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ARMY EDUCATIONAL OUTREACH PROGRAM

2019 Annual Program Evaluation Report
Summative Findings

December 2020

ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

AEOP Priorities

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

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

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

2019 Portfolio Overview

This report includes a detailed evaluation of the FY19 AEOP activities.
A summary of individual program level data is outlined in Table 1 below, which includes applicant and participant data, numbers of Army and DoD S&Es, participating K-12 schools and colleges/universities, collaborating organizations including Army and DoD laboratories and centers, and cost data. Overall participant data summarized for youth and adults by program are presented in Table 2.

AEOP program participation data presented in Table 2 was provided by each program using, in some cases, a combination of data gathered from the Cvent registration portal and individual program site records. The overall underserved participant (U2) calculations were completed using only Cvent registration data which could be independently verified. (Table 3)

AEOP partner engagement is detailed in Table 4 including the number of collaborating educational organizations (both K-12 and college/universities), as well as participating Army and DoD laboratories and centers, and individual scientists and engineers (S&Es) per program.

Some partners participate in more than one AEOP program. The total number of unduplicated organizational partners (K-12 schools, college/universities, and Army/DoD laboratories and centers) is included in Table 5. Additionally, Table 6 includes the total number of unique adult participants (K-12 teachers and Army S&Es). Lastly, AEOP individual program costs are detailed in Table 7.

Table 1. 2019 AEOP Initiatives	
Camp Invention Initiative (CII) **Program Administrator: U.S. Army Corps of Engineers – Engineering Research & Development Center (ERDC)**	
Description	One-week STEM Enrichment activity
Participant Population	K-6 students
Number of Applicants	2,280
Number of Participants	2,140
Number of Participants	94%
Number of Teachers & Other Volunteers	180
Number of Sites	26
Number of Army/DoD Laboratories and Centers	14
Number of K-12 Schools	26
Number of K-12 Schools – Title I	25
Total Cost	$485,310
College Qualified Leaders (CQL) **Program Administrator: Rochester Institute of Technology (RIT)**	
Description	STEM Apprenticeship Program – Summer or school year, at Army laboratories 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/DoD Laboratories and 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	$8,552
eCYBERMISSION (eCM) **Program Administrator: National Science Teachers Association (NSTA)**	
Description	STEM Competition - Nationwide (including DoDEA schools), web-based, including one national event
Participant Population	6th-9th grade students
Number of Student Applicants	19,483
Number of Participants	17,944

Number/Percentage of U2 Participants*	10,511 (58.6%)
Placement Rate	NA (all students who register may participate)
Registered Teams (complete)	5,097
Students Attending National Event	75
Teams Attending National Event	21
Submission Completion Rate	79%
Number of Adults (Team Advisors and Volunteers – incl. S&Es and Teachers)	1,733
Number of Team Advisors (Predominantly math and science teachers)	489
Number Volunteers (Ambassadors, Cyberguides, Virtual Judges)	1,200
Number of Army S&Es	449
Number of Army/DoD Laboratories & Centers	33
Number of K-12 Teachers (including pre-service teachers)	433
Number of K-12 Schools	444
Number of K-12 Schools – Title I	154
Number of Colleges/Universities	131
Number of HBCU/MSIs	15
Number of DoDEA Students	375
Number of DoDEA Teachers	10
Number of DoDEA Schools	13
Number of Other Collaborating Organizations	0
Total Cost	$2,954,682
Total Travel	$499,940
Participant Travel	$390,597
Total Awards	$700,297
Student Awards/Stipends	$694,897
Adult/Teacher/Mentor Awards	$5,400
Cost Per Student	$165
Gains in the Education of Mathematics & Science (GEMS) **Program Administrator: National Science Teachers Association (NSTA)**	
Description	STEM Enrichment Activity - at Army laboratories, hands-on
Participant Population	5th-12th grade students (secondary audience: college undergraduate near-peer mentors, teachers)
Number of Applicants	5,296
Number of Participants	2,985
Number/Percentage U2 Participants*	997 (42%)
Placement Rate	56%
Number of Adults	351
Number of Near-Peer Mentors	128
Number of Resource Teachers	33
Number of Army S&Es	175
Other Adult Volunteers	15
Number of Army/DoD Laboratories & Centers	15

Number of K-12 Teachers	33
Number of K-12 Schools	1,463
Number of K-12 Schools – Title I	409
Number of Colleges/Universities	68
Number of HBCU/MSIs	3
Other Collaborating Organizations	17
Number of DoDEA Students	8
Number of DoDEA Teachers	1
Number of DoDEA Schools	8
Total Cost	$1,206,887
Total Travel	$9,755
Participant Travel	$0
Total Awards	$775,267
Student Awards/Stipends	$270,800
Adult/Teacher/Mentor Awards	$504,467
Cost Per Student	$404
High School Apprenticeship Program (HSAP) **Program Administrator: Rochester Institute of Technology (RIT)**	
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%
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
Junior Science & Humanities Symposium (JSHS) **Program Administrator: National Science Teaching Association (NSTA)**	
Description	STEM Competition - Nationwide (incl. DoDEA schools), research

	symposium that includes 47 regional events and one national event
Participant Population	9th-12th grade students
Number of Applicants	4,493
Number of Regional Student Participants	2,651
Number of National Student Participants	224
Number/Percentage U2 Participants*	1,216 (41%)
Placement Rate	N/A
Number of Adults (Mentors, Regional Directors, Volunteers – incl. Teachers and S&Es)	2,636
Number of Army and DoD S&Es	252
Number of Army/DoD Laboratories and Centers	34
Number of K-12 Teachers	715
Number of K-12 Schools	810
Number of K-12 Schools – Title I	111
Number of DoDEA Students	114
Number of DoDEA Teachers	32
Number College/University Personnel	705
Number of Colleges/Universities	204
Number of HBCU/MSIs	17
Number of Other Collaborating Organizations	144
Total Cost	$1,943,752
Total Travel	$402,055
Participant Travel	$366,485
Total Awards	$428,800
Student Awards/Stipends	$403,500
Adult/Teacher/Mentor Awards	$25,300
Cost Per Student	$733
Junior Solar Sprint (JSS) **Program Administrator: Technology Student Association (TSA)**	
Description	STEM Competition - Solar car competition regional events at Army laboratories, TSA state events, and a national event hosted in conjunction with the TSA national conference
Participant Population	5th-8th grade students
Number of Applicants/Participants	2,224
Number/Percentage of U2 Participants*	1,197 (67.3%)
Placement Rate	N/A (all students who register may participate)
Number of Adults (Mentors and Volunteers – incl. Teachers and Army S&Es)	326
Number of K–12 Teachers (including preservice)	268

