 220) and if they would take this course, or one similar, if it did not offer college credits (Table 221). Approximately three-quarters or more of students reported the following motivations for taking the course: doing something in STEM (79%), college credit (75%), something to do with the cancellation of apprenticeships (75%), and stipend (72%). Nearly all responding students (92%) said they would choose to enroll in a similar course without college credit tied to it.

Table 220. Student Reports of Motivation for Enrollment (n=36)

	Response Percent	Response Total
Something to do with the cancellation of apprenticeships	75.0%	27
Could take it virtually	52.8%	19
College credit	75.0%	27
Stipend	72.2%	26
Work with college professors	61.1%	22
Connect with peers from across the country	36.1%	13
Do something in STEM	77.8%	28
Near peer mentors	19.4%	7
Get ahead	13.9%	5

Table 221. Future Enrollment in Similar Course Without College Credits (n=36)

	Response Percent	Response Total
Yes	91.7%	33
No	8.3%	3

Students were asked to identify their satisfaction level with various program features (Table 222). More than 90% of students (94%-100%) indicated being somewhat or very much satisfied with all program features listed in Table 222. Features with which all students reported being at least somewhat satisfied included the ability of course to meet their expectations (100%) and small group meetings with near peer mentors (100%).

Table 222. Student Satisfaction with AEOP Summer Course Program Features (n=36)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for program	0.0%	5.6%	19.4%	75.0%	
	0	2	7	27	**36**
	0.0%	0.0%	36.1%	63.9%	

ARMY EDUCATIONAL OUTREACH PROGRAM

Ability of course to meet your expectations	0	0	13	23	**36**
Ability of course to enable you to learn new things	0.0%	2.8%	19.4%	77.8%	
	0	1	7	28	**36**
The knowledge and/or skills gained through the course will help you in future studies and/or career	0.0%	2.8%	16.7%	80.6%	
	0	1	6	29	**36**
Ability of course to help me prepare for applying to college	0.0%	5.6%	22.2%	72.2%	
	0	2	8	26	**36**
Webinar series	2.8%	2.8%	22.2%	72.2%	
	1	1	8	26	**36**
Small group meetings with near peer mentors	0.0%	0.0%	8.3%	91.7%	
	0	0	3	33	**36**

Students completing the evaluation survey were asked about the availability of their mentors during their program (Table 223). All but one respondent said their mentor was available at least half of the time (97%), and more than three-quarters (78%) noted their mentor was always available.

Table 223. Student Reports of Availability of Mentors (n=36)

	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	2.8%	1
The mentor was available about half of the time of my project	0%	0
The mentor was available more than half of the time	19.4%	7
The mentor was always available	77.8%	28

Students were also asked to report on their mentors' use of mentoring strategies during the apprenticeship course (Table 224). A large majority of students (72%-100%) reported that their mentors in the course used each of the mentoring strategies about which they were asked. All students reported that mentors encouraged them to share ideas with others who had different backgrounds or viewpoints than they (100%) and gave them feedback to help them improve in STEM.

Table 224. Student Reports of Mentors' Use of Mentoring Strategies (n=36)

	Yes - my mentor used this strategy with me	No - my mentor did not use this strategy with me	Response Total
Helped me become aware of STEM in my everyday life	94.4%	5.6%	
	34	2	**36**
Helped me understand how I can use STEM to improve my community	86.1%	13.9%	
	31	5	**36**
Used a variety of strategies to help me learn	91.7%	8.3%	
	33	3	**36**
Gave me extra support when I needed it	91.7%	8.3%	
	33	3	**36**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	100.0%	0.0%	
	36	0	**36**
Allowed me to work on a team project or activity	77.8%	22.2%	
	28	8	**36**
Helped me learn or practice a variety of STEM skills	88.9%	11.1%	
	32	4	**36**
Gave me feedback to help me improve in STEM	100.0%	0.0%	
	36	0	**36**
Talked to me about the education I need for a STEM career	94.4%	5.6%	
	34	2	**36**
Recommended Army Educational Outreach Programs that match my interests	72.2%	27.8%	
	26	10	**36**
Discussed STEM careers with the DoD or government	83.3%	16.7%	
	30	6	**36**

Students participating in the apprenticeship course were asked to respond to several open-ended questionnaire items. When asked to comment on their overall satisfaction with the course, all 36 students had something positive to say. Students who identified the sources of their satisfaction with the course mentioned the opportunity to meet new people, their learning, the speakers, the NPMs, the career information they received, and their new perspective on social issues related to STEM. Students most consistently commented upon the opportunity to network (with other students, their mentors, and professors) the value of the speakers, and their broadened perspectives about STEM. Students said, for example,

> *"I was really satisfied with this course. I had never taken a course like this, both in terms of what the course was on and how the course was taught. First, I had never taken a course that dived into the ethics and failures aspect of STEM. It was refreshing to learn about these topics because it taught me to take a step back and appreciate what I was doing. Second, I had never taken a course like this online, where I got to bond with 8 other students and 2 near-peer mentors. Though we didn't get much contact with the professors, it was great to know that two mentors knew me relatively well. I was comfortable contacting them and engaging with them."* (Apprenticeship Course Student Participant)
>
> *"I really liked this summer course. It has been a great opportunity for me to learn more practical basic STEM skills like writing a lab report, but it also gave me the opportunity to learn about bigger topics in STEM, such as ethics and discrimination. I also appreciate all of the speakers they course brought in. It was really helpful to see how different STEM majors and subjects can be applied in the working world and how they are all connected."* (Apprenticeship Course Student Participant)
>
> *"I am very satisfied with my AEOP summer course experience. It has given me practice communicating about STEM and considering some of the ethical issues I may face in a STEM career and the impact of my future work. It was very fun and insightful to talk with my small group every day, and the webinar presenters gave me a clearer vision of the path to a career in STEM."* (Apprenticeship Course Student Participant)
>
> *"I really enjoyed this course because it dealt with many interesting and diverse topics. I also enjoyed that the class was very interactive, and I met people from different backgrounds and places."* (Apprenticeship Course Student Participant)
>
> *"It was a lot more interesting and fun than I had originally expected. I learned so much about the aspects of STEM that I had never thought about, and skills that I need like communication or asking questions. I would recommend any STEM student to take the course."* (Apprenticeship Course Student Participant)

Students were also asked, in an open-ended questionnaire item, to list three ways that participating in the course helped them. The 36 students who responded cited a wide variety of benefits. The most frequently mentioned benefits were as follows:

- the general STEM learning students experienced (15 students, or 42%)
- the college information students received (14 students, or 39%)
- the career information students received (12 students, or 33%)

- developing communication skills, including public speaking and writing (11 students, or 31%)

Course benefits mentioned by five to eight students (14%-22%), included:

- acquiring STEM skills or research skills (e.g., writing lab reports) (8 students, or 22%)
- learning about the social aspects of STEM (e.g., ethics, history, inequalities) (8 students, or 22%)
- connecting with peers (7 students, or 19%)
- receiving college credit (5 students, or 14%)
- networking (5 students, or 14%)
- the opportunity to do something productive during the summer (5 students, or 14%)

Other benefits, mentioned by one to four students (3%-11%) included developing time management skills, the quality of the mentors, receiving DoD or AEOP information, the stipend, and increases in their interest in or motivation for STEM.

The following are illustrative examples of the benefits apprenticeship course students listed:

- *"I heard from so many STEM professionals and I learned about many different careers."*
- *"[A benefit of the course was] learning to write a lab report and learning about common knowledge (sig figs, moles, etc.)"*
- *"Connected with students from across the country."*
- *"[Learned] about the history of the scientific community and how it affected underrepresented groups."*
- *"Prepared me for college life and expectations."*
- *"[My] communication skills improved with daily NPM meetings/group discussion."*
- *"I was productive and did something I could be proud of myself for this summer."*

Students were also asked to list three ways that the apprenticeship course could be improved. The 34 students who listed at least one potential improvement made a wide range of suggestions. These suggestions fell into the categories of course assignments and activities, connections with others, course content, communication, and course format or organization. Students' suggestions are summarized here:

- Improvements to course assignments and activities (mentioned 29 times), including:
  - more time to complete assignments (6 comments)
  - more interactive activities (6 comments)
  - more feedback on assignments (3 comments)
  - less strict grading (3 comments)
  - fewer assignments or less reading (2 comments)
  - more help with assignments (2 comments)

- more whole group assignments or activities (2 comments)
- examples of successful work or a video guide to the experiment (2 comments)
- more supplies for the experiment (1 comment)
- add quizzes and tests (1 comment)
- more mini assignments (1 comment)

- Improvements to connections with others (mentioned 21 times), including:
  - more connections with peers and NPMs (9 comments)
  - more connection with professors (7 comments)
  - provide collaborative assignments (3 comments)
  - switch small group members or NPMs during the course (2 comments)

- Improvements to course content (mentioned 14 times), including:
  - more science focus or more variety in topics in webinars and readings (7 comments)
  - more career information or more, or more diverse, speakers (3 comments)
  - less repetition of course material (3 comments)
  - fewer webinars (i.e., every other day instead of every day (1 comment)

- Improvements to communication (mentioned 14 times), including:
  - clarify expectations about activities and/or provide better rubrics (5 comments)
  - provide a course syllabus and rubrics in advance or at the start of the course (5 comments)
  - clearer instructions (3 comments)
  - better instructions for using MyCourses (1 comment)

- Improvements to course format or organization (mentioned 13 times), including:
  - making the course longer (5 comments)
  - holding fewer discussions or no Monday review sessions (2 comments)
  - providing alternative ways to earn participation credit, or provide more opportunities for participation (2 comments)
  - recording NPM sessions (1 comment)
  - providing incentives to watch videos and read (1 comment)
  - allowing small group session times to overlap with each other (1 comment)
  - holding an in-person course (1 comment)

Students were asked in another open-ended item if they would like NPMs to be available to them during the school year. Among the 35 student participants who provided a response, only three indicated that they were not interested in connecting with NPMs during the school year. The other 32 students (91%) responded that they would like to connect with NPMs. Those that expanded on the reasons for their responses commented that the NPMs were useful resources for college and other information. Student apprenticeship course participants said, for example, *"I would love to continue to communicate with our near peer mentors because they taught me so much."*

"If it is possible, I would love to be able to ask current college students about their experience. Also being able to use them as a resource for networking and other opportunities."

"I feel like we have built connections with our NPMs that it would be so nice If we could still be in contact with them."

Students were asked in another open-ended questionnaire item to elaborate on how they would like to work with the NPMs. Three students were not sure how they could connect with NPMs and made no suggestions, and four suggested that NPMs meet with students in groups using videoconferencing technologies. Students who provided more detailed information most frequently indicated that they would like to connect with NPMs regarding college information (21 students, or 60%), including providing college application information (17 students), help with writing essays (2 students), help with selecting colleges (1 student), and having the NPM write recommendation letters (1 student). Other suggestions for how NPMs would work with students included providing information about STEM opportunities or networking (6 students), general advice and guidance (4 students), assistance or tutoring with STEM courses or study habits (4 students) and discussing STEM issues and current events (2 students).

