IT STARTS HERE. ★

ARMY EDUCATIONAL OUTREACH PROGRAM

Apprenticeship Programs

2019 Annual Program Evaluation Report
Executive Summary

July 2020

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

1

1 | AEOP Consortium Contacts

U.S. Army Contacts

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

Jack Meyer
Army Educational Outreach Program (AEOP) Director
Office of the Deputy Assistant Secretary of the Army
for Research and Technology
jack.m.meyer2.ctr@mail.mil

AEOP Cooperative Agreement Manager

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

Battelle Memorial Institute – Lead Organization

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

Apprenticeship Program Lead

Donna Burnette
Apprenticeship Director
Rochester Institute of Technology
Donna.burnette@rit.edu

Jennifer Ardouin
URAP/HSAP Apprenticeship Program Lead
ARO
Jennifer.r.ardouin.civ@mail.mil

Evaluation Team Contacts – NC State University

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

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

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

Report APPRENTICESHIP 03_07152020 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by NC State University College of Education on behalf of Battelle Memorial Institute (Lead Organization) under award W911 SR-15-2-0001.

2 | Executive Summary

This report documents the evaluation study of the AEOP apprenticeship programs, which include: College Qualified Leaders (CQL); Science and Engineering Apprenticeship Program (SEAP); Research and Engineering Apprenticeship Program (REAP); High School Apprenticeship Program (HSAP); and Undergraduate Research Apprenticeship Program (URAP). In FY19 the apprenticeship programs were managed by the Rochester Institute of Technology (RIT). A total of 312 students were enrolled in apprenticeship programs based in Army laboratories and center (CQL and SEAP) and 256 in university-based programs (REAP, HSAP, and URAP) in FY19. The following section provides an overview of each program along with program-specific Fast Facts.

Program Overview

Army Laboratory-Based Programs

College Qualified Leaders (CQL)

The CQL program, managed by the Rochester Institute of Technology (RIT), is a program that matches talented college students (herein referred to as apprentices) with practicing Army scientists and engineers (Army S&Es). The use of the term "mentor" throughout this report will refer to the Army S&E working directly with student apprentices. This direct apprentice-mentor relationship provides apprentice training that is unparalleled at most colleges. CQL allows alumni of Gains in the Education of Mathematics and Science (GEMS) and/or Science and Engineering Apprentice Program (SEAP) to continue their relationships with mentors and/or laboratories, and also allows new college students to enter the program. CQL offers apprentices the opportunity for summer, partial year, or year-round research at Army laboratories and centers, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army laboratories and centers. CQL fosters desire in its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

In 2019, CQL was guided by the following objectives:

1. To nurture interest and provide STEM research experience for college students and recent graduates contemplating further studies;
2. To provide opportunities for continued association with the DoD laboratories and STEM enrichment for previous SEAP, GEMS, and other AEOP participants as well as allow new college students the opportunity to engage with DoD laboratories;

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

Table 1. CQL 2019 Fast Facts	
Description	STEM Apprenticeship Program – Summer or school year, at Army laboratories and centers with Army S&E mentors
Participant Population	College undergraduate students
Number of Applicants	662
Number of Participants	204
Number/Percentage U2 Participants	71/35%
Placement Rate	31%
Number of Mentors	178
Number of Army S&Es	178
Number of Army Research Laboratories & Centers	16
Number of Colleges/Universities	N.A.
Number of HBCU/MIs	N.A.
Total Cost	$1,803,439
Total Travel	$1,287
Participant Travel	$0
Total Awards	$1,744,514
Student Awards/Stipends	$1,744,514
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$8,840

Science and Engineering Apprenticeship Program (SEAP)

SEAP is an AEOP pre-collegiate program for talented high school students that matches these students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es) for an eight-week summer apprenticeship at Army laboratories or centers. 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 laboratories and centers. The intent of the program is that apprentices will return in future summers and continue their association with their original laboratories and mentors and, upon graduation from high school, participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue that relationship. Through their SEAP experiences, apprentices are exposed to the real world of research, experience valuable mentorship, and learn about education and career opportunities in STEM. SEAP apprentices also learn how their research can benefit the Army as well as the civilian community.

In 2019, SEAP was guided by the following objectives:

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

Table 2. SEAP 2019 Fast Facts	
Description	STEM Apprenticeship Program – Summer, at Army laboratories and centers with Army S&E mentors
Participant Population	9th-12th grade students
Number of Applicants	1,286
Number of Participants	108
Number/Percentage U2 Participants	35/32%
Placement Rate	8%
Number of Adults (Mentors)	123
Number of Army S&Es	123
Number of Army Research Laboratories & Centers	10
Number of K-12 Schools	64
Number of K-12 Schools – Title I	25
Total Cost	$482,304
Total Travel	$788
Participant Travel	$0
Total Awards	$367,986
Student Awards/Stipends	$367,986
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$4,466

University-Based Programs

Research and Engineering Apprenticeship Program (REAP)

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

REAP is guided by the following objectives:

1. Provide high school students from groups historically underrepresented and underserved in STEM, including alumni of AEOP's Unite program, with an authentic science and engineering research experience;

2. Introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP;
3. Provide participants with mentorship from a scientist or engineer for professional and academic development purposes; and,
4. Develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.

Table 3. REAP 2019 Fast Facts	
Description	STEM Apprenticeship Program – Summer, at colleges/university laboratories, targeting students from groups historically underserved and under-represented in STEM, college/university S&E mentors
Participant Population	Rising 10th, 11th, and 12th grade high school students, rising first-year college students from groups historically underserved and under-represented in STEM
Number of Applicants	857
Number of Participants	168
Number/Percentage U2 Participants*	163/99%
Placement Rate	20%
Number of Adults (Mentors)	132
Number of College/University S&Es	132
Number of College/Universities	55
Number of HBCU/MSIs	29
Number of K–12 Schools	143
Number of K–12 Schools — Title I	70
Total Cost	$450,165
Total Travel	$2,060
Participant Travel	$0
Total Awards	$353,000
Student Awards/Stipends	$239,000
Adult/Teacher/Mentor Awards	$114,000
Cost Per Student	$2,680

* U2 calculation based upon Cvent participation data that reflects enrollment of n=165

High School Apprenticeship Program (HSAP)

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

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

In 2019, HSAP was guided by the following priorities:

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

Table 4. HSAP 2019 Fast Facts	
Description	STEM Apprenticeship Program – Summer, in Army-funded laboratories at colleges/universities nationwide, with college/university S&E mentors
Participant Population	11th-12th grade students
Number of Applicants	670
Number of Participants	29
Number/Percentage U2 Participants	19/66%
Placement Rate	4.33%
Number of Adults (Mentors)	40
Number of College/University S&Es	40
Number of K-12 Schools	28
Number of K-12 Schools – Title I	8
Number of Army-Funded College/University Laboratories	26
Number of College/Universities	25
Number of HBCU/MSIs	10
Total Cost	$102,785
Total Travel	$788
Participant Travel	$0
Total Awards	$77,700
Student Awards/Stipends	$77,700

Adult/Teacher/Mentor Awards	$0
Cost Per Student	$3,544

University Research Apprenticeship Program (URAP)

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

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

In 2019, URAP was guided by the following priorities:

1. Provide hands-on science and engineering research experience to undergraduates in science or engineering majors;
2. Educate apprentices about the Army's interest and investment in science and engineering research and the associated educational and career opportunities available to apprentices through the Army and the Department of Defense;
3. Provide students with experience in developing and presenting scientific research;
4. Provide apprentices with experience to develop an independent research program in preparation for research fellowships;
5. Develop apprentices' research skills with the intent of preparing them for graduate school and careers in science and engineering research; and,
6. Provide opportunities for apprentices to benefit from the expertise of a scientist or engineer as a mentor.

Table 5. URAP 2019 Fast Facts	
Description	STEM Apprenticeship Program – Summer, in Army-funded labs at colleges/universities nationwide, with college/university S&E mentors
Participant Population	College undergraduate students

Table 5. URAP 2019 Fast Facts	
Number of Applicants	281
Number of Participants	54
Number/Percentage U2 Participants	12/22%
Placement Rate	19%
Number of Adults (Mentors)	51
Number of College/University S&Es	51
Number of Army-Funded College/University Laboratories	42
Number of College/Universities	41
Number of HBCU/MSIs	10
Total Cost	$256,654
Total Travel	$952
Participant Travel	$0
Total Awards	$209,347
Student Awards/Stipends	$209,347
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$4,753

Summary of Findings

The FY19 evaluation of AEOP apprenticeship programs collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings for each program are provided in the Tables 6-10.