Number of Army S&Es[1]	0
Number of Army/DoD Laboratories and Centers	6
Number of K-12 Schools	353
Number of K-12 Schools – Title I	149 reported (majority of schools left blank)
Number of Other Collaborating Organizations	1
Total Cost	$253,663
Total Travel	$47,745
Participant Travel	$43,419
Total Awards	$1,648
Student Awards/Stipends	$1,648
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$114
Research & Engineering Apprenticeship Program (REAP) **Program Administrator: Rochester Institute of Technology (RIT)**	
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

[1] The 2019 registration did not include a separate designation for S&E volunteers; therefore S&Es were registered simply as volunteers and it was not possible to discern from registration which volunteers were S&Es. The 2020 registration form will include the category of "S&E volunteers".

Student Awards/Stipends	$239,000
Adult/Teacher/Mentor Awards	$114,000
Cost Per Student	$2,680
Research Experiences for STEM Educators and Teachers (RESET) **Program Administrator: Tennessee Tech University (TTU)**	
Description	RESET provides a summer research experience at participating Army Laboratories and on-line for teachers and educators across the nation.
Participant Population	Middle school and high school STEM educators
Number of Applicants/Teachers	24
Number of Participants	22
Placement Rate (percentage)	92%
Number of Adults	25
Number of Army S&Es	3
Number of Army/DoD Laboratories and Centers	2
Number of K–12 Teachers	22
Number of K–12 Schools	20
Number of K–12 Schools — Title I	15
Number of Colleges/Universities	1
Number of Other Collaborating Organizations	1
Total Cost	$128,631
Total Travel	$27,699
Participant Travel	$24,583
Total Awards	$47,750
Student Awards/Stipends	$47,750
Adult/Teacher/Mentor Awards	$0
Cost Per Participant	$5,847
Science & Engineering Apprentice Program (SEAP) **Program Administrator: Rochester Institute of Technology (RIT)**	
Description	STEM Apprenticeship Program – Summer, at Army laboratories 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/DoD Laboratories and 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
Unite **Program Administrator: Technology Student Association (TSA)**	
Description	STEM Enrichment Activity - Pre-collegiate, engineering summer program at university host sites, targeting students from groups historically underserved and under-represented in STEM
Participant Population	Rising 9th – 12th grade students from groups historically underserved and under-represented in STEM
Number of Applicants	807
Number of Participants	440
Number/Percentage of U2 Participants*	334 (94%)
Placement Rate	54%
Number of Adults	366
Number of Army S&Es	25
Number of Army/DoD Laboratories and Centers	2
Number of K-12 Teachers & University Educators	133
Number of K-12 Schools	189
Number of K-12 Schools – Title I	92
Number of Colleges/Universities	27
Number of HBCU/MSIs	13
Other Collaborating Organizations	125
Total Cost	$706,997
Total Travel	$17,792
Participant Travel	$0
Total Awards	$188,500
Student Awards/Stipends	$182,900
Adult/Teacher/Mentor Awards	$5,600
Cost Per Student	$1,607
Undergraduate Research Apprenticeship Program (URAP) **Program Administrator: Rochester Institute of Technology (RIT)**	
Description	STEM Apprenticeship Program – Summer, in Army-funded labs at colleges/universities nationwide, with college/university S&E mentors
Participant Population	College undergraduate students

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

*U2 participation rate calculated using data for participants whose demographic information was provided in Cvent.

Youth and adult participation data reported by individual programs are presented in Table 2. A total of 28,947 youth participated in AEOPs in 2019, a 4.5% decrease from 2018 when 30,311 youth participated and a 12% decrease as compared to 2017 when 32,947 youth participated in AEOPs. A total of 6,138 adults participated in 2019, a 37% decrease as compared to the 9,774 adults reported to participate in AEOPs in 2018 and a 29% decrease from the 8,607 adults who participated in 2017. Of the 2019 participants, 497 students and 43 teachers were from DoDEA schools (participating in eCM, GEMS, and JSHS).

Table 2. 2019 AEOP Participation by Youth and Adults Reported by Programs

		Youth	Adults
CII	Camp Invention Initiative	2,140	180
CQL	College Qualified Leaders	204	178
eCM	eCYBERMISSION	17,944	1,733
GEMS	Gains in the Education of Mathematics & Science	2,985	351
HSAP	High School Apprenticeship Program	29	40
JSHS	Junior Science & Humanities Symposium	2,651	2,636
JSS	Junior Solar Sprint	2,224	326
REAP	Research & Engineering Apprenticeship Program	168	132
RESET*	Research Experiences for STEM Educators and Teachers	0	22
SEAP	Science & Engineering Apprentice Program	108	123
Unite	Unite	440	366
URAP	Undergraduate Research Apprenticeship Program	54	51
	Total 2019 AEOP Participants	**28,947**	**6,138**

*Note – RESET participants are teachers, therefore this program has no youth participants.

The majority of adults, including Army S&Es and K-12 teachers, volunteered with the JSHS (2,636 adults) and eCM (1,733 adults) competitions. Youth participation increased in four programs (CII, JSS, Unite, and REAP) and declined slightly in the other seven (CQL, eCM, GEMS, HSAP, JSHS, SEAP, and URAP) as compared to 2018.

Table 3 takes a closer look at youth participant demographics and underserved status (U2). In FY19, the percentage of U2 student participants increased by 10% to 56% overall, compared to 46% for FY18. The AEOP defines underserved and underrepresented (U2) participants as those who possess at least two of the following criteria: attend a rural, urban, or frontier/tribal school; identify as female; identify as racial/ethnic minority; receive free or reduced lunch price at school or receive Pell Grants; speak a language other than English as their primary language; or have no parents who attended college. Overall, 55.8% of FY19 AEOP youth participants were classified as U2.