Apprenticeship course student participants were also asked in an open-ended questionnaire item if they would like to continue to have webinars available them during the school year and, if so, to indicate what topics they are interested in. Of the 36 responding students, 32 (89%) answered affirmatively while four either were not interested or unsure. Of the 32 students interested in webinars, the following were topics of interest:

- College information (mentioned by 17 students), including the following topics:
    - general college admissions and application information (10 students)
    - essays or applications (3 students)
    - choosing a college or a major (2 students)
    - identifying scholarships (1 student),
    - managing college debt (1 student)

- Career information (mentioned by 17 students), including the following topics:
    - general STEM career information (7 students)
    - stories of people in STEM, or a day in the life of various STEM professionals (7 students)
    - types of STEM careers and/or non-traditional STEM careers (3 students)

- General STEM topics (mentioned by 12 students), including the following topics:
    - specific disciplinary content (e.g., physics, mathematics, bioengineering) (5 students)
    - STEM policy issues (2 students)
    - general STEM topics (e.g., intersection of science and technology) (2 students)

- ethics (1 student)
  - scientific processes (1 student)
  - art and STEM (1 student)

- Information about internships and co-ops (2 students)

- Soft skills (1 student)

Previous Program Participation & Future Interest

Students were asked to report on their previous participation in AEOP (Table 225). While two-thirds (67%) said they had never participated in any AEOP, smaller proportions indicated having participated in the following programs: GEMS (15%), Camp Invention (12%), REAP (6%), eCM (3%), and JSHS (3%). Few responding students (9%) reported participating in other STEM programs.

Table 225. Previous Participation in AEOP Programs (n=33) *

Choice	Response Percent	Response Total
Camp Invention	12.1%	4
eCYBERMISSION	3.0%	1
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science (GEMS)	15.2%	5
Unite	0%	0
Junior Science & Humanities Symposium (JSHS)	3.0%	1
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	6.1%	2
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	3.0%	1
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	66.7%	22
Other STEM Program	9.1%	3

*Note – this item was asked at registration, therefore the number of respondents may differ from the evaluation survey

Students were asked to express their level of interest in future AEOP participation (Table 226). More than half of students (61%-86%) were at least somewhat interested in participating in all AEOP listed. Programs students reported being most interested in were: GEMS NPM (86%), REAP (83%), SEAP (83%), SMART (81%), and HSAP (81%).

Table 226. Student Interest in Future AEOP Programs (n=36)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
High School Apprenticeship Program (HSAP)	13.9%	5.6%	13.9%	66.7%	
	5	2	5	24	**36**
Science and Engineering Apprenticeship Program (SEAP)	13.9%	2.8%	16.7%	66.7%	
	5	1	6	24	**36**
Research and Engineering Apprenticeship Program (REAP)	8.3%	8.3%	5.6%	77.8%	
	3	3	2	28	**36**
College Qualified Leaders (CQL)	36.1%	2.8%	19.4%	41.7%	
	13	1	7	15	**36**
Undergraduate Research Apprenticeship Program (URAP)	22.2%	2.8%	22.2%	52.8%	
	8	1	8	19	**36**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	8.3%	11.1%	16.7%	63.9%	
	3	4	6	23	**36**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	27.8%	5.6%	13.9%	52.8%	
	10	2	5	19	**36**
GEMS Near Peer Mentor Program	13.9%	0.0%	27.8%	58.3%	
	5	0	10	21	**36**

Awareness of STEM Careers & DoD STEM Careers & Research

Tables 227 and 228 show that large proportions of students (97%) reported learning about at least one STEM job/career and nearly all (94%) noted learning about three or more general STEM careers. Similarly, a large majority of students (94%) reported they learned about at least one DoD STEM job/career, although fewer (56%) indicated that they learned about three or more Army or DoD STEM jobs/careers during the course.

Table 227. Number of STEM Jobs/Careers Students Learned About During AEOP Summer Course (n=36)

	Response Percent	Response Total
None	2.8%	1
1	0.0%	0
2	2.8%	1
3	11.1%	4
4	8.3%	3
5 or more	75.0%	27

Table 228. Number of Army of DoD STEM Jobs/Careers Students Learned About During AEOP Summer Course (n=36)

	Response Percent	Response Total
None	5.6%	2
1	13.9%	5
2	25.0%	9
3	22.2%	8
4	13.9%	5
5 or more	19.4%	7

Student opinions about DoD researchers and research were overwhelmingly positively with more than 97% agreeing with all statements (Table 229). All students agreed that DoD researchers advance science and engineering fields (100%) and that DoD researchers develop new, cutting edge technologies.

Table 229. Student Opinions about DoD Researchers and Research (n=36)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	44.4%	55.6%	
	0	0	16	20	**36**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	41.7%	58.3%	
	0	0	15	21	**36**
DoD researchers solve real-world problems	0.0%	2.8%	41.7%	55.6%	
	0	1	15	20	**36**
DoD research is valuable to society	0.0%	2.8%	41.7%	55.6%	
	0	1	15	20	**36**

Interest & Future Engagement in STEM

Students reported extremely high levels of likelihood (89%-100%) for engaging in the future with STEM activities outside of their regular school courses listed as a result of participating in the apprenticeship course (Table 230). Composite scores were used to compare apprentice future STEM engagement by Underserved classification and specific variables that make up Underserved. No differences were found in likelihood of future STEM engagement by overall Underserved classification or specific variables investigated.

Table 230. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=36)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	2.8%	69.4%	27.8%	
	0	1	25	10	**36**
Tinker (play) with a mechanical or electrical device	0.0%	11.1%	55.6%	33.3%	
	0	4	20	12	**36**
Work on solving mathematical or scientific puzzles	0.0%	2.8%	63.9%	33.3%	
	0	1	23	12	**36**
Use a computer to design or program something	0.0%	11.1%	50.0%	38.9%	
	0	4	18	14	**36**
Talk with friends or family about STEM	0.0%	0.0%	50.0%	50.0%	
	0	0	18	18	**36**
Mentor or teach other students about STEM	0.0%	0.0%	36.1%	63.9%	
	0	0	13	23	**36**
Help with a community service project related to STEM	0.0%	0.0%	30.6%	69.4%	
	0	0	11	25	**36**
Participate in a STEM camp, club, or competition	0.0%	0.0%	38.9%	61.1%	
	0	0	14	22	**36**
Take an elective (not required) STEM class	0.0%	0.0%	41.7%	58.3%	
	0	0	15	21	**36**
Work on a STEM project or experiment in a university or professional setting	0.0%	2.8%	25.0%	72.2%	
	0	1	9	26	**36**

Students were asked to report on their future educational aspirations after completing the course (Table 231). All (100%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's (25%) or terminal degree (64%).

Table 231. Student Education Aspirations After AEOP Summer Course (n=36)

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)	5.6%	2
Get more education after college	5.6%	2
Get a master's degree	25.0%	9
Get a Ph.D.	25.0%	9
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	22.2%	8
Get a combined M.D. / Ph.D.	16.6%	6
Get another professional degree (law, business, etc.)	0%	0

Resources

Student reports about the impact of AEOP resources on their awareness of DoD STEM careers is provided in Table 232. More than 90% of students reported that the following three resources were at least somewhat impactful: participation in the summer course (97%); presentations shared in the summer course (95%); and summer course instructors (92%). More than a third of students reported they had not experienced AEOP resources such as the AEOP on social media (64%) and AEOP printed materials (36%).

Table 232. Impact of Resources on Student Awareness of DoD STEM Careers (n=36)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	19.4%	13.9%	33.3%	33.3%	
	7	5	12	12	**36**
AEOP on Facebook, Twitter or other social media	63.9%	19.4%	8.3%	8.3%	
	23	7	3	3	**36**
AEOP printed materials	36.1%	27.8%	22.2%	13.9%	
	13	10	8	5	**36**

AEOP Summer course instructors	5.6%	2.8%	38.9%	52.8%	
	2	1	14	19	**36**
Presentations or information shared in the AEOP summer course	2.8%	2.8%	30.6%	63.9%	
	1	1	11	23	**36**
Participation in the AEOP summer course	0.0%	2.8%	27.8%	69.4%	
	0	1	10	25	**36**

Students were also asked which resources impacted their awareness of the various AEOP (Table 233). The same pattern was found here with the most impactful resources being participation in the summer course (97%); presentations from the summer course (97%); summer course instructors (95%); and the AEOP website (86%). More than half of students reported not experiencing AEOP social media for this purpose.

Table 233. Impact of Resources on Student Awareness of AEOP (n=36)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	11.1%	2.8%	33.3%	52.8%	
	4	1	12	19	**36**
AEOP on Facebook, Twitter or other social media	55.6%	22.2%	11.1%	11.1%	
	20	8	4	4	**36**
AEOP printed materials	27.8%	25.0%	33.3%	13.9%	
	10	9	12	5	**36**
AEOP Summer course instructors	0.0%	5.6%	27.8%	66.7%	
	0	2	10	24	**36**
Presentations or information shared through the AEOP summer course	0.0%	2.8%	22.2%	75.0%	
	0	1	8	27	**36**
Participation in the AEOP summer course	0.0%	2.8%	5.6%	91.7%	
	0	1	2	33	**36**

Overall Impact

Approximately three-quarters or more of students (72%-100%) agreed that the summer course contributed in some way to each impact listed in Table 234. Areas of greatest impact, with more than 90% of students agreeing that the program impacted them, were more confidence in STEM knowledge, skills, and abilities (100%) and a greater appreciation of DoD STEM research (92%). The overall impacts composite variable was used to test for differences in overall Underserved classification and among subgroups of apprentices; no significant differences were found.

Table 234. Student Opinions of AEOP Summer Course Impacts (n=36)

	Disagree - This did not happen	Disagree - This happened but not because of the AEOP summer course	Agree – the AEOP summer course contributed	Agree - AEOP summer course was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	0.0%	88.9%	11.1%	
	0	0	32	4	**36**
I am more interested in participating in STEM activities outside of school requirements	0.0%	11.1%	63.9%	25.0%	
	0	4	23	9	**36**
I am more interested in taking STEM classes in school	0.0%	13.9%	75.0%	11.1%	
	0	5	27	4	**36**
I am more interested in earning a STEM degree	0.0%	13.9%	66.7%	19.4%	
	0	5	24	7	**36**
I am more interested in pursuing a career in STEM	0.0%	16.7%	63.9%	19.4%	
	0	6	23	7	**36**
I have a greater appreciation of Army or DoD STEM research	5.6%	2.8%	41.7%	50.0%	
	2	1	15	18	**36**
I am more interested in pursuing a STEM career with the Army or DoD	22.2%	5.6%	36.1%	36.1%	
	8	2	13	13	**36**

9 | Findings and Recommendations

Summary of Findings

The 2020 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 235-240.