CQL Findings

Table 6. 2019 CQL Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although substantially more students applied for CQL apprenticeships in 2019 compared to previous year, a downward trend in the number of students placed in apprenticeships continues.	A total of 662 students applied for CQL apprenticeships compared to 574 in 2018 and 575 in 2017.
	A total of 204 applicants (31%) were placed in apprenticeships. This continues a gradual downward trend in the number of participating apprentices and in placement rate since 2017 (in 2018, 214, or 37%, were placed; in 2017, 229, or 39% were placed.
	Eighteen Army labs and centers accepted applications for CQL apprentices in 2019. Apprentices were hosted at 16 of these sites, an increase over the 13 participating host sites in 2018.
Over a quarter of CQL apprentices met the AEOP definition of U2. Enrollment of apprentices from groups historically underserved and underrepresented in STEM increased in 2019 as compared to 2018.	Slightly over a third (35%) of apprentices met the AEOP definition of underserved or underrepresented (U2) in STEM, an increase from the 20% who met the definition in 2018.
	About half (51%) of participants were female, an increase as compared to 2018 when 45% were female, but a decrease as compared to 2017 when 54% of CQL apprentices were female.
	A somewhat smaller proportion of CQL apprentices identified themselves as White (54%) as compared to previous years (64% in 2018; 67% in 2017), and the proportion of apprentices identifying themselves as Asian decreased slightly (12%) compared to previous years (14% in both 2017 and 2018).
	The proportion of CQL apprentices identifying themselves as Black or African American (18%) increased as compared to 2018 (13%) and 2017 (7%), while participation by apprentices identifying as Hispanic or Latino remained relatively constant (6% in 2019; 6% in 2018; 5% in 2017).
	As in previous years, few CQL apprentices spoke English as a second language (5%) and relatively few were first generation college attendees (16%).

CQL mentors reported gains in 21st Century skills for the apprentices they assessed; gains were statistically significant in all but two areas.	Apprentices demonstrated statistically significant ($p<.05$) growth in all domains of 21st Century skills assessed except fort the domains of Information, Media, & Technology Literacy and Productivity, Accountability, Leadership, & Responsibility. Regardless of the domain, apprentices were observed to be slightly above the Progressing level at pre-observation (average 2.07 to 2.36), and by final observation CQL participants' skill ratings were closer to the Demonstrates Mastery level (average 2.53 to 2.80).
Apprentices reported engaging in STEM practices more frequently in CQL than in their typical college or university experiences; first generation college attendees reported more frequent engagement than those who had a parent who attended college.	More than half of apprentices (58%-98%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (26%) and building/making a computer model (45%). STEM practices CQL apprentices reported being most frequently (weekly or every day) engaged with during the program were interacting with STEM researchers (98%) and working with a STEM researcher or company on a real-world STEM research project (96%).
	No significant differences were found in reported frequency of engaging in STEM Practices in CQL by U2 classification, although first generation college attendees reported significantly greater engagement as compared to their peers who had a parent who attended college (medium effect size).
	Apprentices reported significantly higher frequency of engagement in STEM practices in CQL as compared to in their college or university courses (extremely large effect size), suggesting that CQL offers apprentices substantially more intensive STEM learning experiences than they would generally experience in their coursework.
Apprentices reported gains in their STEM knowledge as a result of participating in CQL; apprentices who met the AEOP definition of U2 and male apprentices reported larger gains than their non-U2 and female peers.	More than 80% of CQL apprentices indicated at least some gains in every area of STEM knowledge on the survey. All apprentices reported at least some gains in their in-depth knowledge of STEM topics (100%), and nearly all reported similarly about their gains in knowledge of research conducted in STEM fields (98%).
	Apprentices who met the AEOP definition of U2 reported significantly greater STEM knowledge gains than non-U2 apprentices (medium effect size), and male apprentices reported significantly greater STEM knowledge gains than female apprentices (large effect size).
Apprentices reported gains in their STEM competencies as a result of participating in CQL with no significant differences across any of the constituent categories of U2 status.	More than half of the responding apprentices (57%-89%) reported at least some gain in all STEM competencies. Competencies most frequently reported as having been impacted (some or large gains) by CQL apprentices were defining a problem that can be solved by developing a new or improved product or process (92%), using knowledge/creativity to suggest a solution to a problem (89%), and supporting an explanation with STEM knowledge (89%).
	There were no differences in gains in STEM competencies by U2 classification or by any of the individual demographic variables investigated.

Apprentices reported that CQL participation had positive impacts on their 21st Century skill; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	Approximately two-thirds or more of apprentices (68%-94%) reported at least some gains on each item associated with 21st Century skills with the exception of the following: creating media products (15%); analyzing media (32%); and leading others in a team (45%). Items with the greatest growth (at least some gains) were solving problems (94%); interacting effectively in a professional manner (94%); adapting to change when things do not go as planned (94%); and incorporating feedback into their work effectively (94%).
	Apprentices who met the AEOP definition of U2 reported significantly greater impacts on their 21st Century skills than non-U2 apprentices (medium effect size).
Apprentices reported gains in their STEM identities as a result of participating in CQL with no significant differences across any of the constituent categories of U2 status.	Approximately three-quarters or more of CQL apprentices (75%-92%) reported some gains or large gains on all items associated with STEM identity, and large majorities of apprentices reported at least some gain in their desire to build relationships with mentors who work in STEM (92%) and sense of accomplishing something in STEM (92%).
	There were no significant differences in gains in STEM identity by U2 classification or by any of the individual demographic variables investigated.

Priority #2: *Support and empower educators with unique Army research and technology resources.*	
CQL mentors used a range of mentoring strategies with apprentices.	CQL mentors reported using strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Most mentors (65%-100%) used four of the strategies to establish relevance of learning activities. Less than half used the strategies of helping students understand how STEM can help them improve their own community (20%), helping students become aware of the role STEM plays in their everyday lives (33%), and asking students to relate real-life events or activities to topics covered in CQL (47%). 2. Most mentors (67%-93%) used five of the strategies associated with supporting the diverse needs of learners. Less than half used strategies of highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (20%) and integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (7%). 3. Most mentors (53%-93%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Most mentors (67%-100%) reported using all strategies to support students' engagement in authentic STEM activities. 5. More than half of mentors (53%-100%) reported implementing six of the strategies focused on supporting students' STEM educational and career pathway. Less than half used strategies of helping students with their resumé, application, personal statement, and/or interview preparations (33%); recommending AEOPs aligned with student goals (40%); discussing economic, political, ethical, and/or social context of a STEM career (40%); and recommending professional organizations in STEM to students (40%).
CQL apprentices were satisfied with program features that they had experienced and identified a number of benefits of CQL. Apprentices also offered various suggestions for program improvement.	More than 80% of CQL apprentices (81%-94%) being somewhat or very much satisfied with all of the listed program features except for other administrative tasks (47%). Features apprentices reported being most satisfied with included the amount of the stipend (94%), the teaching or mentoring provided (94%), and applying or registering for the program (92%).
	Few apprentices expressed dissatisfaction with CQL program features, although 21% of apprentices were not satisfied with administrative tasks such as security clearances and issuing CAC cards.
	A large majority of apprentices (90%-98%) reported being at least somewhat satisfied with each element of their CQL experience. Nearly all were at least somewhat satisfied with their working relationship with their mentor (98%).
	Nearly all (98%) apprentices made positive comments about their satisfaction with CQL in response to open-ended questions. The most frequently mentioned benefits were the research skills and lab experiences they gained, followed by specific STEM skills, career information, and the networking opportunities and mentoring they experienced in CQL.

	In open-ended responses, the improvements most frequently suggested by apprentices were to provide more opportunities for apprentices to connect with one another and to provide better communication from the program.
CQL mentors were satisfied with program features that they had experienced and identified a number of strengths of the CQL program. Mentors also offered various suggestions for program improvements.	More than half of mentors (53%-87%) reported being at least somewhat satisfied with all program features except for the following two items that large proportions of mentors had not experienced: communicating with RIT (53% had not experienced) and support for instruction/mentorship during program activities (40% had not experienced).
	Nearly all mentors made positive comments about CQL in their responses to open-ended questions. The most frequently mentioned strength of CQL was the research and hands-on experience apprentices receive, followed by the career information apprentices receive, the opportunities for apprentices to network, and the value of CQL in developing the future workforce.
	In open-ended responses, the improvement most frequently suggested by mentors was to provide better communication with the program, followed by administrative improvements such as less paperwork and streamlining apprentice onboarding procedures.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Both CQL apprentices and mentors learned about AEOP primarily through DoD and personal contacts.	CQL apprentices most frequently learned about AEOP through someone who works with the DoD (43%), a family member (27%), and someone who works at the school/university they attend (25%).
	More than a third (41%) of mentors reported learning about AEOP through someone who works with the DoD; the same proportion learned about AEOP through workplace communications.
Apprentices were motivated to participate in CQL primarily by the learning opportunities and their interest in STEM.	More than 85% of apprentices indicated that they were motivated to participate in CQL by their interest in STEM (96%), the desire to learn something new or interesting (89%), the opportunity to learn in ways that are not possible in school (86%), and their desire to expand laboratory or research skills (84%).
Most CQL apprentices had not participated in AEOPs in the past although most are interested in participating in AEOPs in the future.	More than half (55%) of CQL apprentices indicated they had never participated in any AEOPs previously. Smaller proportions of apprentices reported having participated in the following AEOPs, however: GEMS (23%), CQL (11%), Camp Invention (4%), and eCM (2%). Few responding CQL participants (6%) reported participating in other STEM programs.
	More than three-quarters of apprentices were at least somewhat interested in participating in CQL again (85%), and approximately half or more of apprentices reported being at least somewhat interested in the SMART Scholarship (70%) and NDSEG Fellowship (47%). More than a third of apprentices had never heard of the NDSEG Fellowship (34%), GEMS-NPM (40%), and URAP (40%).