Table 3. 2019 AEOP Youth Participant Underrepresented (U2) Data by Program

Program	School – Rural, Urban, Frontier	Female	Racial/ Ethnic Minority	Low SES**	ELL	College First Generation	U2
CQL (n=204)	N/A	103 (50.5%)	59 (28.9%)	43 (21.1%)	11 (5.4%)	36 (17.6%)	**71 (34.8%)**
HSAP (n=29)	17 (58.6%)	18 (62.1%)	13 (44.8%)	6 (20.7%)	4 (13.8%)	4 (13.8%)	**19 (65.6%)**
REAP (n=165)	104 (63.0%)	111 (67.3%)	124 (75.2%)	93 (56.4%)	49 (29.7%)	60 (36.4%)	**163 (98.8%)**
SEAP (n=108)	34 (31.5%)	56 (51.9%)	20 (18.5%)	11 (10.2%)	9 (8.3%)	4 (3.7%)	**35 (32.4%)**
Unite (n=356)	259 (72.8%)	208 (58.4%)	271 (76.1%)	264 (74.2%)	37 (10.4%)	163 (45.8%)	**334 (93.8%)**
URAP (n=54)	N/A	21 (38.9%)	13 (24.1%)	N/A	10 (18.5%)	7 (13.0%)	**12 (22.2%)**
eCM (n=17,944)	7,862 (43.8%)	8,888 (49.5%)	7,589 (42.3%)	5,830 (32.5%)	2,898 (16.2%)	2,604 (14.5%)	**10,511 (58.6%)**
NJ&EE (n=75)	23 (30.7%)	46 (61.3%)	12 (16.0%)	8 (10.7%)	8 (10.7%)	1 (1.3%)	**31 (41.3%)**
R-JSHS (n=2,970)	1,137 (38.3%)	1,737 (58.5%)	508 (17.1%)	387 (13.0%)	334 (11.2%)	320 (10.8%)	**1,216 (40.9%)**
N-JSHS (n=229)	81 (35.4%)	122 (53.3%)	38 (16.6%)	17 (7.4%)	37 (16.2%)	16 (7.0%)	**90 (39.3%)**
JSS (n=1,778)	1,373 (77.2%)	783 (44.0%)	497 (28.0%)	698 (39.3%)	153 (8.6%)	479 (26.9%)	**1,197 (67.3%)**
GEMS (n=2,380)	734 (30.8%)	1,135 (47.7%)	900 (37.8%)	326 (13.7%)	67 (2.8%)	214 (9.0%)	**997 (41.9%)**
Total (N=26,292)	11,624 (44.2%)	13,228 (50.3%)	10,044 (38.2%)	7,683 (29.2%)	3,617 (13.8%)	3,908 (14.9%)	**14,676 (55.8%)**

*Low Socio-Economic Status (SES) is measured by the number of participants eligible for free or reduced lunch for K-12 students or CQL participants who have received Pell Grants (Pell Grant data not collected for URAP).

NOTE. U2 calculations were performed using data for participants who provided demographic information in Cvent. Data for some programs must be interpreted with caution as there were a considerable amount of missing/choose not to respond. demographic data in registration files which introduces measurement error in determining U2 status. Additionally, many participants shared no demographic data which makes it impossible to determine U2 status.

CQL: 0% missing individual demographics; all participant U2 calculated
HSAP: 0% missing individual demographics; all participant U2 calculated
REAP: 0% missing individual demographics; all participant U2 calculated
SEAP: 0% missing individual demographics; all participant U2 calculated
Unite: 1%-5% missing individual demographics; all participant U2 calculated
URAP: 0% missing individual demographics; all participant U2 calculated; Pell Grant data was not collected for 2019

eCM: 3%-10% missing individual demographics; all participant U2 calculated
NJ&EE: 0%-5% missing individual demographics; all participant U2 calculated
R-JSHS: 1% missing individual demographics; 4(<1%) participant U2 not calculated
N-JSHS: 0%-9% missing individual demographics; all participant U2 calculated
JSS: 0% missing individual demographics; all participant U2 calculated
GEMS: 0%-13% missing individual demographics; all participant U2 calculated; results based on unique participants as 46 students participated in more than 1 GEMS program and duplicates were removed

REAP and UNITE reached a population of students that was comprised of over 90% U2 participants. JSS, HSAP, and eCM had more than 50% U2 participants. GEMS, JSHS, CQL and SEAP had between 30% and 45% U2 participation. URAP was the only apprenticeship program that included less than 30% U2 students.

Collaboration with other organizations and the involvement of adult participants who serve as mentors, judges, team advisors, and in various other roles are key assets of the AEOP. In particular, AEOP initiatives are distinguished from other STEM outreach programs by the AEOP's ability to leverage Army and DoD S&Es and Army and DoD laboratories in its programs. Table 4 displays the numbers of organizations and the number of Army S&Es participating in each AEOP in 2019. Because these institutions and S&Es may participate in multiple AEOPs, no totals are displayed in Table 4.

Table 4. Number of 2019 Collaborating Schools, Laboratories, Army/DoD S&Es, and Other Organizations

	K-12 Schools		Colleges/Universities (represented by participants or serving as host sites)		Army and DoD Labs/ Centers	Army-Funded University Labs	Army and DoD Scientists & Engineers (S&Es)	Other Collaborating Organizations
Program	Total	Title I	Total	HBCU/MIs				
Camp Invention (CII)	26	25	NA	NA	14	N/A	N/A	N/A
CQL	N/A	N/A	N/A	N/A	16	N/A	178	N/A
eCM	444	154	131	15	33	N/A	449	0
GEMS	1,463	409	68	3	15	N/A	175	17
HSAP	28	8	25	10	N/A	26	N/A	N/A
JSHS	810	111	204	17	34	N/A	252	144
JSS	353	149	N/A	N/A	6	N/A	0	1
REAP	143	70	55	29	N/A	N/A	N/A	N/A
RESET	20	15	1	0	2	N/A	3	1
SEAP	64	25	N/A	N/A	10	N/A	123	N/A
Unite	189	92	27	13	2	N/A	25	125
URAP	N/A	N/A	41	10	N/A	42	N/A	N/A

Table 5 provides information for the number of unique (duplicates eliminated) institutions participating in AEOP and Table 6 provides the numbers of unique K-12 teachers and S&Es participating in AEOPs in 2019. AEOP youth and adult participants represented 2,539 K-12 schools nationwide, and 328 colleges

and universities (86 of which were HBCUs/MSIs) were either home institutions for AEOP participants or acted as host sites for programs. Forty-six Army-funded university labs and 63 Army labs and centers participated in AEOPs in 2019. A total of 1,238 K-12 teachers and 938 DoD S&Es participated in the various AEOPs in 2019.