CQL Findings

Table 235. 2020 CQL Evaluation Findings

Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Fewer students applied for CQL apprenticeships in 2020 compared to 2019; a multi-year downward trend in the number of students placed in apprenticeships continues.	A total of 582 students applied for CQL apprenticeships, a decline from 2019 when 662 students applied, but a slight increase as compared to the 574 applicants in 2018.
	159 students (27% of applicants) were placed in CQL apprenticeships. This continues a downward trend in the number and placement rate of CQL apprentices since 2017 (2019 -204 [31%]; 2018 - 214 [37%]; 2017 – 229 [39%]).
	Apprentices were hosted at 17 sites, an increase over the 16 participating host sites in 2019 and the 13 participating host sites in 2018.
While CQL continues to serve students from diverse backgrounds, enrollment of apprentices from groups historically underserved and underrepresented in STEM decreased in 2020 as compared to 2019.	Slightly over a quarter of apprentices (26%) met the AEOP definition of students underserved or underrepresented (Underserved) in STEM, a decrease from 2019 when 35% of apprentices met the Underserved criteria, but an increase from the 20% who met the definition in 2018.
	Just over a third (35%) of participants identified as female, a decrease as compared to previous years (2019, 51%; 2018, 45%; 2017, 54%).
	A somewhat larger proportion of CQL apprentices identified themselves as White (59%) as compared to 2019 (54%); this is a

	decrease in comparison to 2018 (64%) and 2017 (67%). Likewise, the proportion of apprentices identifying themselves as Asian increased slightly (15%) as compared to 2019 (12%) and previous years (14% in both 2017 and 2018).
	The proportion of CQL apprentices identifying themselves as Black or African American (9%) decreased sharply as compared to 2019 (18%) and 2018 (13%) but was higher than in 2017 (7%). Participation by apprentices identifying as Hispanic or Latino remained relatively constant (5% in 2020; 6% in 2019; 6% in 2018; 5% in 2017).
	As in previous years, nearly all apprentices (94%) identified English as their first language, and a relatively small proportion (18%) were first generation college attendees. Fewer than a quarter (21%) were Pell grant recipients, a proxy for low-income status.
Apprentices reported engaging in STEM practices more frequently in CQL than in their typical college or university experiences.	More than 70% of apprentices (71%-98%) said they participated "at least once" in all STEM practices about which they were asked. Nearly all apprentices reported frequently (weekly or every day) interacting with STEM researchers (94%) and working with a STEM researcher or company on a real-world STEM research project (92%).
	Apprentice-reported engagement in STEM practices in CQL was significantly higher than engagement in the same practices in school (large effect size). These findings indicate that CQL provides apprentices with more intensive engagement in STEM than they typically experience in their college or university coursework.
Apprentices reported gains in their STEM knowledge as a result of participating in CQL; female apprentices and apprentices from minority groups associated with Underserved criteria reported larger gains than their peers.	More than 90% of CQL apprentices indicated that they had experienced medium or large gains in each area of STEM knowledge. Nearly all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (98%) and knowledge of what everyday research work is like in STEM (96%).
	No significant differences in STEM knowledge gains were found by overall Underserved status, however female apprentices and apprentices from minority groups associated with Underserved criteria reported larger gains than their peers (large and medium effect sizes respectively).
Apprentices reported gains in their STEM competencies as a result of participating in CQL.	More than 70% of participating apprentices (71%-89%) reported at least medium gains for all STEM competencies, and 85% or more of responding apprentices reported medium or large gains in using knowledge/creativity to suggest a solution to a problem (85%) and identifying limitations of methods/tools used for collecting data (89%).

Apprentices reported that CQL participation had positive impacts on their 21st Century skills.	Half or more of apprentices (50%-94%) reported at least medium gains for all 21st Century skills items except for creating media products (23%) and analyzing media (37%). CQL apprentices experienced the greatest impacts (medium or large gains) in 21st Century Skills such as solving problems (92%) and incorporating feedback into their work effectively (94%).
Apprentices reported gains in their STEM identities as a result of participating in CQL.	Three-quarters or more of CQL apprentices (75%-98%) reported medium or large gains across all items of the STEM identity scale. More than 90% of apprentices reported at least medium gains in their desire to build relationships with mentors who work in STEM (98%) as a result of CQL.
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. At least two-thirds of CQL mentors (67%-100%) reported using all strategies except one (asking students to relate real life events to CQL topics – 33%) to help make learning activities relevant to students. 2. Half or more of CQL mentors (50%-100%) reported using all strategies to support the diverse needs of students as learners with the exception of the strategy of highlighting under-representation of women and racial/ethnic minority populations in STEM which only 33% of mentors reported using. 3. With the exception of one item (allowing students to resolve conflicts within their team – 33%), half or more of CQL mentors (50%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Half or more (50%-100%) of CQL mentors said they implemented all strategies to support students' engagement in authentic STEM activities. 5. Half or more of CQL mentors (50%-100%) reported using seven of the strategies focused on supporting students' STEM educational and career pathways. A third or fewer (17%-33%) reported implementing the following strategies: recommending extracurricular programs that align with students' goals (33%); recommending student and professional organizations in STEM to students (33%); and discussing the economic, political, ethical, and/or social context of a STEM career (17%).
CQL apprentices were satisfied with program features that they had experienced and identified a number of benefits of CQL. Apprentices also	Approximately three-quarters or more of CQL apprentices (73%-98%) reported being at least somewhat satisfied with all program features listed. The areas in which greatest satisfaction was reported were the amount of stipend (98%); the variety of STEM topics available in CQL (98%); and the timeliness of receiving stipends (94%).

offered various suggestions for program improvement.	Nearly all CQL apprentices reported that their mentors were available at least half of the time (96%), and nearly two-thirds (62%) said their mentors were always available.
	A large majority of apprentices (90%-100%) reported being at least somewhat satisfied with each element of their CQL experience. All apprentices were at least somewhat satisfied with their working relationship with their mentors (100%).
	Nearly all apprentices (98%) made positive comments about their satisfaction with CQL in response to open-ended questions. The most frequently mentioned benefits of CQL cited by apprentices were hands-on lab experiences, the STEM skills apprentices gained, the networking and/or the mentoring they experienced, STEM learning, and the career information they received.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide more or better communication from the program, to provide more opportunities for apprentices to interact with one another and improving or streamlining in-processing procedures.
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.	Half or more of responding mentors (50%-83%) reported being at least somewhat satisfied with all program features except for research abstract preparation requirements (33%), a feature that half of CQL mentors (50%) reported not having experienced. Areas in which mentors reported the greatest satisfaction (somewhat or very much) were the amount of stipends for apprentices (83%); communication with program organizers (83%); the application/registration process (83%); and other administrative tasks (83%).
	All three mentors who responded to an open-ended question about their satisfaction responded positively. The most frequently mentioned strengths of CQL were the STEM and research skills, the experience apprentices receive, and apprentices' opportunities to network.
	Several mentors participating in phone interviews commented on their experiences with mentoring apprentices online. These mentors made positive comments about this format overall and noted that apprentices found ways to network with each other online. The potential for the online format to extend apprenticeships throughout the school year was noted. Difficulties in assisting apprentices having difficulties with their work in the online format were also noted.
	In open-ended responses, the improvements most frequently suggested by mentors were to increase the program's outreach or publicity and to improve communication from the site directors and/or staff.

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 (42%); someone who works with the program (38%); and past participants of the program (38%).
	Half of mentors (50%) reported that they learned about AEOP from a past participant and a third (33%) through workplace communications.
Apprentices were motivated to participate in CQL primarily by the learning opportunities and their interest in STEM.	The most frequently selected motivators were related to apprentice educational interests and learning, including the following: the desire to learn something new/interesting (58%); interest in STEM (56%); and the desire to expand laboratory/research skills (53%).
Most CQL apprentices had not participated in AEOP in the past, however most are interested in participating in AEOP in the future.	Nearly half (47%) of CQL apprentices noted they had not previously participated in AEOP. Smaller proportions indicated having participated in the following programs: CQL (33%), GEMS (11%), and SEAP (9%).
	Approximately three-quarters or more of apprentices were at least somewhat interested in participating in CQL again (85%) and in SMART (71%). Half (50%) indicated they were at least somewhat interested in NDSEG, and more than a third were similarly interested in URAP (42%) and the GEMS NPM program (37%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOP were participation in CQL (98%), CQL mentors (96%), the AEOP website (83%), and presentations shared in CQL (75%). More than half of responding apprentices had not experienced AEOP on social media (65%).
Most mentors discussed CQL and the SMART scholarship with apprentices, however few discussed any other AEOP.	Mentors responding to the questionnaire reported discussing CQL (83%) and SMART (50%) with their apprentices.
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOP was CQL participation (100%), followed by AEOP program administrators (67%) the AEOP website (67%), and AEOP on social media (67%) as resources for exposing apprentices to AEOP.
Most apprentices learned about STEM careers generally	A large proportion of CQL apprentices (96%) reported learning about at least one STEM job/career, and most (81%) reported

and DoD STEM careers specifically during CQL.	learning about three or more general STEM careers. Similarly, a large proportion of apprentices (94%) indicated they learned about at least one DoD STEM job/career, with fewer (63%) learning about three or more STEM careers in the Army or DoD.
	Two-thirds or more of apprentices reported the following four resources as somewhat or very much impactful on their awareness of STEM careers in the Army or DoD: the AEOP website (65%); presentations shared in program (71%); participation in CQL (88%); and the CQL mentors (96%). More than half of CQL apprentices said they had not experienced AEOP resources such as the ARO website (56%) and AEOP on social media (65%).
	CQL mentors were most likely to rate participation in CQL (83%), the AEOP website (67%), AEOP program administration (50%), and invited speakers (50%) as at least somewhat useful resources for exposing students to STEM careers in the Army or DoD.
CQL apprentices expressed positive opinions about DoD research and researchers.	CQL apprentices held extremely positive opinions about DoD researchers and research with more than 95% agreeing to all statements regarding the work of DoD researchers and the research conducted.
Apprentices reported that they were more likely to engage in various STEM activities after participating in CQL.	Nearly all apprentices (89%-100%) reported that after participating in CQL they were more likely or much more likely to engage in all STEM activities about which they were asked.
All CQL apprentices planned to at least complete a bachelor's degree, and many reported an interest in a graduate or terminal degree.	All CQL apprentices (100%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's (38%) or terminal degree (37%) in their field.
CQL apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers.	Approximately 70% or more of apprentices (69%-96%) agreed that CQL contributed in some way to each impact about which they were asked. Areas of greatest impact were increased confidence in STEM knowledge, skills, and abilities (96%) and a greater appreciation of DoD STEM research (90%).