	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in CQL (77%) and their program mentors (64%). More than half of responding apprentices had not experienced AEOP resources such as AEOP on social media (77%) and the AEOP brochure (51%).
Most mentors discussed CQL and the SMART scholarship with apprentices, however few discussed any other AEOPs.	More than half of mentors discussed CQL (87%) and SMART (53%) with their apprentices, however fewer than a quarter discussed any other specific program with apprentices. Over a quarter (27%) reported discussing AEOP in general, but without reference to any specific program.
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs was participation in CQL (73%) followed by the CQL program administrator or site coordinator (60%). Most mentors reported that they did not experience materials provided by AEOP such as social media (73%) and the AEOP brochure (73%) as resources for exposing apprentices to AEOPs.
Most apprentices learned about STEM careers generally and DoD STEM careers specifically during CQL.	A large majority of CQL apprentices (94%) reported learning about at least one STEM job/career and that most (75%) reported learning about three or more general STEM careers. Similarly, a large majority of apprentices (87%) reported learning about at least one DoD STEM job/career, although slightly fewer (72%) reported learning about three or more Army or DoD STEM jobs during CQL.
	Participation in the apprenticeship program (77%) and apprentices' mentors (77%) were most often reported as being somewhat or very much impactful on CQL apprentices' awareness of DoD STEM careers. More than a third of CQL apprentices reported they had not experienced AEOP resources such as the AEOP brochure (36%), the ARO website (61%), and AEOP on social media (70%).
	CQL mentors were most likely to rate participation in CQL (80%) and program mentors (33%) as at least somewhat useful resources for exposing apprentices to DoD STEM careers.
CQL apprentices expressed positive opinions about DoD research and researchers.	CQL apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in CQL with no significant differences across any of the constituent categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after CQL except watching/reading non-fiction STEM (43%). Activities for which more than three-quarters of CQL apprentices reported increased likelihood of engagement were: working on a STEM project in a university or professional setting (85%); talking with friends/family about STEM (77%); and mentoring/teaching other students about STEM (77%).
	There were no differences in likelihood of future engagement by U2 classification or by any of the individual demographic variables investigated.

Nearly all CQL apprentices planned to at least complete a bachelor's degree and many reported an interest in a graduate or terminal degree.	Nearly all CQL apprentices (98%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's (26%) or terminal degree (55%) in their field.
CQL apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	Approximately 60% or more of apprentices agreed that CQL contributed in some way to each impact listed in this section. Areas of greatest impact, with more than 90% of apprentices agreeing, were: more confidence in STEM knowledge, skills, and abilities (9%), more awareness of DoD STEM research and careers (96%), and a greater appreciation of DoD STEM research (94%).
	No significant differences were found in impact of CQL by U2 classification or by any of the individual demographic variables investigated.

SEAP Findings

Table 7. 2019 SEAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although SEAP received applications from substantially more students in 2019, the number of students placed in apprenticeships decreased relative to previous years.	A total of 1,286 applications were received in 2019, a substantial increase (32%) over the 872 applications received in 2018, and a 34% increase over slight the 852 applications received in 2017.
	A total of 108 students (8% of applicants), were placed in apprenticeships, representing a slight decrease in enrollment and a substantial decrease in placement rate as compared to previous years (in 2018, 114, or 13%, of applicants were placed; in 2017, 113, or 13%, were placed).
	Fifteen Army labs accepted applications for SEAP apprentices in 2019 and apprentices were hosted at 10 of these sites (11 sites hosted apprentices in 2018).
Nearly a third of SEAP apprentices met the AEOP definition of U2. While SEAP continues to serve apprentices from a variety of races and ethnicities, somewhat fewer apprentices from groups historically underserved and underrepresented in STEM were enrolled in 2019 as compared to previous years.	Nearly a third of SEAP apprentices (32%) met the met the AEOP definition of U2, an increase from 2018 when 27% of apprentices qualified for U2 status.
	Similar to previous years lightly more than half of SEAP apprentices (52%) were female (53% in 2018 and 54% in 2017).
	As in previous years, the most frequently represented races/ethnicities were White (55%) and Asian (24%). The proportion of White apprentices continues to increase (47% in 2018, 42% in 2017), however the proportion of Asian apprentices decreased as compared to 2018 (27%) and 2017 (32%).
	The proportion of apprentices identifying themselves as Black or African American (10%) continues to trend downward as compared to 2018 (12%) and 2017 (17%), while a similar proportion of apprentices identified themselves as Hispanic or Latino in 2019 (4%) as in 2018 (4%) and 2017 (3%)
	As in previous years, few apprentices received free or reduced price school lunches (10% in 2019, 9% in 2018), spoke a language other English as their first language (8% in 2019, 5% in 2018), and would be first generation college attendees (4% in 2019, 2% in 2018).

SEAP mentors reported significant gains in apprentices' 21st Century skills; gains were statistically significant in only one area.	While apprentices demonstrated an increase in all 21st Century skills domains, only one (Information, Media, & Technological Literacy) had large enough average increases to be considered statistically significant growth ($p<.05$). All assessed skills showed increases from pre- to post-observations with the exception of "Think creatively", which showed a very slight decline over time, and "Communicate clearly", which had no growth. None of the items tested demonstrated enough growth to be considered statistically significant due to the small sample size (5-6 apprentices).
Apprentices reported engaging in STEM practices more frequently in SEAP than in their typical school experiences with no differences in engagement across any of the constituent categories of U2 status.	More than half of SEAP apprentices (55%-100%) reported participating in all STEM activities about which they were asked at least monthly. STEM practices SEAP apprentices reported being engaged in most frequently (weekly or every day) during their program were using laboratory procedures and tools (91%) and solving real world problems (91%).
	No significant differences were found in reported frequency of engaging in STEM Practices in SEAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices in SEAP as compared to in school (extremely large effect size), suggesting that SEAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in SEAP with no differences in gains across any of the constituent categories of U2 status.	Nearly all SEAP apprentices (91%-100%) reported at least some gains in their STEM knowledge as a result of participating in their program
	No significant differences were found in reported gains in STEM knowledge in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM competencies as a result of participating in SEAP with no differences in gains across any of the constituent categories of U2 status.	More than 80% (82%-100%) of SEAP apprentices reported at least some gains in all STEM competencies (Table 64) as a result of participation in their program.
	No significant differences were found in gains in STEM competencies in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that SEAP participation had positive impacts on their 21st Century skills with no differences in gains across any of the constituent categories of U2 status.	Nearly three-quarters or more of SEAP apprentices (73%-100%) reported at least some gains in all 21st Century skills items except for creating media products (46%) as a result of their program participation.
	No significant differences were found in gains in 21st Century skills in SEAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM identities as a result	All SEAP apprentices (100%) reported some gains or large gains on all items associated with STEM Identity,

of participating in SEAP with no differences in gains across any of the constituent categories of U2 status.	No significant differences were found in gains in STEM identity in SEAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
SEAP Mentors used a range of mentoring strategies with apprentices.	SEAP mentors reported using strategies associated with each of the five areas of effective mentoring about which they were asked: 1. More than half of (55%-100%) reported using all strategies to help make learning activities relevant to students except for helping students understand how STEM can help them improve their own community (36%). 2. More than half of SEAP mentors (55%-91%) reported using all but two strategies to support the diverse needs of students as learners. Less than half used the strategies of integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (18%) and highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM (18%). 3. Approximately two-thirds or more of SEAP mentors (64%-91%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Approximately two-thirds or more (64%-100%) of SEAP mentors reported using all strategies to support students' engagement in authentic STEM activities. 5. Approximately two-thirds or more of SEAP mentors (64%-91%) reported using all but three strategies focused on supporting students' STEM educational and career pathways. Less than half used the strategies of helping students with their resumé, application, personal statement, and/or interview preparations (9%); discussing the economic, political, ethical, and/or social context of a STEM career (36%); and discussing STEM career opportunities in private industry or academia (46%).

SEAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of SEAP. Apprentices also offered various suggestions for program improvement.	More than 80% of SEAP apprentices (82%-100%) reported being somewhat or very much satisfied with all of the listed program features except for other administrative tasks such as security clearance and CAC card issuance (27%). All apprentices reported being at least somewhat satisfied with the physical location of their apprenticeship activities (100%).
	Few apprentices expressed dissatisfaction with SEAP program features, although 18% of apprentices were not satisfied with administrative tasks such as security clearances and issuing CAC cards and 18% were not satisfied with the timeliness of payment of stipends.
	More than 90% of SEAP apprentices reported being at least somewhat satisfied with each element of their apprenticeship experience. All reported being at least somewhat satisfied with the research experience overall (100%) and the amount of time they spent doing meaningful research (100%).
	Nearly all SEAP apprentices (91%) who responded to open-ended questions made positive comments about their satisfaction with SEAP. The most frequently mentioned benefits were gaining STEM skills and/or real-world research experience, networking opportunities, and career information and exposure.
	In open-ended responses, the improvements most frequently suggested by apprentices were to provide guidance or orientation for new apprentices orientation and/or improve in-processing procedures, followed by suggestions for improving communication and providing more opportunities for apprentices to interact with one another.
SEAP mentors were satisfied with program features that they had experienced and identified a number of strengths of the SEAP program. Mentors also offered various suggestions for program improvements.	More than half of mentors (55%-73%) reported being at least somewhat satisfied with all features except for the following three: communicating with SEAP organizers (82% did not experience); other administrative tasks (18% did not experience and 27% were not at all satisfied); and research abstract preparation requirements (27% did not experience).
	Some mentors (two of five respondents) made positive comments about SEAP in their response to an open-ended questionnaire item. Mentors identified a number of strengths of the program including the value of apprentices' exposure to hands-on real-world research, the value of the mentorship experience, the exposure to DoD research, the career information apprentices received, the value of networking with STEM professionals, and the program structure.
	Mentors offered a wide variety of suggestions for program improvement; however none were mentioned by more than 4 respondents (50%). The most frequently mentioned suggestions were to reduce the amount of paperwork and/or improving in-processing procedures, provide seminars or training for apprentices throughout the summer, and provide more clear learning objectives and/or expectations for apprentices' presentations.

Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Both SEAP apprentices and mentors learned about AEOP primarily through DoD and personal contacts.	Apprentices most frequently learned about AEOP through family members (75%) and someone who works for the DoD (63%).
	Responding mentors most frequently learned about AEOP through workplace communications (46%) and through past participants (36%).
Apprentices were motivated to participate in SEAP primarily by the learning opportunities and their interest in STEM.	More than 85% of apprentices indicated that they were motivated to participate in SEAP by their interest in STEM (100%), the opportunity to use advanced laboratory technology (100%), their desire to expand laboratory or research skills (88%) and figuring out education or career goals (88%).
Few apprentices had participated in AEOPs other than GEMS and SEAP in the past but are interested in participating in AEOPs in the future.	Half (50%) of the eight respondents for whom data were available indicated they had not previously participated in any AEOPs. Smaller proportions reported having participated in the following AEOPs in the past: GEMS (38%), SEAP (25%), and JSS (13%). More than a third of SEAP participants reported participating in other STEM programs (38%).
	Approximately three-quarters or more of apprentices were at least somewhat interested in participating in each program. Less than 20% of apprentices had never heard of each AEOP listed (9%-18%).
	Approximately two-thirds or more (73%-91%) of SEAP apprentices indicated all resources except two were at least somewhat impactful on their awareness of AEOPs. More than a third (36%) had not experienced either AEOP on social media or the AEOP brochure.
No mentors discussed AEOPs other than SMART and CQL with apprentices.	The only programs SEAP mentors reported discussing with their apprentices were SMART (55%) and CQL (36%). Over a third (36%) of mentors reported talking about AEOP in general with their apprentices but without reference to any specific program.
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were participation in SEAP (91%) and SEAP program administrators (36%). All other resources were not experienced my more than half of SEAP mentors.
SEAP apprentices learned about STEM careers generally and STEM careers within the DoD during SEAP.	All SEAP apprentices (100%) reported learning about at least one STEM job/career, and most (73%) reported learning about three or more general STEM careers. Similarly, a large majority of apprentices (91%) reported learning about at least one DoD STEM job/career, and slightly more than half (55%) reported learning about three or more Army or DoD STEM jobs or careers during SEAP.

	Participation in the apprenticeship program (91%) and apprentices' mentors (82%) were most often reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers. Many apprentices reported that they had not experienced AEOP resources such as AEOP on social media (46%), the ARO website (36%), and the AEOP brochure (36%).
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers was participation in SEAP (82%). Few mentors rated any other resource as being useful, and more than half of SEAP mentors reported having not experienced all other resources for this purpose.
Apprentices expressed positive opinions about DoD research and researchers.	SEAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than nearly 90% agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in SEAP with no difference in likelihood across any constituent categories of U2 status.	Approximately three-quarters or more of apprentices indicated they were more likely or much more likely to engage in all STEM activities after their SEAP experience. Activities all SEAP apprentices (100%) reported being more likely to engage in after their program were talking with friends/family about STEM, taking an elective STEM class, and working on a STEM project in a university or professional setting.
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any of the individual demographic variables investigated.
All SEAP apprentices planned to at least complete a bachelor's degree, and many reported an interest in earning a graduate or terminal degree.	All responding SEAP apprentices (100%) reported wanting to at least earn a bachelor's degree and many reported a desire to earn a master's degree (18%) or terminal degree (64%) in their field.
SEAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	Nearly all SEAP apprentices (91%-100%) agreed that SEAP contributed in some way to each impact listed. All apprentices (100%) agreed, for example, that SEAP contributed to their confidence in their STEM knowledge skills, and abilities; to their awareness of other AEOPs; and their interest in pursuing a STEM career with the Army or DoD.
	No significant differences were found in impact of SEAP by U2 classification or by any of the individual demographic variables investigated.

REAP Findings

Table 8. 2019 REAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
More students applied for and were placed in REAP apprenticeships as compared to previous years.	In 2019, 857 students applied for the REAP program, an 11% decrease from the 949 applicants in 2018, and a 17% increase over the 709 applicants in 2017.
	A total of 168 students were placed in apprenticeships, an 18% increase over the 138 placed in 2018, and a 30% increase over the 118 apprentices placed in 2017.
Two more colleges and universities hosted REAP apprentices in 2019 than in 2018; a slightly smaller percentages of those institutions were HBCUs/MSIs than in previous years.	A total of 55 colleges and universities participated in REAP in 2019, a slight increase (4%) from the 53 institutions that participated in 2018 and a 25% increase over the 41 participating institutions in 2017. Of these institutions, 29 (53%) were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs), compared to 31 (57%) in 2018 and 25 (60%) in 2017.
REAP continues to serve apprentices from groups historically underserved and underrepresented in STEM, with increases in the participation of some racial/ethnic groups and a large majority of apprentices meeting the AEOP definition of U2.	Nearly all REAP apprentices (99%) qualified for U2 status under the AEOP definition (96% in 2018).
	The proportion of female participants (67%) increased somewhat as compared to previous years (62% in 2018; 61% in 2017).
	The proportion of REAP apprentices identifying themselves as White (9%) was similar to 2018 (8%) but substantially lower than in 2017 (27%). The proportion of REAP apprentices identifying as Asian continues to decrease relative to previous years (14% in 2019 as compared to 20% in 2018 and 27% in 2017).
	The proportions of apprentices identifying themselves as Black or African American continues to increase as compared to previous years (44% in 2019 as compared to 40% in 2018 and 29% in 2017). Likewise, participation by Hispanic or Latino apprentices continues to increase (26% in 2019 as compared to 22% in 2018 and 15% in 2017).
	More than half of REAP apprentices (56%) qualified for free or reduced-price school lunches (FARMS), and over a quarter (30%) spoke a language other than English as their first language.
REAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	Statistically significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their REAP experiences (p<.001) were found in all six skill sets of 21st Century skills. Apprentices demonstrated the most growth in the Creativity & Innovation skill set.

Apprentices reported engaging in STEM practices more frequently in REAP than in their typical school experiences with no significant differences in engagement across any of the constituent categories of U2 status.	More than half of REAP apprentices (61%-90%) reported participating at least monthly in all activities with the exceptions of presenting their STEM research to a panel of judges (23%), designing research investigation based on their own questions (45%), and building/making a computer model (45%). Nearly all REAP apprentices reported regularly (weekly or every day) working collaboratively as part of a team (90%).
	No significant differences were found in reported frequency of engaging in STEM Practices in REAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices in REAP as compared to in school (extremely large effect size), suggesting that REAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in REAP with no significant differences in knowledge gains across any of the constituent categories of U2 status.	A large majority of REAP apprentices (90%-94%) reported at least some gains in their STEM knowledge as a result of participating in the program.
	No significant differences were found in STEM knowledge gains in REAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM competencies as a result of participating in REAP with no differences in gains across any of the constituent categories of U2 status.	Approximately three-quarters or more of REAP apprentices (74%-97%) reported at least some gains on all STEM competencies items. More than 90% of apprentices reported at least some gains in supporting an explanation with STEM knowledge (97%) and carrying out an experiment and recording data accurately (94%).
	No significant differences were found in gains in STEM competencies in REAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that REAP participation had positive impacts on their 21st Century skills with no differences in gains across any of the constituent categories of U2 status.	Approximately two-thirds or more of REAP apprentices (65%-100%) reported at least some gains in all 21st Century skills items with the exception of creating media products (42%)
	No significant differences were found in gains in 21st Century skills in REAP by U2 classification or by any constituent group of U2 classification.