Table 5. Total Number of Unique Schools and Laboratories Participating in AEOPs in 2019	
Type of Institution	**Total Number of Unique Institutions**
K-12 Schools	2,539
Colleges/Universities represented by participants or serving as host sites (HBCU/MSI)	328 (86)
Army-Funded University Labs	46
Army and DoD Labs and Centers	63
Other Organizations	279

Table 6. Total Number of Unique Teachers and Army DoD Scientists and Engineers Participating in AEOPs in 2019	
Type of Participant	**Total Number of Unique Participants**
K-12 Teachers	1,238
Army/DoD Scientists and Engineers	938

Costs associated with the implementation of the 2019 AEOP portfolio of programs are detailed in Table 7. The portfolio is broken into four categories of programming: competitions, STEM enrichment programs, apprenticeships, and STEM educator programs. As in previous years, the apprenticeship programs and the STEM educator program (RESET) had the highest costs per participant while the competitions were the least costly of the AEOPs on a per student basis. The cost of AEOP competitions (eCM, JSS, and JSHS) in 2019 ranged from $114 per student (JSS) to $733 per student (JSHS). The cost of STEM enrichment programs (CII, GEMS, Unite) ranged from $227 per student for CII, typically a 1-week summer STEM experience, to $1,607 for Unite, a 4-6-week summer STEM experience for students from historically underserved and under-represented groups. Apprenticeship program (CQL, HSAP, REAP, SEAP, URAP) costs ranged from $2,680 per apprentice (REAP) to $8,840 per apprentice (CQL), with cost variations reflecting the duration of the program and academic level of apprentices. RESET is currently the only STEM educator program in the AEOP and cost $5,847 per participant in 2019.

Seven programs, CII, GEMS, HSAP, JSS, REAP, Unite, and URAP had slightly lower costs per student participant in FY19 as compared to FY18. All other programs experienced slight increases in cost per student in FY19 as compared to FY18.

Table 7. 2019 AEOP Program Total Costs				
	Program Type	Program Cost	Cost Per Participant	Average Stipend Per Participant
CII	STEM Enrichment Program (grades K-6)	$485,310	$227	N/A
CQL	STEM Apprenticeship Program (undergraduate/graduate)	$1,803,439	$8,840	$8,552
eCM	STEM Competition (grades 6-9)	$2,954,682	$165	N/A
GEMS	STEM Enrichment Program (grades 5-12)	$1,206,887	$404	$91
HSAP	STEM Apprenticeship Program (grades 9-12)	$102,785	$3,544	$2,679
JSHS	STEM Competition (grades 9-12)	$1,943,752	$733	N/A
JSS	STEM Competition (grades 5-8)	$253,663	$114	N/A
REAP	STEM Apprenticeship Program (grades 9-12)	$450,165	$2,680	$1,423
RESET	STEM Educator Program	$128,631	$5,847	$2,170
SEAP	STEM Apprenticeship Program (grades 9-12)	$482,304	$4,466	$3,407
Unite	STEM Enrichment Program (grades 9-12)	$706,997	$1,607	N/A
URAP	STEM Apprenticeship Program (undergraduate)	$256,654	$4,753	$3,877

4 | Evaluation Strategy

The 2019 AEOP portfolio evaluation was conducted by NC State University. The evaluation was comprised of a two-pronged strategy. The first and primary focus of the evaluation was to assess current program year effectiveness for each of eleven AEOP elements: CQL, eCM, GEMS, HSAP, JSHS, JSS, REAP, RESET, SEAP, Unite, and URAP. The secondary focus of the evaluation, beginning in FY16, was a long-term alumni study. This component includes an examination of the mid to long-term outcomes of the AEOP.

The evaluation team conducted all data collection for FY19 including questionnaire data for programs and alumni, site visits for selected programs, 21st Century skill assessments, and focus group/individual interviews with selected program participants (both current and alumni). NC State University conducted all data analysis and prepared all AEOP FY19 evaluation reports with the exception of the Camp Invention Initiative (CII). NC State University assessed and evaluated these AEOP elements in collaboration with AEOP CA consortium members,[2] individual program administrators (IPAs), the Army Cooperative Agreement Managers (CAMs), and personnel responsible for implementing programs at specific sites (Command Level Coordinators, Lab Coordinators, Regional Directors, etc.). The 2019 AEOP evaluation was standardized across all programs, with the exception of RESET, to allow for the reporting of consistent information about program quality and impacts. Because of the small number of RESET participants, a formative approach consisting of interviews with participants and information provided by the IPA was utilized to evaluate the program. Elements of the data available through Camp Invention that were aligned with the overall AEOP portfolio evaluation are included for reference in this report.

The 2019 evaluation was informed by AEOP priorities and by the objectives of individual AEOP elements. Evaluation studies were carried out using a logic model that proposes a pathway of influence for the AEOP, ultimately linking AEOP inputs and activities to intended outcomes that align with AEOP priorities and objectives as well as federal requirements for reporting on federal STEM investments. The logic model provides a framework for the near- and long-term AEOP evaluation plan, ensuring that evaluation questions yield information that is valuable to the AEOP and that evaluation assessments include appropriate measures of intended outputs and outcomes that align with the AEOP's priorities and objectives and federal requirements.

[2] The 2019 AEOP consortium members included the Rochester Institute of Technology (RIT; Apprenticeship Programs), the Technology Student Association (TSA; JSS, Unite), the National Science Teaching Association (NSTA; eCM, GEMS, JSHS), NC State University (Evaluation Lead); Metriks Amerique (Alumni Management); Widmeyer (Communications and Marketing); Battelle Memorial Institute (Lead Organization).