SEAP Findings

Table 236. 2020 SEAP Evaluation Findings
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*

The COVID-19 pandemic had a profound effect on the placement of SEAP apprentices in 2020. Fewer applications were received than in 2019, and the number of students placed in apprenticeships declined precipitously.	Fifteen Army labs or centers accepted applications for SEAP apprentices in 2020. The COVID-19 pandemic had a profound effect on the placement of SEAP apprentices in 2020 and apprentices were hosted at only three of these sites (10 sites in 2019 and 11 sites in 2018).
	A total of 938 students applied for SEAP apprenticeships in 2020, a decrease of 27% as compared to 2019 when 1,286 students applied but an 8% increase compared to the 872 applications received in 2018 (852 applications received in 2017). Of these applicants, only 28, or 3%, were placed in apprenticeships. This is a marked decrease in both the number of apprentices placed and the placement rate as compared to previous years (108 [8%] in 2019; 114 [13%] in 2018; 113 [13%] in2017).
	In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP high school apprentices who wished to participate. This course served 31 students who had applied for SEAP apprenticeships.
While SEAP continued to serve apprentices from groups historically underrepresented and underserved in STEM, the proportions of female students and the proportion of students meeting the AEOP definition of Underserved declined in 2020 as compared to previous years.	Unlike previous years, less than half (36%) of SEAP apprentices were female (52% in 2019, 53% in 2018, and 54% in 2017).
	As in previous years, the most frequently represented races/ethnicities were White (32%) and Asian (39%), although 2020 was the first year that the most frequently represented race/ethnicity was Asian (24% in 2019, 27% in 2018, 32% in 2017).
	The proportion of apprentices identifying themselves as Black or African American (14%), began to reverse a multi-year downward trend (10% in 2019; 12% in 2018; 17% in 2017). The proportion of apprentices identifying themselves as Hispanic or Latino in 2020 (4%) was similar to previous years (4% in 2019, 4% in 2018, 3% in 2017).
	As in 2019, a majority of apprentices (82%) attended suburban schools (68% in 2019) and few (4%) received free or reduced-price school lunches (FARMS) (10% in 2019). All apprentices spoke English as their first language (100%) and none would be first-generation college attendees.
	Less than a quarter of SEAP apprentices (21%) met the AEOP definition of Underserved, a decrease as compared to previous years (32% in 2019, 27% in 2018).
Apprentice and mentor participation in the evaluation survey was very low and was likely limited by the small number of participants in 2020.	Only three apprentices and three mentors participated in the SEAP evaluation survey in 2020. Because of the small sample size of apprentices, no statistical comparisons of findings between groups could be conducted.

SEAP apprentices reported engaging in STEM practices more frequently in SEAP than in their typical school experiences.	With the exception of one item (presenting STEM research to a panel of judges from industry or military), at least two out of three responding SEAP apprentices indicated they had engaged in each STEM activity at least once. STEM practices in which all three SEAP apprentices reported engaging in frequently (most days or every day) during SEAP were: working with a STEM researcher or company on a real-world STEM research project (100%); designing and carrying out an investigation (100%); analyzing data or information and drawing conclusions (100%); and solving real world problems (100%).
	Apprentice engagement in STEM practices in SEAP were higher than their engagement in the same practices in school, however, these differences could not be assessed statistically due to the small sample size. Descriptive statistics suggest that SEAP provides apprentices with more intensive engagement in STEM than they typically experience in school
Apprentices reported gains in their STEM knowledge as a result of participating in SEAP.	All SEAP apprentices (100%) reported a high degree of STEM knowledge gains (medium or large) as a result of participating in CQL for all items except for gains in their knowledge of what everyday research work is like in STEM (67%)
Apprentices reported gains in their STEM competencies as a result of participating in SEAP.	Two-thirds or more of SEAP apprentices (67%-100%) indicated medium or large gains in all STEM competencies about which they were asked except for creating a hypothesis that can be tested in an experiment (33%).
Apprentices reported that SEAP participation had positive impacts on their 21st Century skills.	Two or three responding apprentices (67%-100%) reported at least medium gains across all 21st Century skills items except for working creatively with others (33%); using creative ideas to make a product (33%); leading others in a team (33%); analyzing media (0%); and creating media products (0%).
Apprentices reported gains in their STEM identities as a result of participating in SEAP.	Two to three of the responding SEAP apprentices (67%-100%) reported at least medium gains on all survey items associated with STEM Identity
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
SEAP Mentors used a range of mentoring strategies with apprentices.	The three responding SEAP mentors reported using strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Two or three SEAP mentors (67%-100%) indicated they used all but two of the strategies to help make learning activities relevant to students. The two strategies used by only one mentor were: encouraging students to suggest new readings, activities, or projects (33%); and helping students understand how STEM can help them improve their own community (33%). 2. Two or three SEAP mentors (67%-100%) reported that they used all strategies to support the diverse needs of students as learners except for integrating ideas from education literature to teach/mentor

	students from underrepresented groups in STEM (0%) and highlighting under-representation of women and racial/ethnic minority populations in STEM (0%). 3. Two or three SEAP mentors (67%-100%) noted implementing all but two strategies to support students' development of collaboration and interpersonal skills. The two strategies used by only one SEAP mentor were having students exchange ideas with others whose backgrounds/viewpoints are different (33%) and having students give/receive constructive feedback with others (33%). 4. Two or three mentors (67%-100%) indicated they used all strategies to support students' engagement in authentic STEM activities except for supervising students while they practice STEM research skills (33%); and encouraging students to learn collaboratively (33%). 5. Two or three SEAP mentors (67%-100%) reported that they used most strategies focused on supporting students' STEM educational and career pathways with the exception of the following: helping students with their resumé, application, personal statement, and/or interview preparations (33%); discussing STEM career opportunities in private industry or academia (33%); and discussing the economic, political, ethical, and/or social context of a STEM career (0%).
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.	Two or three of SEAP apprentices (67%-100%) reported being at least somewhat satisfied with all program features. All three apprentices reported being at least somewhat satisfied with more than half of the features listed, including the following: applying for the program (100%); the variety of STEM topics available (100%); the teaching/mentoring provided (100%); amount of the stipend (100%); and the timeliness of receiving the stipend (100%).
	All SEAP apprentices (100%) reported that their mentors were always available.
	All three SEAP apprentices reported being at least somewhat satisfied with each area of their apprenticeship experience with the exception of the working relationship with the group/team, an area in which only two of the three apprentices (67%) at least somewhat satisfied.
	Because all apprentices interviewed participated in fully online apprenticeships, they were asked to comment on their experience with the online format. All apprentices noted that they had ultimately had good experiences with their online apprenticeships and most commented favorably on their access to their mentors.
	All three SEAP apprentices who responded to open-ended questions made positive comments about their satisfaction with SEAP. The most frequently mentioned benefits were gaining experience in the real-world application of STEM and gaining specific STEM skills.

	In open-ended responses to an item asking apprentices to list improvements to SEAP, no single improvement was suggested more than once. Suggested improvements included improving communication from the program, clarifying expectations for posters and abstracts, and providing more opportunities to connect with other apprentices and/or see other apprentices' work.
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.	Two or three of the responding mentors (67%-100%) reported being at least somewhat satisfied with all features except for the following: timeliness of stipend pay (67% did not experience); support for instruction during program activities (33% did not experience); and research presentation process (33% did not experience).
	The one mentor interviewed commented favorably upon the online format of SEAP in 2020, and reported holding daily online meetings with apprentices, adding that apprentices were able to contact mentors at his site easily throughout the day. This mentor reported also reported that his site had intentionally provided ways for apprentices to connect with one another.
	The one mentor who responded to an open-ended questionnaire item asking about overall satisfaction with SEAP responded favorably and cited the program administration as a source of satisfaction. Mentors noted several strengths of SEAP, including the apprentice selection process, the program's administration, apprentices' exposure to real-world research, and apprentices' opportunities to network.
	Mentors suggested as improvements coordinating with other labs to hold weekly research seminars and addressing difficulties associated with hosting minor apprentices at Army sites, suggesting that the availability of online apprenticeships might encourage some sites to more readily accept minor apprentices.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
SEAP apprentices learned about AEOP primarily through the AEOP website and personal contacts; mentors learned about AEOP from past participants.	The most frequently selected sources of information (selected by two of the three apprentices completing the survey) were the AEOP website (67%) and friends (67%).
	All three responding mentors (100%) indicated they learned about AEOP from past participants.
Apprentices were motivated to participate in SEAP primarily by the learning opportunities and their interest in STEM.	Apprentices indicated that their motivations for participating in SEAP were related to their educational interests and learning, including their interest in STEM (100%); the desire to learn something new/interesting (67%); and learning in ways not possible in school (67%).

No apprentices had participated in AEOP other than SEAP in the past but were interested in participating in AEOP in the future.	All three survey respondents indicated they had never participated in any AEOP program.
	Two of the three SEAP apprentices (67%) reported being at least somewhat interested in participating in CQL, URAP, and SMART. Two of the three (67%) had never heard of NDSEG and the GEMS NPM program
	The resources apprentices most frequently indicated were somewhat or very much impactful on their awareness of AEOP were participation in SEAP (67%), SEAP mentors (67%), the AEOP website (67%), and presentations shared in SEAP (100%).
No mentors discussed specific AEOP other than SMART and CQL with apprentices.	The only programs SEAP mentors reported discussing with their apprentices were SMART (67%) and CQL (67%). Two-thirds (67%) 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 AEOP were participation in SEAP (100%) and AEOP program administrators (36%). All three responding mentors reported that they did not experience AEOP printed materials (67%) or AEOP on social media (67%) as resources for exposing apprentices to AEOP.
SEAP apprentices learned about STEM careers generally and STEM careers within the DoD during SEAP.	All three responding SEAP apprentices (100%) indicated learning about at least one STEM job/career, and two (67%) reported learning about e or more general STEM careers. Similarly, all apprentices (100%) reported learning about at least one DoD STEM job/career, and two (67%) reported learning about three or more Army or DoD STEM jobs or careers
	Two-thirds of apprentices (two individuals) reported that the following resources were somewhat to very much useful for making them aware of DoD STEM careers: the AEOP website (67%); presentations shared in the program (67%); participation in SEAP (67%); and SEAP mentors (67%).
	When asked to select resources useful for making apprentices aware of DoD STEM careers, mentors selected participating in SEAP (100%), the AEOP website (67%), and AEOP program administrators (67%). All three responding mentors reported having not experienced AEOP social media.
Apprentices expressed positive opinions about DoD research and researchers.	SEAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with all three responding apprentices (100%) strongly agreeing with each statement about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the	Either all three or two of three SEAP apprentices responding to the evaluation survey (67%-100%) indicated they were more likely or much more likely to engage in each STEM activity listed after their SEAP experience

future after participating in SEAP.	
All SEAP apprentices planned to at least complete a bachelor's degree, and all reported an interest in earning a terminal degree.	When asked their formal education aspirations, all three responding SEAP apprentices (100%) reported wanting to at least earn a bachelor's degree. While none (0%) reported wanting to end their higher education with a master's degree, all three (100%) reported a desire to earn a terminal degree in their field.
SEAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers.	Two or three of the responding SEAP apprentices (67%-100%) agreed that SEAP contributed in some way to each impact about which they were asked. Areas of greatest impact (all three agreed) were more interested in participating in STEM activities outside of school requirements (100%) and a greater appreciation of DoD STEM research (100%).

REAP Findings

Table 237. 2020 REAP Evaluation Findings	
Priority #1: ***Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base***	
Many fewer students were placed in REAP apprenticeships at fewer institutions than in previous years due to the COVID-19 pandemic, however the number of applications received was comparable to 2019.	In 2020, REAP received 802 applications from 527 students. This is a slight decrease in the number of applications as compared to 2019 when 857 applications were received (949 in 2018).
	A total of 86 students (16% of applicants) were placed in REAP apprenticeships at 47 colleges and universities around the country, a marked decrease as compared to 2019 when 168 students were placed in apprenticeships at 55 colleges and universities and 2018 when 138 students were placed at 53 institutions in 2018. The 49% decrease in the number of students placed in apprenticeships in 2020 as compared to 2019 can be largely attributed to campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020.
	Of the institutions hosting apprentices in 2020, 23 (49%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 29 (53%) in 2019 and 31 (57%) in 2018.
	In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP apprentices that served 54 students who had applied for REAP apprenticeships.