Apprentices reported gains in their STEM identities as a result of participating in REAP with no differences in gains across any of the constituent categories of U2 status.	More than three-quarters of REAP apprentices (77%-97%) reported at least some gains on all items associated with STEM identity and nearly all reported at least some gains in their sense of accomplishing something in STEM (97%) and interest in a new STEM topic (97%).
	No significant differences were found in reported gains in STEM identity in REAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
REAP mentors used a range of mentoring strategies with apprentices.	A majority of REAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. More than three-quarters of REAP mentors (78%-98%) reported using all strategies to help make learning activities relevant to students. 2. More than half of REAP mentors (60%-95%) reported using all strategies to support the diverse needs of students as learners. 3. More than three-quarters of REAP mentors (78-98%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. Nearly all REAP mentors used strategies to support students' engagement in authentic STEM activities (95%-100%). 5. More than half of REAP mentors (58%-95%) reported using strategies to support students' STEM educational and career pathways.
REAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of REAP. Apprentices also offered various suggestions for program improvement.	Approximately two-thirds or more of REAP apprentices (61%-94%) reported being somewhat or very much satisfied with all of the listed program features. Aspects of the program apprentices reported being most satisfied with included applying/registering for the program (94%) and the amount of the stipend (90%).
	Few apprentices expressed dissatisfaction with REAP program features, although 10% of apprentices were not satisfied with timeliness of stipend payments.
	More than 80% of REAP apprentices (83%-100%) reported being at least somewhat satisfied with all elements of their research experience. All REAP apprentices (100%) indicated being at least somewhat satisfied with the amount of time they spend doing meaningful research and nearly all felt similarly about their overall research experience (97%).
	All apprentices who responded to open-ended questions made positive comments about their satisfaction with REAP. The most frequently cited benefits of REAP were the STEM skills and research skills and experience they gained, followed by their STEM learning, the teamwork they experienced, and the opportunity to present and/or write about their research findings.

	In open-ended responses, the improvements most frequently suggested by apprentices were related to communication, including suggestions for better program communication with mentors, faster replies, more frequent communication, information about symposiums and conferences, and providing more program information in advance of the start of the apprenticeship. Other improvements suggested included providing more choice in projects, improvements to the stipend (e.g., a larger stipend, faster payment, or more frequent payment), and improvements to mentoring (e.g., providing more mentors, more contact with the mentor, more instruction on content such as stoichiometry, and help with presentations).
REAP mentors were satisfied with program features that they had experienced and identified a number of strengths of the REAP program. Mentors also offered various suggestions for program improvements.	More than half of REAP mentors (55%-73%) reported being at least somewhat satisfied with various program features of REAP. Very few mentors (one or two) reporting being dissatisfied with any program feature, however up to a third of mentors had not experienced some of the features such as the research abstract preparation requirements (18% had not experienced), application/registration process (25% had not experienced), and communication with REAP organizers (33% had not experienced).
	All mentors made positive comments about REAP in their responses to open-ended questions. The most frequently mentioned strengths of REAP were apprentices' exposure to STEM research and opportunity for hands-on laboratory experiences, followed by REAP's focus on engaging students underserved or underrepresented in STEM fields and other strengths such as the career information apprentices receive, apprentices' acquisition of specific STEM skills, the stipend, and the program's administration.
	In open-ended responses, the improvements most frequently suggested by mentors were focused on communication, including suggestions that the program provide mentors with more information or guidelines, that communication be faster, or better in general. Other suggestions for program improvements included providing more DoD information and/or career information (for example, providing more DoD speakers or webinars), extending the length of the program, providing more funding to the host institution (e.g., for materials), improving the apprentice stipend (e.g., a larger stipend or earlier payment of the stipend), and accepting more apprentices into the program.

Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
REAP apprentices and mentors learned about AEOP primarily through communications through their school or through professional or AEOP contacts.	The most frequently selected sources of information about AEOP, selected by more than a quarter of apprentices, were someone who works at the school they attend (39%); school/university newsletter, email, or website (29%); and someone who works with the program (25%).
	More than a quarter of mentors reported they learned about AEOP from a colleague (33%), a supervisor or superior (33%), or from the AEOP website (28%). Slightly less than a quarter (23%) of REAP mentors indicated that they had learned about AEOP through an AEOP site director or host.
Apprentices were motivated to participate in REAP primarily by the learning opportunities and their interest in STEM.	More than two-thirds of apprentices indicated that they were motivated to participate in REAP by their desire to learn something new or interesting (89%), interest in STEM (86%), and learning in ways that are not possible in school (71%).
Most apprentices had not participated in AEOPs other than REAP, and were interested in participating in URAP and SMART, although many had not heard of other AEOPs.	While 54% indicated they had never participated in any AEOP programs in the past, smaller proportions reported having participated in the following AEOPs: REAP (14%), UNITE (11%), and GEMS (4%). Twenty-eight percent of responding REAP participants reported participating in other STEM programs.
	More than half of apprentices reported being at least somewhat interested in participating in URAP (61%) and SMART (58%). More than half of apprentices reported not having heard of CQL, NDSEG, and GEMS (52%-58%).
	The resources apprentices most frequently cited as being somewhat or very much useful for their awareness of AEOPs were participation in REAP (74%) and the AEOP website (74%). More than a third of apprentices had not experienced AEOP on social media (58%), the AEOP brochure (42%), and presentations shared through the program (36%).
Few mentors discussed specific AEOPs with their apprentices although most discussed AEOP generally.	A third or less of REAP mentors discussed any of the specific AEOPs with their apprentices, however nearly three-quarters (73%) reported discussing AEOPs in general with their apprentices.
	The resource mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs was participation in REAP (75%). Half or more of mentors also indicated that the REAP program administrator (58%) and the AEOP website (55%) were at least somewhat useful. More than a third of mentors reported not experiencing AEOP on social media (53%), invited speakers (50%), and AEOP printed materials (38%).
Apprentices learned about STEM careers during REAP, although they learned about more STEM careers generally	Nearly all REAP apprentices (94%) reported learning about at least one STEM job/career, and approximately two-thirds (68%) reported learning about three or more general STEM careers during their apprenticeship. Much smaller proportions of apprentices (45%) reported learning about at least one DoD STEM job/career, and even fewer (19%) reported learning about three or more Army or DoD STEM jobs during REAP.

than STEM careers specifically within the DoD.	More than half of REAP participants reported the following resources as being somewhat or very much impactful on their awareness of DoD STEM careers: participation in REAP (61%), program mentors (58%), and the AEOP website (52%). More than a third of apprentices indicated they had not experienced all other resources such as AEOP on social media (55% had not experienced) and the ARO website (55% had not experienced).
	Approximately half or more of mentors reported the following resources as being at least somewhat useful for exposing apprentices to DoD STEM careers: participation in REAP (65%), AEOP administrator/site coordinator (55%), AEOP website (50%), and AEOP printed materials (48%). Half or more of responding mentors reported not experiencing AEOP on social media (53%) and invited speakers (50%).
Apprentices expressed positive opinions about DoD research and researchers.	REAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 80% agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in REAP with no significant differences across any of the constituent categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after REAP. Items for which more than 85% of REAP apprentices expressed increased likelihood of engagement were talking with friends/family about STEM (90%) and working on a STEM project in a university or professional setting (87%).
	No differences were found in future STEM engagement by overall U2 classification or by any of the individual demographic variables investigated.
Nearly all REAP apprentices planned to at least complete a bachelor's degree and many reported an interest in earning a graduate or terminal degree.	Nearly all (97%) REAP apprentices reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's degree (19%) or terminal degree (71%) in their field.

REAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent categories of U2 status.	More than half of REAP apprentices agreed that REAP contributed in some way to each impact listed in this section. Areas of impact noted by more than 80% of apprentices were confidence in STEM knowledge, skills, and abilities (97%), interest in participating in other AEOPs (84%), greater appreciation of DoD STEM research (84%), and interest in participating in STEM activities outside of school requirements (81%).
	No significant differences were found in impact in REAP by U2 classification or by any of the individual demographic variables investigated.

HSAP Findings

Table 9. 2019 HSAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Although more students applied for HSAP apprenticeships, fewer were placed in apprenticeships than in previous years.	In 2019, 670 students applied for HSAP apprenticeships, a 17% increase as compared to the 559 applicants in 2018 and a 6% increase over the 629 students who applied to HSAP in 2017.
	A total of 29 applicants (4%) were placed in apprenticeships, a 66% decrease in enrollment as compared to 2018 when 48 students were placed in HSAP apprenticeships and an 86% decrease in enrollment compared to 2017 when 54 apprentices were placed.
Slightly fewer colleges and universities hosted HSAP apprentices than in previous years, and fewer of those institutions were HBCUs/MSIs than in previous years.	Ten of the 25 host institutions (40%) in 2019 were HBCU/MSIs, compared to the 13 of the 33 host institutions (39%) in 2018 and 19 of 36 (53%) in 2017.
Nearly two-thirds of HSAP apprentices met the AEOP definition of U2. Enrollment demographics showed slight variations from previous years.	Nearly two-thirds of apprentices (66%) qualified for U2 status under the AEOP definition, an increase as compared to 2018 when 54% met the AEOP definition of underserved.
	As in previous years, over half of apprentices were female (62% in 2019, 60% in both 2018 and 2017).
	As in previous years, the most commonly reported races/ethnicities were White (31% in 2019, 31% in 2018, 42% in 2017) and Asian (21% in 2019, 33% in 2018, 25% in 2017).
	The percentage of apprentices identifying as Hispanic or Latino (24%) increased as compared to previous years' enrollment (15% in 2018, 14% in 2017).
	Relatively few apprentices received free or reduced-price school lunch (21%), spoke English as a second language (14%), and would-be first-generation college attendees (14%).
HSAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	There were significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their HSAP experiences (p<.01-.001) for all areas of 21st Century skills. Skills associated with media and information management saw the largest increases from pre- to post- observations.