Table 8. AEOP Priorities and Objectives (2019)
PRIORITY ONE: STEM Literate Citizenry
Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.
Objectives
• Encourage and reward student participation in STEM opportunities.
• Inspire students to excel in science and mathematics.
• Increase participation of underserved populations in the AEOP.
• Expand the involvement of students in ongoing DoD research.
• Increase awareness of DoD STEM career opportunities.
PRIORITY TWO: STEM Savvy Educators
Support and empower educators with unique Army research and technology resources.
Objectives
• Partner with schools and teachers at local and state educational agencies for shared standards in science and mathematics.
• Use incentives to promote teacher participation in the AEOP.
• Provide online resources for educators to share best practices.
• Provide and expand mentor capacity of the Army's highly qualified scientists and engineers.
PRIORITY THREE: Sustainable Infrastructure
Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.
Objectives
• Develop and implement cohesive program metrics for each individual program and across all of the AEOP.
• Provide STEM educational opportunities for students at all stages of their K-12 education.
• Integrate programs in a central branding scheme, inclusive of a centralized website, for a strategic and comprehensive marketing strategy.
• Establish a competitive process for funding new STEM investments that align to the overall program strategy.

In 2019, the AEOP evaluation studies focused predominantly on assessing the quality of AEOP programs as well as near- and mid-term impacts. Thus, data collection included questions about the benefits of participation to participants, program strengths and challenges, and overall effectiveness in meeting AEOP and program objectives. In addition, each program evaluation noted which recommendations from previous evaluations had been implemented (evidence-based change). Figure 1 provides a simple graphic depiction of the AEOP Evaluation logic model.

Figure 1. AEOP Evaluation Logic Model

Inputs	Activities	Outputs	Outcomes (Near-term)	Impact (Mid- and Long-Term)
• US Army sponsorship • Broad roster of AEOP initiatives available for student engagement • IPAs providing coordination and oversight of programs • Operations conducted at Army/DoD laboratories and centers, universities, schools, and local/regional and national competitions • Army/DoD and university S&Es, local and DoDEA/DoDDS educators, and other volunteers serving as STEM "mentors" • Online and on-site curricular resources • Stipends and awards for students and educator participants • Centralized branding and comprehensive marketing • Centralized evaluation and annual reporting	• Engagement in "authentic" STEM experiences through: • Curriculum-driven summer programs at Army research institutions and universities • Summer and academic year apprenticeship programs at Army research institutions and universities • Local/regional and national STEM competitions	• Increasing numbers and diversity of student participants • Increasing numbers and diversity of mentor participants • Increasing numbers and diversity of Army/DoD scientists and engineers engaged in programs • Increasing numbers of K-college schools served through participant engagement • Increasing number of curricular resources distributed through websites and program participation • Students, mentors, site coordinators, and IPAs contributing to evaluation	• Increased student interest and engagement in STEM (formal and informal) • Increased participant STEM skills, knowledge, abilities, and confidence • Increased participant knowledge of other AEOP opportunities • Increased participant knowledge of Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve programs	• Increased student participation in other AEOP opportunities and DoD scholarship/ fellowship programs • Increased student interest in and pursuit of STEM coursework in secondary and post-secondary schooling • Increased student interest in and pursuit of STEM degrees • Increased student interest in and pursuit of STEM careers • Increased student interest in and pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of the AEOP

The 2019 AEOP evaluation plan is summarized by program in Table 9. In short, most evaluations utilized participant questionnaires, as well as focus groups or interviews with youth participants (herein called

students and apprentices) and adult participants who led educational activities or supervised research (herein called mentors, team advisors, or adults).

Table 9. 2019 AEOP Evaluation Strategy		
AEOP Element	**Assessment Tools**	**Program-Level Objectives**
CQL	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Apprentice focus groups • Mentor focus groups • 21st Century Skills Assessment	• To nurture interest and provide research experience in STEM for college students. • To provide opportunities for continued association with the DoD laboratories and STEM enrichment of previous SEAP, GEMS, and other AEOP program participants as well as allow new college students the opportunity to engage with DoD laboratories. • To outreach to participants inclusive of youth from groups historically under-represented and underserved in STEM. • To increase participant knowledge in targeted STEM areas and develop their research and laboratory skills as evidenced by mentor evaluation and the completion of presentations of research (poster, paper, oral presentation, etc.). • To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories. • To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community. • 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.
eCM	Program Evaluation: • Student questionnaire • Mentor questionnaire • Student focus groups • Mentor focus group • NJ&EE observation	• Increase number of student and Team Advisor registrants and folder submissions. • Increase the number of participants from Title I schools. • Increase the number of volunteers and Army volunteers. • Increase Team Advisor retention rate and implement programs to exceed our target rate. • Increase number of classroom integrated programs. • Increase number of students from DoDEA schools. • Increase participants' awareness of other AEOP and DoD STEM opportunities and Army/DoD technologies and increase student interest in STEM learning and pursuit of STEM-related degrees.
GEMS	Program Evaluation: • Student questionnaire • Mentor questionnaire • Student focus groups	• To nurture interest and excitement in STEM for middle and high school participants. • To nurture interest and excitement in STEM for mentor participants.

	• Mentor focus groups • Site observations	• To implement STEM enrichment experiences through hands-on, inquiry-based educational modules that enhance in-school learning. • To increase participant knowledge in targeted STEM areas and laboratory skills. • To increase the number of outreach participants inclusive of youth from groups historically under-represented and underserved in STEM. • To encourage participants to pursue secondary and post-secondary education in STEM. • To educate participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories. • To provide information to participants about opportunities for STEM enrichment through advancing levels of GEMS as well as other AEOP initiatives.
HSAP	<u>Program Evaluation:</u> • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews • Mentor interviews • 21st Century Skills Assessment	• Expand apprenticeship opportunities for underserved populations in cooperation with HBCUs/MSIs and other affinity groups, and in cooperation with recruitment objectives of LPCs by disseminating program information to a broader and a more diverse audience. • Expand cross marketing and outreach of apprenticeship programs to include other AEOP programs to mentors and LPCs. • Encourage apprentices to continue pursuit of AEOP STEM/Army STEM careers • Encourage more students already in the AEOP pipeline to continue with an apprenticeship program • Increase participant's knowledge of other AEOP programs and STEM careers • Improve the overall participant and mentor apprenticeship experience.
JSHS	<u>Regional Symposia Evaluation:</u> • Student questionnaire • Mentor questionnaire <u>National Symposium Evaluation:</u> • Student questionnaire • Mentor questionnaire[3] • Student focus groups • Mentor focus group	• To promote research and experimentation in STEM at the high school level. • To recognize the significance of research in human affairs and the importance of humane and ethical principles in the application of research results. • To search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering. • To recognize innovative and independent research projects of youth in regional and national symposia.