REAP continues to serve apprentices from groups historically underserved and underrepresented in STEM, with increases in the proportions of female and Hispanic/Latino students served; a large majority of apprentices met the AEOP definition of Underserved.	All but three REAP apprentices for whom data were available (94%) met the criteria for Underserved status under the AEOP definition (99% in 2019).
	The proportion of female participants (70%) in 2020 was similar to 2019 when 67% of participants were female (62% in 2018, 61% in 2017).
	The proportion of apprentices identifying themselves as Black or African American (36%) declined somewhat compared to 2019 (44%) and 2018 (40%) but remained higher than in 2017 (29%). Participation by Hispanic or Latino apprentices (33% in 2020) continues to increase as compared to previous years (26% in 2019, 22% in 2018, and 15% in 2017). The proportion of REAP apprentices identifying themselves as White (4%) was lower than in previous years (9% in 2019, 8% in 2018, 27% in 2017). The proportion of REAP apprentices identifying as Asian (14%) remained at 2019 levels (14% in 2019, 20% in 2018, 27% in 2017).
	Half of REAP apprentices (50%) qualified for free or reduced-price school lunches (FARMS) (56% in 2019), a third (33%) spoke a language other than English as their first language (30% in 2019), and over a quarter (29%) would be first generation college attendees (36% in 2019).
	No significant differences were found by Underserved status or individual demographic categories of Underserved status for any 2020 evaluation survey items.
Apprentices reported engaging in STEM practices more frequently in REAP than in their typical school experiences.	Nearly half or more of REAP apprentices (47%-100%) reported participating at least once during their program in all STEM practices. All REAP apprentices responding to the evaluation survey indicated regularly (most days or every day) interacting with STEM researchers (100%) and analyzing data/information and drawing conclusions (100%).
	Apprentices reported that their engagement in STEM practices in REAP was significantly higher than their engagement in the same practices in school (large effect size). These findings indicate that REAP provides apprentices with more intensive engagement in STEM than they typically experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in REAP.	All REAP apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in REAP. More than 90% indicated medium or large gains in every survey area of STEM knowledge.
Apprentices reported gains in their STEM competencies as a result of participating in REAP.	More than 70% of participating apprentices (71%-100%) noted at least medium gains across competencies. All responding

	apprentices reported medium or large gains in supporting an explanation with STEM knowledge (100%).
REAP Apprentices reported that REAP participation had positive impacts on their 21st Century skills.	More than half of apprentices (59%-100%) reported at least medium gains across all items except for creating media products (36%) and analyzing media (35%). REAP apprentices were most likely to report medium or large gains in the following 21st Century Skills: solving problems (100%); interacting effectively in a respectful/professional manner (100%); setting goals and utilizing time wisely (100%); working independently and completing tasks on time (100%); and producing results (100%).
Apprentices reported gains in their STEM identities as a result of participating in REAP.	More than 85% of REAP apprentices (88%-100%) reported at least medium gains on all STEM identity survey items. All apprentices noted at least medium gains in their feeling of preparedness for more challenging STEM activities (100%).
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. Three-quarters or more of REAP mentors (79%-100%) indicated implementing all strategies to help make learning activities relevant to students. 2. Nearly three-quarters or more of REAP mentors (71%-93%) noted using all strategies to support the diverse needs of students as learners. 3. More than three-quarters of REAP mentors (79%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. more than 85% of REAP mentors (86%-100%) indicated implementing all strategies to support students' engagement in authentic STEM activities. 5. Approximately two-thirds or more of REAP mentors (64%-100%) noted trying all strategies focused on supporting students' STEM educational and career pathways.
REAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of REAP. Apprentices also offered various suggestions for program improvement.	More than half of REAP apprentices (53%-100%) noted being at least somewhat satisfied with all program features listed except for physical location, which 59% did not experience. All REAP apprentices reported being very much satisfied with their amount of stipend pay (100%).
	All REAP apprentices reported that their mentors were available more than half of the time (100%), and more than three-quarters (88%) reported that their mentors were always available.
	Almost all REAP apprentices (94%-100%) reported being at least somewhat satisfied with all components of their research experience. All REAP apprentices (100%) reported being at least somewhat satisfied with all components of their experience

	except their working relationship with the group/team (94% at least somewhat satisfied).
	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 career and/or college information they gained, the STEM learning they experienced, gaining specific STEM skills or research skills, gaining real-world and hands-on experience, and the opportunity to network with professors and mentors.
	Apprentices who provided feedback during interviews on the virtual format of REAP apprenticeships all made positive comments, although the consensus was that they would have liked to complete their apprenticeships in person.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide more interaction with other students; to provide more teaching or learning resources; and to improve communication from the program, including more timely communication and providing clearer instructions and guidelines.
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.	Approximately two-thirds or more of mentors (64%-93%) noted they were at least somewhat satisfied with all features of REAP about which they were asked. The aspect REAP mentors were most satisfied (somewhat or very much) with was the research abstract preparation requirements (93%).
	All but one mentor made positive comments about REAP in their responses to an open-ended question asking about their satisfaction with the program. The most frequently mentioned strengths of REAP were apprentices' opportunity to participate in real-life research, apprentices' STEM learning and exposure to STEM generally, teamwork, and the program stipends.
	In open-ended responses, the improvements most frequently suggested by mentors were focused on stipends, including suggestions for providing larger mentor and student stipends. Other frequently mentioned suggestions included providing more time for recruiting, interviewing, and/or placing students in apprenticeships; having more involvement by sponsoring agencies (Battelle and the DoD) in the program; having students give presentations or write papers; providing applicants with more information about sites and projects at the point of application; and expanding the program to serve more students.
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 the AEOP website, personal contacts, and, for apprentices, school communications.	The most frequently selected sources of information about AEOP for apprentices, selected by a quarter or more, were the AEOP website (38%); past participants (31%); family members (33%); and school newsletters, emails, or websites (25%).
	Half (50%) of REAP mentors indicated they learned about AEOP through the AEOP website, and 21% had learned about AEOP through a colleague, a supervisor, or someone who works for the DoD.
Apprentices were motivated to participate in REAP primarily by the learning opportunities and their interest in STEM.	Half or more of apprentices reported being motivated to participate in REAP by their personal educational interests and learning; the most frequently reported motivators were interest in STEM (81%) and the desire to expand laboratory/research skills (50%).
Most apprentices had not participated in AEOP other than REAP, but most were interested in participating in other AEOP in the future.	Half (50%) of REAP apprentices reported they had not previously participated in any AEOP. Smaller proportions indicated having participated in Unite (25%) and GEMS (6%).
	More than half of apprentices indicated they were at least somewhat interested in participating in GEMS NPM (53%), CQL (53%), NDSEG (59%), SMART (71%), and URAP (82%). Over a third had not heard of CQL (41%), NDSEG (35%), and GEMS NPM (47%).
	Two-thirds or more of REAP apprentices (65%-100%) indicated all resources listed were at least somewhat impactful on their awareness of AEOP except for AEOP social media (6% useful, 65% did not experience). All apprentices (100%) said participation in REAP was at least somewhat impactful.
More mentors discussed specific AEOP with their apprentices than in 2019, and most discussed AEOP generally.	At least half of mentors reported discussing the following specific AEOP with apprentices: URAP (64%), HSAP (57%), SMART (57%), and NDSEG (57%). Additionally, nearly three-quarters (71%) of mentors said they discussed AEOP in general. In 2019, only a third or less of REAP mentors discussed any of the specific AEOP with their apprentices.
	Nearly all mentors reported that REAP participation (93%) and the AEOP website (93%) were at least somewhat useful for exposing students to AEOP. Additionally, at least half indicated AEOP program administrators (57%) and AEOP printed materials (67%) were at least somewhat useful for this purpose. Most mentors said they did not experience AEOP on social media (64%) or invited speakers (64%).
Apprentices learned about STEM careers during REAP, although they learned about	All REAP apprentices (100%) indicated learning about at least one STEM job/career during their apprenticeship, and approximately two-thirds (65%) learned about three or more STEM careers in

more STEM careers generally than STEM careers specifically within the DoD.	general. Much smaller proportions of apprentices (53%), however, reported learning about at least one DoD STEM job/career, and even fewer (24%) noted learning about three or more Army or DoD STEM jobs/careers.
	Two-thirds or more of REAP apprentices reported that the following resources were somewhat or very much impactful on their awareness of DoD STEM careers: participation in REAP (94%); REAP mentors (82%); the AEOP website (82%); and presentations shared in REAP (65%). More than half of REAP apprentices said they had not experienced AEOP resources such as the ARO website (59%) and AEOP on social media (59%).
	Mentors were most likely to rate participation in REAP participation (86%), the AEOP website (86%), AEOP program administration (57%), and AEOP printed materials (50%) as at least somewhat useful resources for exposing students to DoD STEM careers.
Apprentices expressed positive opinions about DoD research and researchers.	REAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with all or nearly all (94%-100%) expressing agreement with each item 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.	More than 85% of apprentices (88%-100%) reported being more likely or much more likely to engage in all STEM activities after REAP. All REAP apprentices (100%) noted an increased likelihood of participating in the following activities: working on solving mathematical or scientific puzzles; using a computer to design/program somethings; helping with a community service project related to STEM; and working on a STEM project/experiment in a university/professional setting.
All REAP apprentices planned to at least complete a bachelor's degree and many reported an interest in earning a graduate or terminal degree.	All REAP apprentices (100%) said they wanted to earn at least a bachelor's degree. Many indicated a desire to earn a master's degree (29%) or terminal degree (59%) in their field.
REAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers.	More than half of REAP apprentices (59%-100%) agreed that REAP contributed in some way to each impact about which they were asked. The greatest area of impact, with all apprentices agreeing, was feeling more confident in their STEM knowledge, skills, and abilities (100%).