Apprentices reported engaging in STEM practices more frequently in HSAP than in their typical school experiences with no significant differences in engagement across any of the constituent categories of U2 status.	Half or more of HSAP apprentices (67%-94%) reported participating at least monthly in all activities except for presenting their STEM research to a panel of judges (11%). STEM practices HSAP apprentices reported being most frequently (weekly or every day) engaged in during their program were interacting with STEM researchers (94%), working with a STEM researcher or company on a real-world STEM research project (89%), and analyzing data or information and drawing conclusions (89%).
	No significant differences were found in reported frequency of engaging in STEM Practices in HSAP by U2 classification or by any constituent group of U2 classification.
	Apprentices reported significantly higher frequency of engagement in STEM practices in HSAP as compared to in school (extremely large effect size), suggesting that HSAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in HSAP with no differences in gains across any of the constituent categories of U2 status.	More than 90% (90%-100%) of HSAP apprentices reported at least some gains in all areas of their STEM knowledge as a result of participating in the program.
	No significant differences were found in reported gains in STEM knowledge in HSAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported gains in their STEM competencies as a result of participating in HSAP with no differences in gains across any of the constituent categories of U2 status.	More than 60% (61%-100%) of HSAP apprentices reported at least some gains in all STEM competencies
	No significant differences were found in reported gains in STEM competencies in HSAP by U2 classification or by any constituent group of U2 classification.
Apprentices reported that HSAP participation had positive impacts on their 21st Century skills with no differences in gains across any of the constituent categories of U2 status.	With the exception of two items, half or more of apprentices (56%-100%) reported at least some gains in all areas of 21st Century skills due to their participation in HSAP. The exceptions were analyzing media (44%) and creating media products (28%).
	No significant differences in impacts on HSAP apprentices' 21st Century skills were found by U2 classification or by any constituent group of U2 classification.

Apprentices reported gains in their STEM identities as a result of participating in HSAP with no differences in gains across any of the constituent categories of U2 status.	More than three-quarters of HSAP apprentices (78%-95%) reported at least some gains on all STEM identity items, and nearly all reported at least some gains in feeling prepared for more challenging STEM activities (95%) and confidence to try out new ideas/procedures on their own in a STEM project (95%).
	No significant differences were found in gains in STEM identity in HSAP by U2 classification or by any constituent group of U2 classification.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
HSAP mentors used a range of mentoring strategies with apprentices.	A majority of HSAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Half or more of HSAP mentors (50%-86%) reported using all strategies to help make learning activities relevant to students. 2. More than half of HSAP mentors (57%-93%) reported using each strategy to support the diverse needs of students as learners. 3. More than three-quarters of mentors (79%-100%) indicated using each strategy to support student development of collaboration and interpersonal skills. 4. More than 90% of responding HSAP mentors (all or all but one) indicated using each strategy to support student engagement in authentic STEM activities. 5. More than half of HSAP mentors (57%-100%) reported using all strategies focused on supporting students' STEM educational and career pathways.
HSAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of HSAP. Apprentices also offered various suggestions for program improvement.	Two-thirds or more of HSAP apprentices (67%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of stipend payment (56%). Features apprentices reported being most satisfied with included applying or registering for the program (100%) and the physical location of their program activities (94%).
	Very few apprentices expressed dissatisfaction with any program feature although 11% indicated that they were "not at all" satisfied with the timeliness of the stipend payment.
	A large majority (89%-100%) of HSAP apprentices reported being at least somewhat satisfied with various elements of their research experience. Two aspects with which all apprentices were somewhat or very much satisfied were their working relationship with their mentors (100%) and the overall research experience (100%).

	All apprentices who responded to open-ended questions made positive comments about their satisfaction with HSAP. The most frequently cited benefits of HSAP were the research exposure and laboratory experience and the STEM skills apprentices gained during HSAP, followed by the opportunity to develop 21st Century or workplace skills such as the ability to work independently, critical thinking, time management, collaboration, and communication; career and college information; STEM learning; and opportunities for networking.
	In open-ended responses, the improvements most frequently suggested by apprentices focused on communication from the program and information about the program, including communication generally, providing clearer objectives and/or communication with mentors about guidelines, defining the start and end date of the apprenticeship, and providing clearer instructions or clearer descriptions of research topics. Other suggestions for improvement include providing more networking opportunities (e.g., with mentors and alumni) and providing a longer program or opportunities for apprentices to extend their research experience by, for example, writing a paper.
HSAP mentors were satisfied with program features that they had experienced and identified a number of strengths of the HSAP program. Mentors also offered various suggestions for program improvements.	More than 80% of HSAP mentors (86%-93%) reported being at least somewhat satisfied with all program features except for communication with the ARO (50%) and research abstract preparation requirements (71%); relatively large numbers of mentors reported having not experienced either of these features (43% and 14% respectively).
	Mentors who responded to open-ended items all made positive comments about HSAP. Mentors most frequently mentioned as program strengths the hands-on research experience apprentices receive, followed by the career information apprentices receive, the stipends apprentices are paid, and the program's administration.
	The program improvements most frequently suggested by mentors related to funding, including faster or smoother stipend payment, providing funding for mentors, and providing funding for more apprentices or increasing stipends. The next most frequently suggested improvements were to accept more apprentices and provide apprentices with opportunities to present their research.

Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices and mentors learned about AEOP through their school or workplace, the AEOP website, or a DoD contact.	The most frequently selected sources of information about AEOP for apprentices were someone who works at their school/university (61%), followed by the AEOP website (28%) and school/university newsletter, email, or website (22%).
	More than a third of mentors reported learning about AEOP through the AEOP website (43%), their supervisor or superior (36%), or someone who works with the DoD (36%).
Apprentices were motivated to participate in HSAP primarily by the learning opportunities and their interest in STEM.	More than 80% of apprentices indicated that they were motivated to participate in HSAP by their desire to learn something new/interesting (94%), their interest in STEM (89%), the opportunity to use advanced laboratory technology (83%), and the opportunity to expand their laboratory/research skills (83%).
Only one apprentice reported participating in an AEOP in the past, but most were interested in participating in AEOPs in the future.	Seventy percent of HSAP apprentices indicated they had never participated in any AEOPs in the past, and only one apprentice reported having participated in JSHS (5%). One quarter of responding HSAP participants reported participating in other STEM programs (25%).
	With the exception of CQL (39%), half or more of apprentices reported being at least somewhat interested in participating in all other AEOPs (50-83%), however more than a third of HSAP apprentices indicated they had never heard of each AEOP (39%-61%) except URAP, which all had heard of.
	Half or more HSAP apprentices reported all resources except two were at least somewhat impactful on their awareness of AEOPs. Over half had not experienced AEOP on social media (56%) and over a third had not experienced the AEOP brochure (39%).
Mentors primarily discussed HSAP and URAP with their apprentices.	More than three-quarters of mentors reportedly discussed HSAP (93%) and URAP (79%) with their apprentices. Slightly more than a third also discussed SMART (36%) and NDSEG (36%). Additionally, more than a third (36%) discussed AEOPs in general with apprentices.
	More than half indicated the following resources were at least somewhat useful for this purpose: the AEOP website (79%), HSAP participation (79%), and AEOP program administrator/ coordinator (57%). More than a third reported not experiencing other resources such as AEOP on social media (64%) and invited speakers or "career" events (64%).
Apprentices learned about STEM careers during HSAP, although they learned about more STEM careers generally	All HSAP apprentices (100%) reported learning about at least one STEM job/career, although only a third (33%) reported learning about three or more general STEM careers during their apprenticeships. Considerably fewer apprentices (50%) reported learning about at least one DoD STEM job/career, and very few (11%) reported learning about three or more Army or DoD STEM jobs during HSAP.

than STEM careers specifically within the DoD.	Participation in the apprenticeship program (61%) was the only resource reported as being somewhat or very much impactful on apprentices' awareness of DoD STEM careers by a majority of apprentice respondents. A majority of apprentices reported that they had not experienced AEOP on social media (56%).
	Half or more of HSAP mentors indicated that participation in HSAP (64%) and the AEOP website (50%) were at least somewhat useful for exposing apprentices to DoD STEM careers. Most mentors had not experienced invited speakers (79%), AEOP on social media (71%), AEOP printed materials (57%), and AEOP program administrators (57%) as resources for exposing apprentices to DoD STEM careers.
Apprentices expressed positive opinions about DoD research and researchers.	HSAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with 90% or more agreeing to all statements about DoD researchers and research.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in HSAP with no difference in likelihood across any constituent categories of U2 status.	More than half of apprentices indicated they were more likely or much more likely to engage in all STEM activities after HSAP. Activities for which more than three-quarters of HSAP apprentices indicated an increased likelihood of engagement were using a computer to design/program something (83%), talking with friends/family about STEM (78%), taking a STEM elective (78%), and working on a STEM project in a university/professional setting (78%).
	No significant differences were found in reported likelihood of engaging in future STEM activities by U2 classification or by any of the individual demographic variables investigated.
All HSAP apprentices planned to at least complete a bachelor's degree and many reported an interest in earning a graduate or terminal degree.	When asked about how much formal education REAP apprentices wanted to earn after participating in their program, all (100%) reported wanting to at least earn a Bachelor's degree and many indicated a desire to earn a master's degree (22%) or terminal degree (61%) in their field.

HSAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers with no differences in impact across any constituent U2 categories.	Approximately two-thirds or more of HSAP apprentices agreed that HSAP contributed in some way to each impact listed in this section. All apprentices reported that HSAP contributed to their increased confidence in their STEM knowledge, skills, and abilities (100%).
	No significant differences were found in overall impact by U2 classification or by any of the individual demographic variables investigated.

URAP Findings

Table 10. 2019 URAP Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
The number of URAP applicants decreased as compared to 2018, and fewer students were placed in URAP apprenticeships in 2019 than in previous years.	In 2019, 281 students applied for URAP apprenticeships, a 14% decrease as compared to the 321 who applied in 2018 and a 15% increase in applicants as compared to the 239 students who applied in 2017.
	A total of 54 applicants (19%) were placed in apprenticeships, a 24% decrease in number of students placed compared to 2018 when 67 were placed, and a 9% decrease compared to 2017 when 59 apprentices were placed.
Fewer colleges and universities hosted URAP apprentices in 2019 than in 2018, and fewer were HBCUs/MSIs than in previous years.	41 colleges and universities hosted URAP apprentices in 2018 (compared to 48 in 2018, and 39 in 2017). Of these institutions, 10 (24%) were HBCU/MSIs, a notable decrease as compared to 2018 (22, or 46% of institutions) and 2017 (17, or 44% of institutions).
Over a fifth of URAP apprentices met the AEOP definition of U2; demographic characteristics of participants varied as compared to previous years.	Over a fifth (22%) of URAP apprentices met the AEOP definition of U2, compared to 18% in 2018.
	The proportion of female apprentices was the same as in 2018 and smaller than in 2017 (39% in 2019, 39% in 2018, 58% in 2017).
	The proportion of apprentices identifying as White (57%) decreased as compared to 2018 (64%) but was higher than in 2017 (53%). The proportion of apprentices identifying as Asian (19%) increased as compared to both 2018 (9%) and 2017 (14%).
	The proportion of apprentices identifying as Black or African American (6%) was smaller than in previous years (9% in 2018; 8% in 2017), although the proportion of apprentices identifying as Hispanic or Latino (15%) increased as compared to 2018 (10%) and was the same as in 2017 (15%).
	Most apprentices (82%) spoke English as their first language, and few (13%) were first generation college attendees.
URAP mentors reported significant gains in apprentices' 21st Century skills in all areas.	Significant increases in apprentices' observed skills from the beginning (pre) to the end (post) of their URAP experiences ($p<.001$) were found for all six skill sets of 21st Century skills. Skills associated with accessing information and applying technological skills saw the largest increases from pre- to post-observations.

Apprentices reported engaging in STEM practices more frequently in URAP than in their typical college or university experiences; apprentices meeting the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices.	More than half of URAP apprentices (61%-97%) reported participating at least monthly in all STEM practices except presenting their STEM research to a panel of judges (16%) and building or making a computer model (45%). STEM practices URAP apprentices reported engaging with most frequently (weekly or every day) during the program were working with a STEM researcher or company on a real-world STEM research project (97%) and interacting with STEM researchers (94%).
	Although no significant differences in engaging in STEM practices composite scores were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (very large effect size).
	Apprentices reported significantly more frequent engagement in STEM practices in URAP as compared to in their college or university coursework (very large effect size), suggesting that URAP offers apprentices substantially more intensive STEM learning experiences than they would generally experience in school.
Apprentices reported gains in their STEM knowledge as a result of participating in URAP; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	Approximately 90%-93% of URAP participants indicated at least some gains in each area of STEM knowledge, and nearly all apprentices reported at least some gain in their knowledge of research conducted in a STEM topic or field (94%) and knowledge of what everyday research work is like in STEM (94%).
	Although no significant differences in gains in STEM knowledge were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).
Apprentices reported gains in their STEM competencies as a result of participating in URAP; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	About two-thirds or more of URAP apprentices (65%-90%) reported some gains or large gains in their STEM competencies as a result of participation in the program. Apprentices were most likely to report gains (some or large) in the following competencies: using knowledge/creativity to suggest a solution to a problem (90%). supporting an explanation with relevant STEM knowledge (90%) and presenting an argument that uses data from an experiment (90%).
	Although no significant differences in gains in STEM competencies were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).

Apprentices reported that URAP participation had positive impacts on their 21st Century skills; apprentices who met the AEOP definition of U2 and female apprentices reported greater gains than their peers.	Approximately two-thirds or more of URAP apprentices (65%-100%) reported at least some gains in all areas of 21st Century skills except for analyzing media (26%) and creating media products (16%). All URAP apprentices reported at least some gains in adapting to change when things do not go as planned (100%) and working independently and complete tasks on time (100%).
	Apprentices who met the AEOP definition of underserved reported greater gains in their 21st Century skills than non-U2 apprentices (large effect size), and females reported greater gains than males (large effect size).
Apprentices reported gains in their STEM identities as a result of participating in URAP; apprentices who met the AEOP definition of U2 reported greater gains than non-U2 apprentices.	A large majority of URAP apprentices (81%-94%) reported at least medium gains on all items associated with STEM identity. Apprentices were most likely to report gained in their sense of accomplishing something in STEM (94%), feeling prepared for more challenging STEM activities (94%), and their confidence to try out new ideas/procedures on their own in a STEM project (94%).
	No significant differences existed by individual demographics used to determine U2 classification, however, apprentices who met the AEOP definition of U2 reported significantly greater gains than non-U2 apprentices (large effect size).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
URAP mentors used a range of mentoring strategies with apprentices.	A majority of URAP mentors reported using all strategies associated with each of the five areas of effective mentoring about which they were asked: 1. Approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to help make learning activities relevant to students. 2. Approximately two-thirds or more (64%-96%) of URAP mentors reported using all strategies to support the diverse needs of students as learners. 3. More than 70% of URAP mentors (71%-100%) reported using all strategies to support students' development of collaboration and interpersonal skills. 4. More than 90% of URAP mentors (93%-100%) reported using all strategies to support students' engagement in authentic STEM activities. 5. More than half of URAP mentors (54%-93%) reported using all strategies focused on supporting students' STEM educational and career pathways

URAP apprentices were satisfied with program features that they had experienced and identified a number of benefits of URAP. Apprentices also offered various suggestions for program improvement.	About three-quarters or more of URAP apprentices (74%-100%) reported being somewhat or very much satisfied with all of the listed program features except for timeliness of payment (58%). Features apprentices reported being most satisfied with included the physical location of their program (100%), application/registration for the program (97%), and the teaching or mentoring provided (97%).
	Few apprentices expressed dissatisfaction with any feature, although 16% reported being "not at all" satisfied with timeliness of stipend payments.
	More than 90% of URAP apprentices (94%-100%) indicated they were at least somewhat satisfied with all aspects of their apprenticeship experience. All apprentices reported being somewhat or very much satisfied with the amount of time spent with their research mentor (100%) and the overall research experience (100%).
	All apprentices who responded to open-ended questions made positive comments about their satisfaction with URAP. The most frequently cited benefits of URAP were the research experience and skills and the real-world laboratory experience they gained, followed by the career information they received, the mentoring, and their STEM learning generally.
	Apprentices suggested a wide variety of improvements in open-ended responses. The most frequently mentioned improvements related to communication with the program, including suggestions for clearer or more concise communication from the program or more frequent communication, followed by suggestions for improvements to the stipend, including more frequent payment of the stipend, a larger stipend, or better communication about the stipend. Other suggested improvements included providing apprentices with more information about the DoD or STEM careers within the DoD and improvements to mentoring, including suggestions for apprentices to have more contact with or more guidance from mentors, the program providing better information to mentors, and providing earlier contact with mentors.