[3] A single mentor questionnaire was administered to all mentors, regardless of whether their student was selected for the National Symposium.

		• To expose students to academic and career opportunities in STEM and to the skills required for successful pursuit of STEM. • To expose students to STEM careers in Army and/or DoD laboratories. • To increase the future pool of talent capable of contributing to the nation's scientific and technological workforce.
JSS	<u>Program Evaluation:</u> • Student questionnaire • Mentor questionnaire • Student focus groups	• Increase outreach to populations that are historically underserved and underserved in STEM. • Increase participants' awareness of Army/DoD STEM careers. • Increase participants' awareness of other AEOP opportunities. • To create a national infrastructure to manage local, regional, and national JSS events and increase participation. • To enhance training opportunities and resources for teachers/mentors. • To coordinate tracking and evaluation opportunities for student and teacher participation in JSS. • To leverage AEOP through cross-program marketing efforts.
REAP	<u>Program Evaluation:</u> • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews • Mentor interviews • 21st Century Skills Assessment	• To provide high school students from groups historically under-represented and underserved in STEM, including alumni of the AEOP's Unite program, with an authentic science and engineering research experience. • To introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP. • To provide participants with mentorship from a scientists or engineer for professional and academic development purposes. • To develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.
RESET	<u>Program Evaluation:</u> • Participant interviews	• To increase teacher knowledge and access to research. • To create digital professional learning community (D-PLC) for educators and mentors to share best practices. • To prepare teacher participants to create Legacy Cycle lessons based on DoD research and careers.
SEAP	<u>Program Evaluation:</u> • Apprentice questionnaire • Mentor questionnaire • Apprentice focus groups • Mentor focus groups	• To acquaint qualified high school students with activities of Army laboratories and centers through summer research and engineering experiences. • To provide students with opportunities and exposure to scientific and engineering practices and personnel not available in their school environments.

	• 21st Century Skills Assessment	• To expose those students to DoD research and engineering activities and goals in a way that encourages a positive image and supportive attitude toward our defense community. • To establish a pool of students preparing for careers in science and engineering with a view toward potential government service. • To 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. • To involve a larger percentage of students from previously under-represented segments of our population, such as women, African-Americans and Hispanics, in pursuing science and engineering careers.
Unite	<u>Program Evaluation:</u> • Student questionnaire • Mentor questionnaire • 21st Century Skills Assessment	• To effectively show participants the real word applications of math and science. • To raise participant confidence in the ability to participate in engineering activities. • To inspire participants to consider engineering majors in college. • To remove social barriers and negative attitudes about engineering. • To promote collaboration and problem solving in a team environment. • To expose participants to STEM careers in the Army and DoD. • To increase the number of STEM graduates to fill the projected shortfall of scientists and engineers in national and DoD careers.
URAP	<u>Program Evaluation:</u> • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews • Mentor interviews • 21st Century Skills Assessment	• Expand apprenticeship opportunities for underserved populations in cooperation with HBCUs/MSIs and other affinity groups, and in cooperation with recruitment objectives of LPCs by disseminating program information to a broader and a more diverse audience. • Expand cross marketing and outreach of apprenticeship programs to include other AEOP programs to mentors and LPCs. • Encourage apprentices to continue pursuit of AEOP STEM/Army STEM careers • Encourage more students already in the AEOP pipeline to continue with an apprenticeship program • Increase participant's knowledge of other AEOP programs and STEM careers • Improve the overall participant and mentor apprenticeship experience.

Evaluation instruments were iteratively reviewed and revised by individual program administrators (IPAs), the Army Cooperative Agreement Managers (CAMs), and evaluators. All instruments and protocols were approved by NC State University's Institutional Review Board (IRB) for the protection of human research subjects.

5 | Study Sample

For the FY19 AEOP evaluation, evaluation surveys were the primary data collection method. Response rates by program along with their corresponding margins of error at the 95% confidence level were computed for students and mentors within each group (Table 10). An acceptable margin of error rate is 2-5%, and nearly all groups do not meet this standard. In part, this can be attributed to the fact that random sampling is not used for participation in the surveys. A large margin of error can indicate possible response bias (those who chose to respond to the questionnaire may not be representative of the entire population) and, consequently, results from evaluation survey data should be viewed as preliminary indicators of program quality and impact and not as conclusive.

Some programs had less than 20 evaluation survey participants in either the student or mentor groups (CQL, HSAP, JSS, SEAP). Yet multiple programs had more than the 40% benchmark participation rate for students (NJ&EE, HSAP, Unite, URAP).

Table 10. 2019 AEOP Program Participant Questionnaire Participation

Program	2019 Questionnaire	Sample	Population*	Participation Rate	Margin of Error @ 95% Confidence[4]
CQL	Apprentice	48	204	23.5%	±12.40%
	Mentor	15	178	8.4%	±24.28%
eCM	Overall Participants	628	17,944	3.4%	± 3.84%
	NJ&EE Participants	68	75	90.7%	± 3.66%
	Team Advisor	145	489	29.7%	± 6.83%
GEMS	Student	2,224	2,380	93%	±.53%
	Mentor (incl. NPM, RT, S&Es)	27	376	7.2%	±18.19%
HSAP	Apprentice	18	29	62.1%	±14.48%
	Mentor	14	40	35.0%	±21.39%
JSHS	Regional Symposia Student	554	2,970	18.65%	±3.76%
	National Symposium Student	91	229	39.7%	± 7.99%
	Mentor	332	1,110	29.9%	± 4.50%
JSS	Student	63	1,778	3.54%	±12.13%
	Mentor	10	326	3.1%	±30.56%
REAP	Apprentice	31	168	18.5%	±15.94%
	Mentor	40	132	30.3%	±12.99%
SEAP	Apprentice	11	108	10.2%	±28.13%

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

	Mentor	11	123	8.9%	±28.31%
Unite	Student	356	356	100%	±0.00%
	Mentor	92	366	25.1%	±8.85%
URAP	Apprentice	31	54	57.4%	±11.60%
	Mentor	28	51	54.9%	±12.56%
Alumni Study		358	2,700	13.3%	±4.82%
Total AEOP Questionnaire Participation		**5,195**	**33,300**	**15.6%**	**±1.25%**

*Cvent enrollment data was used for statistical analysis of evaluation survey findings throughout the program evaluations

Focus groups or interviews were also conducted with participants and mentors from programs. Purposive sampling was used for assembling diverse focus groups when larger populations were available at a site, and convenience sampling was employed when small numbers of participants were available at a site. In total, 294 students, apprentices, and mentors participated in focus groups and interviews. Interviews were conducted with 56 individual AEOP participants, and focus groups were conducted with 238 students, apprentices, and mentors. Table 11 summarizes focus group and interview participation.