HSAP Findings

Table 238. 2020 HSAP Evaluation Findings

Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although fewer applications were submitted for HSAP apprenticeships than in previous years in 2020 and fewer institutions hosted apprentices, more students were placed in apprenticeships than in 2019.	In 2020, the program received a total of 434 student applications for HSAP apprenticeships, a 35% decrease as compared to the 670 student applications received in 2019 and a 22% decrease as compared to the 559 applications in 2018.
	A total of 32 students (7% of applicants) were placed in apprenticeships, a 10% increase over the 29 students placed (4% placement rate) in 2019, but a 33% decrease in enrollment as compared to 2018 when 48 students were placed.
	The HSAP program was affected by campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020. In response to the cancelation of many apprenticeship positions for high school students due to the pandemic, RIT planned and hosted an online summer course for displaced AEOP apprentices that served 17 students who had applied for HSAP apprenticeships.
	Few apprentices (n=8) and only one mentor participated in the evaluation survey. Because of the small sample size of apprentice respondents, no statistical comparisons of evaluation survey findings between groups could be conducted.
Fewer colleges and universities hosted HSAP apprentices than in previous years, and fewer of those institutions were HBCUs/MSIs.	A total of 20 universities hosted HSAP apprentices in 2020, a 20% decrease as compared to 2019 when 25 institutions hosted HSAP apprentices and a 39% decrease from 2018 when 33 institutions hosted apprentices. Seven of the 20 host universities (35%) were HBCU/MSIs, compared to 10 of 25 (40%) in 2019 and 13 of 33 (39%) in 2018.
Fewer HSAP apprentices met the AEOP definition of Underserved than in previous years, and enrollment demographics indicate that the program served fewer females and students from underserved minority groups than in the past.	Less than half of apprentices (47%) qualified for Underserved status under the AEOP definition, a decrease as compared to previous years (66% in 2019, 54% in 2018).
	As opposed to previous years, less than half of apprentices (44%) were female in 2020 (62% in 2019, 60% in both 2018 and 2017).
	As in previous years, the most commonly reported races/ethnicities were White and Asian, however fewer apprentices were White (19%) and more were Asian (50%) compared to previous years (31% White, 21% Asian in 2019; 31% White, 33% Asian in 2018; 42% White, 25% Asian in 2017).
	The proportion of students identifying as Black or African American declined markedly in 2020 (6% in 2020, 14% in 2019,

	15% in both 2018 and 2017). The percentage of apprentices identifying as Hispanic or Latino (16%) decreased as compared to 2019 (24%) but was slightly higher than in previous years (15% in 2018, 14% in 2017).
	More than half of HSAP apprentices (66%) spoke English as their first language (86% in 2019), few (16%) received free and reduced-price school lunches (FARMS) (21% in 2019), and very few (6%) would be first generation college attendees (14% in 2019).
Apprentices reported engaging in STEM practices more frequently in HSAP than in their typical school experiences.	Half or more of HSAP apprentices (50%-100%) reported participating at least once in all STEM practices during their apprenticeships. STEM practices that more than 85% of apprentices reported being frequently (most days or every day) engaged in during HSAP were: designing their own research/investigation based on their own question(s) (88%); interacting with STEM researchers (88%); analyzing data/information and drawing conclusions (88%); and solving real world problems (100%).
	Apprentices reported significantly higher frequency of engagement in STEM practices in HSAP as compared to in school (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.	All HSAP apprentices (100%) reported some degree of STEM knowledge gains as a result of participating in HSAP. Nearly 90% or more (88%-100%) indicated medium or large gains in every survey area of STEM knowledge. For example, all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (100%) and in-depth knowledge of a STEM topic (100%).
Apprentices reported gains in their STEM competencies as a result of participating in HSAP.	Half or more of participating apprentices (50%-100%) noted at least medium gains for all STEM competencies. All responding HSAP apprentices reported medium or large gains in two domains: defining a problem that can be solved by developing a new product/process (100%) and supporting an explanation with STEM knowledge (100%).
Apprentices reported that HSAP participation had positive impacts on their 21st Century.	More than half of apprentices (63%-100%) reported at least medium gains for all 21st Century skills items except for creating media products (0%) and analyzing media (38%). HSAP impacted all apprentices (medium or large gains) in 21st Century Skills such as the following: using technology as a tool (100%); incorporating feedback into their work effectively (100%); setting goals and utilizing time wisely (100%); working independently and completing tasks on time (100%); taking initiative (100%); and prioritizing, planning, and managing projects (100%).

Apprentices reported gains in their STEM identities as a result of participating in HSAP.	Three-quarters or more of HSAP apprentices (75%-100%) reported at least medium gains on all surveyed STEM identity items. All apprentices reported at least medium gains in their sense of accomplishing something in STEM (100%) and desire to build relationships with mentors who work in STEM (100%).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
The responding HSAP mentor used a range of mentoring strategies with apprentices.	The one responding HSAP mentor reported using strategies associated with each of the five areas of effective mentoring about which he was asked: 1. The mentor used all strategies, except giving students real-life problems to investigate or solve, to help make learning activities relevant to students. 2. The mentor used all strategies related to supporting the diverse needs of students as learners with the exception of integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM; identifying different learning styles of students at the beginning of the program; and interacting with students and other personnel the same way regardless of background. 3. The mentor used all strategies to support student development of collaboration and interpersonal skills. 4. The mentor used each strategy to support student engagement in authentic STEM activities except for having students search for technical research to support their work. 5. The mentor used fewer than half of the strategies to support students' STEM educational and career pathways. The three strategies this mentor reported using were: asking their student about educational/career goals; providing guidance about educational pathways that will prepare their student for a STEM career; and discussing the economic, political, ethical, and/or social context of a STEM career.
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.	Approximately two-thirds or more of HSAP apprentices (63%-100%) reported that they were at least somewhat satisfied with all program features listed. Features all HSAP apprentices reported being most satisfied with (somewhat or very much) included: applying or registering for the program (100%); the variety of STEM topics available (100%); the teaching/mentoring provided (100%); and the amount of the stipend (100%).
	All HSAP apprentices reported that their mentors were available more than half of the time (100%), and more than three-quarters (88%) reported their mentors were always available.
	All HSAP apprentices (100%) indicated they were somewhat or very much satisfied with all elements of their research experience. All apprentices were "very much" satisfied with their working relationship with their mentors.

	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 STEM skills and research skills apprentices gained, apprentices' STEM learning, the college and career information they received, and the opportunity to connect with other students.
	Apprentices participating in phone interviews commented positively on their experience with the virtual format of their apprenticeships. Some apprentices noted that communication was more difficult virtually than in person, but most felt that their mentors were accessible. One apprentice commented that the virtual format did not accommodate interactions between apprentices well and that she would have liked more time for interactions between students and faculty and between students.
	In open-ended responses, the improvements most frequently suggested by apprentices focused on communication from the program, including suggestions for more communication and clearer abstract requirements. Other suggestions included allowing more time for applying STEM skills rather than receiving instruction, more seminars or speakers, allowing apprentices more input into the project design or providing more choices of topics, and providing opportunities for apprentices to interact or collaborate.
The responding HSAP mentor was satisfied with program features he had experienced; HSAP mentors identified strengths of HSAP and offered various suggestions for program improvements.	With the exception of two items, the one HSAP mentor responding to the evaluation survey was somewhat or very much satisfied with all program features.
	The mentor who responded to open-ended questionnaire items made positive comments about HSAP. Mentors mentioned the following as program strengths: apprentices' exposure to STEM research, the encouragement apprentices receive to consider STEM careers, the opportunity to develop STEM skills, apprentices' exposure them to academic settings, and the AEOP support for research.
	Mentors who participated in phone interviews responded positively about the virtual format of HSAP for 2020 but noted that creating connections between students was particularly challenging. Mentors employed various online mentoring tools, including virtual syllabi for research, virtual meeting tools, and online seminars.
	The program improvements suggested by mentors included increasing the number of HSAP apprentices participating online, offering the apprenticeship course simultaneously with the apprenticeship, providing virtual seminars to connect apprentices across the country, expanding the program to include more students, creating a hybrid virtual/in person program, providing stipends for graduate student mentors, ensuring that

	sites receive information from the program in a timely fashion, and clarifying expectations for abstract.
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, the AEOP website or AEOP staff, and from a supervisor.	The most frequently selected sources of information about AEOP for apprentices, each selected by 50% of respondents were the AEOP website and someone who works at the school they attend.
	The one responding mentor reported that he learned about AEOP from a supervisor and an AEOP site host/director.
Apprentices were motivated to participate in HSAP primarily by the learning opportunities and their interest in STEM.	Approximately two-thirds or more of apprentices selected interest in STEM (75%), the desire to learn something new/interesting (63%); and the desire to expand laboratory/research skills (63%) as motivating factors for their participation in HSAP.
Most apprentices had not participated in AEOP previously, but most were interested in participating in AEOP in the future.	Three-quarters (75%) of apprentices reported they had not previously participated in any AEOP. A quarter (25%) had participated in Camp Invention previously, and a small proportion indicated having participated in HSAP previously (13%).
	Except for CQL (39%) and GEMS NPM (39%), half or more of apprentices reported being at least somewhat interested in the other AEOP (50%-88%). At the same time, half or more of HSAP apprentices reported having never heard of most AEOP (NDSEG – 50%, GEMS NPM – 63%, CQL – 63%).
	Large proportions of apprentices reported the following four resources to be particularly impactful (somewhat or very much) for exposing them to AEOP: participation in HSAP (100%), HSAP mentors (100%), the AEOP website (100%), and presentations shared in HSAP (63%). Half or more of responding apprentices had not experienced AEOP on social media (88%) or AEOP printed materials (50%).
The responding mentors had only discussed HSAP with his apprentices.	The responding mentor had not discussed any AEOP other than HSAP with apprentices.
	The responding mentor indicated the AEOP website and participation in HSAP were very much useful for exposing apprentices to AEOP. All other resources were not experienced by this mentor for this purpose.
Apprentices learned about STEM careers during HSAP, although they learned more about STEM careers generally than STEM careers specifically within the DoD.	All HSAP apprentices (100%) indicated they learned about at least one STEM job/career, while approximately a third (38%) noted learning about three or more general STEM careers. Three-quarters of apprentices (75%) reported learning about at least one DoD STEM job/career, and a quarter (25%) reported learning about three or more Army or DoD STEM jobs/careers.

	Half or more of apprentices reported the following resources as somewhat or very much impactful for their awareness of STEM careers in the DoD: the AEOP website (50%); presentations shared in program (63%); HSAP mentors (75%); and participation in HSAP (88%). More than half of HSAP apprentices said they had not experienced AEOP resources such as the ARO website (63%), AEOP printed materials (75%), and AEOP on social media (75%).
	The one responding HSAP mentor indicated he had experienced only the AEOP website as a useful resource for exposing apprentices to DoD STEM careers. He reported having not experienced any of the other resources for this purpose.
Apprentices expressed positive opinions about DoD research and researchers.	HSAP apprentices expressed extremely positive opinions about DoD researchers and research with all (100%) agreeing with each statement 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.	All apprentices reported that they were more likely or much more likely to participate in each STEM activity about which they were asked with the exception of watching or reading non-fiction STEM (88%) and talking with friends/family about STEM (88%).
All HSAP apprentices planned to at least complete a bachelor's degree, and many reported an interest in earning a graduate or terminal degree.	All HSAP apprentices (100%) reported wanting to at least earn a bachelor's degree. Many indicated a desire to earn a master's degree (13%) or terminal degree (75%) in their field.
HSAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers.	Approximately two-thirds or more (63%-100%) of HSAP apprentices agreed that the program contributed in some way to each impact about which they were asked. All apprentices said HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%) and gave them a greater appreciation of Army/DoD STEM research (100%).