URAP mentors were satisfied with program features that they had experienced and identified a number of strengths of the URAP program. Mentors also offered various suggestions for program improvements.	Nearly two-thirds or more of the responding URAP mentors (61%-89%) reported being at least somewhat satisfied with all program components they experienced except for communicating with ARO (25% somewhat or very much satisfied), a feature that 71% of mentors reported having not experienced. Program features mentors were most satisfied (somewhat/very much) with were the stipends (89%) and the application/registration process (82%).
	All mentors who responded to open-ended items made positive comments about URAP. The most frequently mentioned strength was apprentices' exposure to research and the research experience they gain in URAP, followed by the apprentice stipends, the quality of the apprentices the program recruits, and communication with the program and/or program administration.
	In open-ended responses, mentors' most frequently mentioned suggestions were to increase the number of apprentices in the program; to provide ways for apprentices to disseminate their research (e.g., a virtual symposium, a post-program event, or an abstract book); and improvements to the apprentice stipend, including providing a larger stipend, faster processing, or more frequent payment. Other suggestions included providing a longer program and clearer information about applications, guidelines, and goals.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Apprentices and mentors learned about AEOP primarily through their school or workplace or from the AEOP website or DoD contacts.	The most frequently selected sources of information about AEOP for apprentices were someone who works at the school they attend (60%), followed by school communications (newsletter, email, or website) (40%) and someone who works with the program (17%).
	A quarter or more of mentors reported learning about AEOP through the AEOP website (32%), their supervisor or superior (32%), or someone who works with the DoD (25%).
Apprentices were motivated to participate in URAP primarily by the learning opportunities and their interest in STEM.	Approximately three-quarters or more of apprentices indicated that they were motivated to participate in URAP by their interest in STEM (90%), their desire to learn something new or interesting (90%), their desire to expand laboratory/research skills (83%), and the opportunity to learn in ways that are not possible in school (73%).

Only two URAP apprentices reported having participated in other AEOPs in the past but many expressed some interest in future participation, although large proportions had not heard of AEOPs other than URAP.	Eighty percent of URAP apprentices reported having not participated in any AEOP, and only one indicated participating in Camp Invention (3%) and URAP (3%). Approximately 13% of apprentices reported participating in other STEM programs. Most URAP participants had not heard of CQL (77%) and GEMS NPM (71%).
	More than half of URAP apprentices reported that the following three resources were at least somewhat impactful on their awareness of AEOPs: participation in URAP (61%), the AEOP website (61%), and their URAP mentor (55%). Large proportions of apprentices had not experienced other resources such as AEOP on social media (65%) and the AEOP brochure (52%).
Most mentors discussed SMART with their apprentices, although few discussed any other AEOP besides NDSEG.	SMART was the only AEOP that a majority of mentors (79%) reported speaking to apprentices about, although 43% discussed NDSEG. Large proportions of mentors (71%-93%) reported not discussing AEOPs other than SMART and NDSEG with their apprentices.
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of AEOPs were participation in URAP (79%) and the AEOP website (61%). Between 50% and 75% of mentors also reported not having experienced all other resources for this purpose.
Apprentices learned about STEM careers during URAP, although they learned about more STEM careers generally than STEM careers specifically within the DoD.	A large majority of URAP apprentices (84%) reported learning about at least one STEM job/career, and slightly more than half (55%) reported learning about three or more general STEM careers. Considerably fewer apprentices (45%) reported learning about at least one DoD STEM job/career, and even less (10%) reported learning about three or more Army or DoD STEM jobs during URAP.
	When asked about resources that impacted their awareness of DoD STEM careers, apprentices most frequently chose “did not experience” for each resource. The resources most frequently cited as at least somewhat useful for this purpose were participation in URAP (43%), the AEOP website (39%), and mentors (37%).
	The resources mentors most frequently cited as being somewhat or very much useful for making apprentices aware of DoD STEM careers were participation in URAP (79%) and the AEOP website (61%). Between 50% and 75% of mentors also reported not having experienced all other resources for this purpose.

Apprentices expressed positive opinions about DoD research and researchers.	URAP apprentices' opinions about DoD researchers and research were overwhelmingly positively with more than 90% agreeing to all statements about DoD research and researchers.
Apprentices reported that they were more likely to engage in various STEM activities in the future after participating in URAP; apprentices who met the AEOP definition of U2 were more likely to report increased likelihood of engagement than non-U2 apprentices.	More than half of URAP apprentices reported more likelihood of engaging with all activities about which they were asked except for tinkering with mechanical/electrical devices (48%) and working on solving math/science puzzles (48%).Activities for which more than three-quarters of URAP apprentices reported increased likelihood of engagement were talking with friends/family about STEM (81%); and working on a STEM project in a university/professional setting (81%).
	Apprentices who met the AEOP definition of underserved reported greater gains in their 21st Century skills than non-U2 apprentices (large effect size).
All URAP apprentices planned to at least complete a bachelor's degree and many reported an interest in earning a graduate or terminal degree.	All responding apprentices (100%) reported wanting to at least earn a bachelor's degree and many indicated a desire to earn a master's degree (26%) or terminal degree (58%) in their field.
URAP apprentices reported that participating in the program impacted their confidence and interest in STEM and STEM careers; apprentices who met the AEOP definition of U2 reported greater impacts than non-U2 apprentices.	Three-quarters or more of URAP apprentices agreed that URAP contributed in some way to each area of program impact. Areas of impact noted by 90% or more of apprentices were increased confidence in their STEM knowledge, skills, and abilities (97%); greater appreciation for DoD STEM research (94%); and more interest in pursuing a STEM career with the DoD (90%).
	Although no significant differences in engaging in STEM practices composite scores were found by any of the individual demographic components of U2 status, apprentices who met the AEOP definition of U2 reported significantly greater impacts than non-U2 apprentices (large effect size).

Overall Recommendations for FY20 Program Improvement/Growth

Evaluation findings for apprenticeship programs overall were very positive. All programs (CQL, SEAP, REAP, HSAP, URAP) enabled participants to experience some growth in their STEM practices, STEM knowledge, STEM competencies, and STEM identities. While these successes are commendable, there are some areas that remain with potential for growth and/or improvement for apprenticeship programs. The evaluation team therefore offers the following recommendations for FY20 and beyond:

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

1. Some of the apprenticeship programs experienced an increase in the number of applications in FY19 (CQL, SEAP, HSAP). However, despite the growth in number of applicants, CQL (FY18 214 students to FY19 194 students), SEAP (FY18 114 students to F19 108 students), HSAP (FY18 48 students, FY19 29 students) placed a smaller number and percentage of students than in FY18. Other programs experienced a decrease in applications in FY19, including REAP which dropped 11% but was able to place 30 more apprentices in FY19 – an 18% increase overall. URAP also saw a decrease in applications (14%) and an accompanying 24% decrease in participation (FY19 54 participants compared to FY18 67 participants). The overwhelming demand for AEOP apprenticeship programs is something that must be strongly considered by the consortium. The evaluation team recommends investing more resources into funding, recruiting mentors and sites, and overall efforts to providing access and opportunity to more applicants in FY20 and the future.

2. All apprenticeship programs were successful in growing their percentage of underserved participants in FY19. CQL increased from 20% to 28%, SEAP from 27% to 32%, REAP from 96% to 99%, HSAP from 54% to 66%, and URAP from 18% to 22%. However, there is still room for growth with four of the five programs. The evaluation team commends apprenticeship programs for their efforts in this area and encourages RIT and ARO to continue to focus on this in FY20 and the future.

AEOP Priority: Support and empower educators with unique Army research and technology resources

No recommendations

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

1. Apprenticeship participation in the annual AEOP evaluation is still much lower than desirable. HSAP, URAP, SEAP, and CQL had very poor participation in the evaluation questionnaires for both participants and mentors. Program participation in the required 21st Century Skills Assessment for all apprentices was also very low in FY19 for CQL, SEAP, HSAP, URAP. RIT and ARO must work

directly with mentors for the programs to convey these required components of the AEOP evaluation early and frequently across the summer to provide reminders and support for participants to complete the questionnaire. It is recommended that this become a required activity on the last day of the apprenticeship for both the student and the mentor. In regard to the 21st Century Skills Assessment, NCSU provides live webinars that are an orientation to the tool with follow-up support as needed. It is strongly recommended that the apprenticeship programs invest extra efforts to achieve at least 40% participation in all AEOP evaluation tasks for FY20.

2. Across all apprenticeship programs in FY19, as in FY18, the majority of mentors are not discussing specific AEOP programs with students. For example, 40% of CQL participants had never heard of URAP and 27% of CQL mentors reported only discussing AEOP generally – with the other 73% not discussing AEOP at all. Findings for the other apprenticeship programs were similar – a pervasive concern that has been highlighted for multiple years. It is recommended that RIT, as it fully assumes leadership in FY20, make this an area of emphasis and expectation for mentors in AEOP apprenticeship programs. The consortium has developed materials that can be provided to help support this effort.

3. As in FY18, the FY19 apprentices from all programs indicated very little engagement with AEOP on social media. This is a missed opportunity to connect and provide more learning opportunities to participants, as well as a way to grow their knowledge of the AEOPs. It is recommended that the IPAs promote the social media hashtags, etc. in communications with sites in FY20.