Table 11. 2019 AEOP Program Participant Focus Group and Interview Participation

Program	2019 Focus Group and Interview	Focus Group Sample	Interview Sample
CQL	Apprentice	5	
	Mentor	3	
eCM	NJ&EE Student	21	
	NJ&EE Team Advisor	22	
GEMS	Student	40	
	Mentor	9	
HSAP	Apprentice		8
	Mentor		5
JSHS	Regional and National Symposium Participants	15	
	Competition Advisor/Mentor	3	
JSS	Student	90	
	Mentor	0	
REAP	Apprentice		10
	Mentor		8
RESET	Teacher participants		7
SEAP	Apprentice	22	
	Mentor	8	
Unite	Student		
	Mentor		
URAP	Apprentice		9
	Mentor		9
Total AEOP Focus Group/Interview Participation		**238**	**56**

The FY19 evaluation also included a mid to long-term study of AEOP alumni. The alumni respondent profile is included in Table 12.

Table 12. Alumni Respondent Profile (Longitudinal FY19 participants)		
Demographic Category	**Questionnaire Respondents**	
Gender (*n*=358)		
Female	201	56.1%
Male	147	41.1%
Choose not to report	10	2.8%
Race/Ethnicity (*n*=358)		
Asian	56	15.6%
Black or African American	49	13.7%
Hispanic or Latino	40	11.2%
Native American or Alaska Native	3	<1%
Native Hawaiian or Other Pacific Islander	3	<1%
White	181	50.6%
Other race or ethnicity (specify):[†]	23	6.4%
Choose not to report	3	<1%
Program Year (*n*=358)		
2019	22	6.1%
2018	164	45.8%
2017	97	27.1%
2016	48	13.4%
2015	15	4.2%
2014	3	<1%
2013	4	1.1%
2012	5	1.4%
High School Graduation Year (*n*=358)		
Before 2012	72	20.1%
2012	2	<1%
2013	2	<1%
2014	10	2.8%
2015	12	3.4%
2016	15	4.2%
2017	9	2.5%
2018	20	5.6%
2019	37	10.3%
2020	39	10.9%
2021	94	26.3%
2022	13	3.6%
2023	9	2.5%
2024	0	0%
2025	1	<1%
Choose not to report	23	6.4%

The 21st Century Skills Assessment (Johnson & Sondergeld, 2016) was used by mentors in multiple programs to use in observations of their students'/apprentices' skill growth. Pre- and post-observations were completed for apprentices in CQL, SEAP, HSAP, REAP, URAP, as well as participants in Unite and eCM. Pre-observation was completed in the first days of the program to assess baseline skills. Post-observation was completed at the end of the program to determine skill growth as a result of the program. Participants were rated on the six domains of 21st Century skills:

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

AEOP participants were rated by their mentors on a scale of 0 – 3 with 0 = Did Not Observe; 1 = Needs Improvement; 2 = Progressing; and 3 = Demonstrates Mastery across items.

The program participants who had both a pre- and a post-assessment completed were included in the analysis for this component of the evaluation. FY19 Completion rates ranged from 1% to 64%. Table 13 provides sample information by program.

Table 13. Pre-Post Assessment Participation by Program

Program Number of Participants Total	Pre-Assessment Participation	Post-Assessment Participation	Included Matched Pre-Post Assessments
CQL (n=204)	44	23	13
eCM (n=17,944)	162	121	114
HSAP (n=29)	25	19	15
REAP (n=168)	168	122	107
SEAP (n=108)	22	13	6
UNITE (n=356)	181	176	155
URAP (n=54)	41	38	22
Total	**643**	**512**	**432**

6 | Evaluation Findings

The 2019 AEOP evaluation findings are organized within the three AEOP priorities and associated research questions to provide insight into portfolio progress toward achieving the desired outcomes of the AEOP. The priorities and research questions for the near-term (annually) are found in Table 14 and the mid to long-term (multiple years) research questions are detailed in Table 15.

Table 14. AEOP Priorities and Near-Term Research Questions (2019)
PRIORITY ONE: STEM Literate Citizenry
Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.
Research Question #1 - To what extent do participants report growth in interest and engagement in STEM?
Research Question #2a - To what extent do participants report increased STEM competencies, 21st Century/STEM skills, STEM knowledge, STEM abilities, and STEM confidence?
Research Question #2b – To what extent do participants demonstrate use of and growth in 21st Century skills?
Research Question #3 - To what extent do participants and mentors report increased participant interest in STEM research and careers?
Research Question #4 - To what extent do participants and mentors report increased awareness of and interest in Army/DoD STEM research and careers?
Research Question #5 - To what extent do participants report increased enrollment, achievement, and completion of STEM degree programs?
PRIORITY TWO: STEM Savvy Educators
Support and empower educators with unique Army research and technology resources.
Research Question #6 - What is the impact of scientist and engineer (S&E) mentors on AEOP participants?
Research Question #7 - To what extent do teacher participants report increased use of new approaches to teaching research concepts within STEM practices, and infusion of careers?
PRIORITY THREE: Sustainable Infrastructure
Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.
Research Question #8 - To what extent do participants report growth in awareness of and/or interest in AEOP opportunities?