URAP Findings

Table 239. 2020 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 and apprentices decreased as compared to previous years.	In 2020, URAP received 258 student applicants for URAP apprenticeships, an 8% decrease from the 281 applicants received in 2019, and a 20% decrease as compared to the 321 who applied in 2018.
	A total of 49 applicants (19% of applications) were placed in apprenticeships in 2020, a 9% decrease compared to the 54

	students placed in 2019 and a 27% decrease in placement compared to 2018 when 67 students were placed.
	URAP enrollment was affected by campus shutdowns and/or restrictions placed on many college and university labs as a result of the COVID-19 pandemic in 2020
Fewer colleges and universities hosted URAP apprentices in 2020 than in previous years, and fewer were HBCUs/MSIs than in previous years.	A total of 30 institutions (29 universities and one institute for psychiatric research) hosted apprentices, a 27% decrease as compared to the 41 host institutions in 2019 and a 38% decrease compared to the 48 host institutions in 2018. Of these institutions, six (20%) were HBCU/MSIs, a decrease as compared to previous years (10, or 24% in 2019; 22, or 46% in 2018).
The proportion of female URAP apprentices and apprentices who met the AEOP definition of Underserved grew relative to previous years, however the proportion of apprentices from underserved minority group declined relative to previous years.	Over a quarter (29%) of URAP apprentices met the AEOP definition of Underserved, an increase compared to previous years (22% in 2019, 18% in 2018).
	The proportion of female apprentices in 2020 (45%) grew relative to the two previous years (39% in 2019, 39% in 2018, 58% in 2017).
	The proportion of apprentices identifying as White (35%) decreased as compared to previous years (57% in 2019, 64% in 2018, 53% in 2017). The proportion of apprentices identifying as Asian (37%) increased sharply as compared to previous years (19% in 2019, 9% in 2018, 14% in 2017).
	The proportion of apprentices identifying as Black or African American (4%) continued a multi-year decline (6% in 2019, 9% in 2018, 8% in 2017). The proportion of apprentices identifying as Hispanic or Latino (12%) decreased from 2019 (15% in 2019, 10% in 2018, 15% in 2017).
	As in 2019, most apprentices (82% for both 2019 and 2020) spoke English as their first language, and few (14% in 2020, 13% in 2019) were first generation college attendees. A quarter (25%) of apprentices were Pell Grant recipients.
Apprentices reported engaging in STEM practices more frequently in URAP than in their typical college or university experiences.	More than half of URAP apprentices (56%-100%) reported participating in all STEM practices at least once during their program with the exception of presenting their STEM research to a panel of judges (0%). STEM practices that more than 90% of apprentices reported being frequently (most days or every day) engaged in included: working with a STEM researcher or company on a real-world STEM research project (94%); working collaboratively as part of a team (94%); and analyzing data/information and drawing conclusions (100%).

	Apprentices reported significantly more frequent engagement in STEM practices in URAP as compared to in their college or university coursework (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 Underserved reported greater gains than non-Underserved apprentices.	Three quarters or more (75%-100%) of apprentices reported medium or large gains in each surveyed area of STEM knowledge. For example, all apprentices reported at least medium gains in knowledge of how scientists and engineers work on real problems in STEM (100%) and in their in-depth knowledge of a STEM topic (100%).
	Although no significant differences in gains in STEM knowledge were found by any of the individual demographic components of Underserved status, apprentices who met the AEOP definition of Underserved reported significantly greater gains than non-Underserved 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 Underserved reported greater gains than non-Underserved apprentices.	More than half of participating URAP apprentices (56%-94%) noted at least medium gains across competencies. More than 90% of responding apprentices reported medium or large gains in two domains: using knowledge/creativity to suggest a solution to a problem (94%) and defining a problem than can be solved by developing a new product/process (94%).
	Although no significant differences in gains in STEM competencies were found by any of the individual demographic components of Underserved status, apprentices who met the AEOP definition of Underserved reported significantly greater gains than non-Underserved apprentices (large effect size).
Apprentices reported that URAP participation had positive impacts on their 21st Century skills; apprentices who met the AEOP definition of Underserved and female apprentices reported greater gains than their peers.	Half or more of apprentices (50%-100%) reported at least medium gains across all items except for creating media products (13%) and analyzing media (25%). CQL impacted all apprentices (medium or large gains) in the 21st Century skills area of adapting to change when things do not go as planned (100%).
	Apprentices who met the AEOP definition of underserved reported greater gains in their 21st Century skills than non-Underserved 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 identified as belonging to a racial or ethnic minority group included in the Underserved definition reported greater gains.	More than 80% of URAP apprentices (81%-100%) indicated at least medium gains on all survey items associated with STEM identity (Table 68). All reported at least medium gains in their feeling prepared for more challenging STEM activities (100%).
	While no significant differences were found by overall Underserved status, apprentices who identified as belonging to a racial or ethnic minority group included in the AEOP definition of Underserved reported significantly greater gains than their peers (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 strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Nearly two-thirds or more (60%-90%) of URAP mentors reported that they implemented all strategies to help make learning activities relevant to students. 2. Half or more (50%-100%) of URAP mentors reported that they used all strategies to support the diverse needs of students as learners. 3. More than two-thirds of URAP mentors (70%-100%) indicated implementing all strategies to support students' development of collaboration and interpersonal skills. 4. More than three-quarters (80%-100%) of URAP mentors reported using all strategies to support students' engagement in authentic STEM activities. 5. Half or more of URAP mentors (50%-90%) reported using all strategies focused on supporting students' STEM educational and career pathways except for recommending AEOP that align with students' goals (40%).
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.	Three-quarters or more of URAP apprentices (75%-100%) reported being at least somewhat satisfied with all program features listed except for physical location (50% did not experience, 50% somewhat/very much satisfied). Features that all apprentices were satisfied with were the application/registration for program (100%) and the variety of STEM topics available (100%).
	Nearly all apprentices indicated that their mentors were available at least half of the time (94%), and more than two-thirds (69%) responded that their mentors were always available.
	All responding URAP apprentices reported high levels of satisfaction (somewhat or very much) for each aspect of their research experience. All apprentices indicated that they were "very much" satisfied with their apprenticeship experience overall.
	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 value of the networking opportunities and their relationships with their mentors, the research experience and skills they gained, STEM learning, and gaining career information.
	Apprentices participating in phone interviews also commented upon their satisfaction with the virtual format of the program. All apprentices made positive comments about the online format.

	While most apprentices noted that they would have preferred to complete their apprenticeships on site, they reported feeling engaged with the research process.
	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 more frequent communication and more communication about guidelines and requirements. Other suggestions included providing more career information, providing more interactions between apprentices, providing ways for apprentices to share their work with others or for apprentices to learn about others' research, and improvements to the stipend (e.g., timely payment, biweekly payment, and more clear communication about the stipend).
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.	More than three-quarters of URAP mentors (80%-90%) indicated they were at least somewhat satisfied with all program components they had experienced. Program features mentors reported being most satisfied with (somewhat or very much) were the timeliness of stipend payment to apprentices (90%); research abstract preparation requirements (90%); and the research presentation process (90%).
	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 apprentices gain in URAP, followed by mentors' opportunity to work with talented students, and the DoD information apprentices gain.
	Mentors participating in phone interviews who commented on the virtual format of URAP were positive about the experience but noted that formulating ways for apprentices to interact with one another online is a challenge. Mentors noted a variety of ways they engaged with students, including holding daily or biweekly meetings, giving students regular feedback, and having daily discussions using videoconferencing.
	In open-ended responses, mentors' most frequently mentioned suggestions were to provide more outreach or advertising to increase the number of applicants, to provide opportunities for apprentices to present their research, to communicate more clearly about requirements for the abstracts, and to extend the program's length (e.g., through the school year).
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	The most frequently selected sources of information about AEOP for apprentices were someone who works at the school/university they attend (83%), followed by someone who works with the program (25%).

workplace or from DoD contacts.	The two most commonly selected responses for how mentors learned about AEOP were their supervisor/superior (30%) and someone who works with the DoD (30%).
Apprentices were motivated to participate in URAP primarily by the learning opportunities and their interest in STEM.	Half or more of apprentices noted they were motivated to participate in URAP because of a desire to learn something new/interesting (58%) and an interest in STEM (50%).
Only one URAP apprentice reported having participated in another AEOP in the past, but many expressed interest in future participation, although large proportions had not heard of AEOP other than URAP.	Nearly all apprentices (92%) reported they had never participated in any other AEOP. Only one respondent indicated they had previously participated in JSHS (8%).
	Most apprentices were interested in participating in URAP again (94%) and over 40% were interested in SMART (44%). Half of more of apprentices said they had not heard of programs other than URAP: CQL (69%), GEMS-NPM (63%), NDSEG (63%), and SMART (50%).
	Half or more reported the following four resources as particularly impactful (somewhat or very much) on their awareness of AEOP: URAP mentors (100%); the AEOP website (94%); participation in URAP (81%); and presentations shared in URAP (50%). More than half of responding apprentices had not experienced AEOP on social media (69%) or AEOP printed materials (56%).
Few mentors discussed any specific AEOP other than URAP with their apprentices.	A majority of mentors (70%) reported speaking with their apprentices about URAP (70%), and two mentors (20%) discussed SMART and NDSEG with apprentices. Another 40% had discussed AEOP generally, but without reference to any specific program.
	More than half of mentors reported that URAP participation (80%) was at least somewhat useful for making apprentices aware of AEOP, followed by the AEOP website (60%). Most mentors indicated that they did not experience invited speakers (70%) or AEOP on social media (60%) as resources for exposing apprentices to AEOP.
Apprentices learned about STEM careers during URAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	A large proportion of URAP apprentices (81%) indicated learning about at least one STEM job/career during URAP, and approximately a third (31%) reported that they learned about three or more STEM careers in general. Considerably fewer apprentices (31%) reported learning about at least one DoD STEM job/career, and none (0%) reported learning about three or more Army or DoD STEM jobs/careers.

	Approximately two-thirds of apprentices reported the following resources as somewhat or very much impactful on their awareness of DoD STEM careers: the AEOP website (63%); URAP mentors (63%); and participation in URAP (69%). Half or more of URAP apprentices said they had not experienced AEOP resources such as AEOP on social media (69%) and AEOP printed materials (50%).
	Mentors were most likely to rate participation in URAP (70%) and the AEOP website (70%) as at least somewhat useful resources for exposing apprentices to DoD STEM careers. More than half of responding URAP mentors had not experienced invited speakers (70%) and AEOP on social media (60%).
Apprentices expressed positive opinions about DoD research and researchers.	URAP apprentices expressed extremely positive opinions about DoD researchers and research with all (100%) agreeing with 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 Underserved, females, and low-income apprentices were more likely to report increased likelihood of future engagement than non-Underserved apprentices.	All or nearly all URAP apprentices (94%-100%) indicated that after participating in URAP they were more likely to engage with all activities about which they were asked. The only activity for which less than 100% of apprentices reported increased likelihood of engagement was participating in a STEM camp, club, or competition (94% were more likely to engage).
	Apprentices who met the AEOP definition of underserved, female apprentices, and low-income apprentices reported greater likelihood of future engagement than others (all large effect sizes).
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 URAP apprentices (100%) reported aspiring to earn at least a bachelor's degree. Many said they desired to earn a master's degree (44%) or terminal degree (44%) in their field.
URAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers.	Nearly 70% or more (69%-100%) of URAP apprentices agreed that participating in URAP contributed in some way to each impact listed. All apprentices reported that participating in URAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%).

Summer Apprenticeship Course Findings

Table 240. 2020 Summer Apprenticeship Course Evaluation Findings
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*

Students displaced from the three high school AEOP apprenticeship programs participated in the Summer Apprenticeship Course.	The apprenticeship course *Science in the Real World: Finding Your Voice* served 104 students. Of these students, 54 were displaced REAP students, 17 were displaced HSAP students, and 31 were displaced SEAP students. Two additional students who had not applied to apprenticeship programs were also accepted for the course.
The apprenticeship course served students from diverse backgrounds, and most met the AEOP definition of Underserved.	Nearly three-quarters (73%) of students met the AEOP definition of Underserved.
	Nearly three quarters of students enrolled in the apprenticeship course were female (74.5%) and just over a quarter (25.5%) were male.
	The most frequently reported race ethnicity was Asian (45%) followed by Black or African American (27%), White (11%), and Hispanic or Latino (10%).
	Most students (68%) attended suburban schools, and most (56%) were in the 11th grade. Less than a third (29%) received free or reduced-price school lunches (FARMS). Most students in the course (71%) spoke English as their first language, and relatively few (19%) would-be first-generation college attenders.
Students reported gains in their STEM knowledge as a result of participating in the apprenticeship course; students who would-be first-generation college attendees and ELL students experienced larger gains.	Approximately 70% of students or more (70%-95%) reported either medium or large gains in every area of STEM knowledge on the survey. The area with the largest knowledge gain was students' knowledge of research processes, ethics, and rules for conduct in STEM (95%).
	No significant differences in STEM knowledge gains were found by overall Underserved status, however students who did not have a parent who attended college and students for whom English was not a first language reported larger gains than their peers (medium and large effect sizes respectively).
Students reported that participating in the apprenticeship course had positive impacts on their 21st Century skills.	More than half of students reported high levels (medium to large) of 21st Century skills gains (58%-97%) across survey items as a result of participating in the course with the exception of creating media products (17% - medium/large gains). Three items for which nearly all participants reported at least medium gains were: communicating clearly (94%); evaluating others' evidence, arguments, and beliefs (95%); and collaborating with others effectively in diverse teams (97%).
Students reported gains in their STEM identities as a result of participating in the apprenticeship course.	Approximately three-quarters or more of students (72%-95%) reported medium or large gains on all items associated with STEM identity. Nearly all students reported at least medium gains in their desire to build relationships with mentors who work in STEM (95%).

Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Apprenticeship course student were satisfied with program features that they had experienced and identified a number of benefits of the course. Students also offered various suggestions for program improvement.	More than 90% of students (94%-100%) indicated being somewhat or very much satisfied with all program features. Features with which all students reported being at least somewhat satisfied included the ability of course to meet their expectations (100%) and small group meetings with near peer mentors (100%).
	When asked to comment on their overall satisfaction with the course, all 36 students had something positive to say. Students who identified the sources of their satisfaction with the course mentioned the opportunity to meet new people, their learning, the speakers, the NPMs, the career information they received, and their new perspective on social issues related to STEM. Students most consistently commented upon the opportunity to network (with other students, their mentors, and professors) the value of the speakers, and their broadened perspectives about STEM.
	In open-ended responses, the improvements most frequently suggested by students were related to course assignments and activities (e.g., more time for assignments, more interactive activities), connections with others (e.g., more connections with peers, NPMs, and professors), course content (e.g., more science focus or more variety in topics), communication (e.g., clarifying expectations, providing syllabi and rubrics), and course format or organization (e.g., making the course longer).
Students reported that their mentors were available to them regularly and that mentors used a variety of mentoring strategies during the course.	All but one respondent said their mentor was available at least half of the time (97%), and more than three-quarters (78%) noted their mentor was always available.
	A large majority of students (72%-100%) reported that their mentors in the course used each of the mentoring strategies about which they were asked. All students reported that mentors encouraged them to share ideas with others who had different backgrounds or viewpoints than they (100%) and gave them feedback to help them improve in STEM.
Apprenticeship course student expressed the desire to work with NPMs throughout the school year in various ways.	A large majority of students (91%) responded that they would like to connect with NPMs throughout the school year. Those that expanded on the reasons for their responses commented that the NPMs were useful resources for college and other information.
	Students who provided details about how they would like to work with NPMs most frequently indicated that they would like to connect with NPMs regarding college information (e.g., college application information, assistance with writing essays). Other suggestions for how NPMs would work with students included providing information about STEM opportunities or networking), general advice and guidance, assistance or

	tutoring with STEM courses or study habits, and discussing STEM issues and current events.
Apprenticeship course students expressed the desire to have webinars available to them throughout the school year; students' interests in topics varied.	Nearly all students (98%) were interested in having webinars available to them during the school year.
	Students were interested in webinars about college (e.g., admissions information and application information), STEM career information (e.g., personal stories of people in STEM careers, types of STEM careers), general STEM topics (e.g., specific disciplinary content, policy issues), information about internships and co-ops, and information about soft skills.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprenticeship course participants enrolled in the course for a variety of reasons and indicated interest in future enrollment in a similar course that did not offer college credit.	Approximately three-quarters or more of students reported the following motivations for taking the course: doing something in STEM (79%), college credit (75%), something to do with the cancellation of apprenticeships (75%), and the stipend (72%).
	Nearly all responding students (92%) said they would choose to enroll in a similar course without college credit tied to it.
Most apprenticeship course students had not participated in AEOP in the past; however, most are interested in participating in AEOP in the future.	Two-thirds (67%) of students said they had not previously participated in any AEOP, however smaller proportions indicated having participated in the following programs: GEMS (15%), Camp Invention (12%), REAP (6%), eCM (3%), and JSHS (3%).
	More than half of students (61%-86%) were at least somewhat interested in participating in AEOP in the future. The programs that students reported being most interested in were GEMS NPM (86%), REAP (83%), SEAP (83%), SMART (81%), and HSAP (81%).
	The resources students most frequently cited as being somewhat or very much useful for their awareness of AEOP were participation in the summer course (97%); presentations from the summer course (97%); summer course instructors (95%); and the AEOP website (86%). More than half of students reported not experiencing AEOP social media for this purpose.
Most apprenticeship course participants learned about STEM careers generally and DoD STEM careers specifically during the course.	Large proportions of students (97%) reported learning about at least one STEM job/career and nearly all (94%) also noted learning about three or more general STEM careers. Similarly, a large majority of students (94%) reported they learned about at least one DoD STEM job/career, although fewer (56%) indicated that they learned about three or more Army or DoD STEM jobs/careers during the course.

	More than 90% of students reported that the following three resources were at least somewhat impactful on their awareness of DoD STEM careers: participation in the summer course (97%); presentations shared in the summer course (95%); and summer course instructors (92%). More than a third of students reported they had not experienced AEOP resources such as the AEOP on social media (64%) and AEOP printed materials (36%).
Apprenticeship course participants expressed positive opinions about DoD research and researchers.	Student opinions about DoD researchers and research were overwhelmingly positively with more than 97% agreeing with all statements regarding the work of DoD researchers and the research conducted.
Apprenticeship course participants reported that they were more likely to engage in various STEM activities after participating in the course.	Students reported extremely high levels of likelihood (89%-100%) for engaging in the future with STEM activities outside of their regular school courses listed as a result of participating in the apprenticeship course
All apprenticeship course students planned to at least complete a bachelor's degree, and many reported an interest in a graduate or terminal degree.	All students (100%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's (25%) or terminal degree (64%).
Apprenticeship course participants reported that participating in the course impacted their confidence and interest in STEM and STEM careers.	Approximately three-quarters or more of students (72%-100%) agreed that the summer course contributed in some way to each impact. Areas of greatest impact, with more than 90% of students agreeing that the program impacted them, were more confidence in STEM knowledge, skills, and abilities (100%) and a greater appreciation of DoD STEM research (92%).

Overall Recommendations for FY21 Program Improvement/Growth

Evaluation findings for apprenticeship programs overall were very positive. All programs 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 FY21 and beyond:

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

As expected, most of the apprenticeship programs in FY20 experienced a decline in both applications and participation due to the impact of COVID-19 on access to apprenticeship program host sites on university campuses and at Army/DoD laboratories, and participation of mentors to deliver the program virtually. However, the number of applications despite COVID-19 still greatly exceeded the number of apprenticeships that were available for students due to a lower number of sites and mentors. HSAP was able to navigate the move to a virtual program while growing participation slightly in FY20 to 32 apprentices (compared to 29 in FY19). All other AEOP apprenticeship programs declined in number of students included in FY20 including CQL 159 (compared to 194 in FY19), REAP 86 (compared to 168), SEAP 28 (compared to 108 in FY19), and URAP 49 (compared to 54 in FY19). The demand for AEOP apprenticeships continues to exceed current capacity. Therefore, it is recommended that RIT and the consortium consider strategies to increase the scale of opportunity for apprenticeships. Further, given that COVID-19 may create additional need in FY21 for delivery of apprenticeships in a virtual format, coupled with the positive feedback on the online program delivery, it is suggested that this option be explored for growing the AEOP apprenticeship program overall.

In regard to participation of individuals from historically underserved backgrounds according to the AEOP definition, most apprenticeship programs experienced a decline in percentages of underserved participants, with the exception of URAP in FY20 at 29% (22% in FY19). Program declines ranged from slight drops including CQL at 26% FY20 (compared to 35% in FY19); SEAP at 21% in FY20 (compared to 32% in FY19); and REAP at 94% in FY20 (compared to 99% inFY19). HSAP experienced a larger decrease in FY20, experiencing a nearly 20% decline with 47% underserved participants. Clearly the AEOP were met with challenges due to COVID-19. However, it is critical for mentors, program directors, and others involved in the selection process to keep in mind this important priority for AEOP overall when making acceptance/placement decisions.

AEOP Priority: Support and empower educators with unique Army research and technology resources

Overall, participants reported having a successful experience participating in their AEOP apprenticeship program. However, one common finding across programs was the lack of mentor emphasis on academic program and career pathway discussions/information/activities. It is recommended that RIT consider the development (along with AEOP consortium overall) of materials, activities, and resources that apprenticeship mentors and adults leading AEOP can use in the course of their program delivery to provide both exposure and support for students who are thinking about (high school) and in some cases planning (college) their future while participating in these apprenticeships. It is possible that this may be a focus area that the entire consortium may want to consider collaborating to address.

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

Apprenticeship participation in the annual AEOP evaluation for FY20 was considerably lower than in previous years, possibly exasperated by COVID-19. Some programs had less than five respondents for participants and mentors which makes it very difficult to conduct typical analyses. In addition, as in previous years, overall, apprenticeship program participants reported they were not introduced to other AEOP opportunities. It is recommended that all AEOP apprenticeship programs develop a plan and support for FY21 to increase participation in the AEOP evaluation accordingly and continue to work with mentors to provide resources to enable them to disseminate information about other AEOP with their students.