Table 15. AEOP Priorities and Mid to Long Term Research Questions (2019)
PRIORITY ONE: STEM Literate Citizenry
Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.
Research Question #1 - To what extent do alumni report positive, sustained interest and engagement in STEM?
Research Question #2 - To what extent do alumni report positive attitudes toward STEM, and particularly Army/DoD STEM?
Research Question #3 - To what extent do alumni report pursuit of and achievement in STEM courses in secondary school, post-secondary STEM degrees, STEM careers, and Army/DoD STEM careers?
Research Question #4 - To what extent do alumni report awareness of and interest in STEM research and careers overall and for the Army/DoD specifically?
Research Question #5 – To what extent do alumni report an increase in STEM career participation and success overall, as well as within the Army/DoD specifically?
PRIORITY TWO: STEM Savvy Educators
Support and empower educators with unique Army research and technology resources.
Research Question #6 - What is the impact of scientist and engineer (S&E) mentors on AEOP alumni?
Research Question #7 – Are there measurable changes in teacher approaches to teaching research concepts within STEM practices, and careers after participation in AEOP (RESET)?
PRIORITY THREE: Sustainable Infrastructure
Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.
Research Question #8 - To what extent do alumni report increased awareness of and/or interest in AEOP opportunities?
Research Question #9 - To what extent do alumni report participation in an AEOP program multiple times, in other AEOP elements, or in other DoD workforce development programs?

Near-Term Evaluation – Findings for FY19 AEOPs

Priority One: STEM Literate Citizenry

Findings from the FY19 AEOP evaluation reveal progress toward achieving a STEM Literate Citizenry with some continued challenges. Major trends that support the achievement of this AEOP priority along with evidence from assessment data that inform the findings are presented below by associated research question(s).

Research Question #1 - To what extent do participants report growth in interest and engagement in STEM?

AEOPs continued to engage a strong pool of diverse future STEM talent – over 29,000 participants, including 56% underserved students. The AEOP portfolio consisted of STEM programs designed to nurture students' STEM interests and aspirations throughout their educational careers. AEOPs include STEM competitions (eCM, JSHS, and JSS), STEM enrichment activities (CII, GEMS, and Unite), and STEM apprenticeship programs (CQL, HSAP, REAP, SEAP, and URAP). The GEMS Near-Peer Mentor (NPM) program also provided opportunities for undergraduate student scientists and engineers (S&Es)-in-training, to lead educational activities for youth in the GEMS program, and RESET provided professional development experiences for STEM educators by offering on-line learning and on-site research experiences.

In FY19, the AEOP engaged 28,947 youth participants, a 4.5% decrease from 2018 when 30,311 youth participated and a 12% decrease as compared to 2017 when 32,947 youth participated in AEOPs. This decrease continues a multi-year downward trend in enrollment (with the exception of FY17 when enrollments increased). Enrollments since FY14 were as follows: 41,802 in FY14; 38,039 in FY15; 30,972 in FY16; 32,947 in FY17; 30,334 in FY18; 28,947 in FY19. eCM, the AEOP that serves the greatest number of students, experienced an enrollment decline of 11% in FY19, following a 6% decrease in participation in FY18, and a 3% decrease in participation as compared to the prior program years. JSS enrollment continued to grow, however, and served 51% more students than in FY18, continuing an upward trend in enrollment (17% more students were served in FY18 than in than in FY17). The number of students enrolled in apprenticeship programs in FY19 decreased by 3% as compared to FY18.

AEOP youth application numbers and placement rates for FY19 are detailed in Table 16. The various AEOPs received a total of 38,339 applications in FY19, a 3% decrease from the 39,325 applications received in FY18, and a 21% decrease from the 48,419 applications received in FY17, but an increase of 2% over the 37,399 applications received in FY16. The number of applications that AEOPs receive indicate that there is strong student interest in AEOPs, although the current number of applications reflects a continuing downward trend since FY14 when 49,686 applications were received. There continues to be considerably higher demand for many programs than spaces available, however.

The overall placement rate across AEOPs for FY19 (76%) was similar to that of FY18 (78% in FY19, 77% in FY18), but higher than the 68% placement rate in FY17. All programs except for REAP had decreases in placement rates as compared to prior years:

- CQL placed 31% of applicants in FY19 compared to 37% in FY18, and 41% FY17
- GEMS placed 56% of applicants in FY19 compared to 61% in both FY18 and FY17
- HSAP placed 4% of applicants as compared to 9% in both FY18 and FY17
- SEAP placed 8% of applicants in FY19 as compared to 13% in both FY18 and FY17
- Unite placed 54% of applicants, a decrease compared to the 59% of applicants who were placed in FY18, but an increase over FY17 when 45% of Unite applicants were placed
- URAP placed 19% of applicants in FY19, a slight decrease from the 20% who were placed in FY18 but an increase from the 9% placed in FY17.

REAP placed 20% of applicants in FY19, an increase from the 15% who were placed in FY18 as compared and the 17% placed in FY17.

More than 6,000 adults, including K-12 teachers and Army and DoD S&Es, engaged in AEOPs in FY19, leading educational activities, supervising research, or serving as competition advisors, judges, event hosts or other volunteers. These numbers do not capture numerous others who may have been impacted within the organizations of those participating in AEOPs, nor do they reflect the potentially broader and undetermined impact of the AEOP's online educational resources made freely available through eCM and JSS, or those resources available to GEMS NPMs and GEMS resource teachers. Adult participation (6,138) was approximately 37% lower than in FY18 (9,774) and 29% lower than in FY17 (8,607).

Registration data indicate that many AEOPs were filled to capacity while others had capacity for more participants but were unable to fill slots due to limited interest, funding limitations, or lack of adequate programmatic support (e.g., mentors, volunteers). eCM, a web-based STEM competition for 6th-9th grade students, continues to enroll the largest number of participants among AEOPs, enrolling 60% of the total number of AEOP participants in FY19 (66% in FY18). JSS, another STEM competition, was similarly open to all those who met registration qualifications and increased participation by 51% from FY18 to FY19. All programs except for CII, JSS, and REAP experienced declines in enrollment as compared to FY18.

Because of individual program capacities and varying levels of interest in AEOPs, placement rates vary across the AEOP. Apprenticeship programs (CQL, HSAP, REAP, SEAP, and URAP) continued to be particularly competitive, with placement rates ranging from 4% (HSAP) to 31% (CQL). The number of applicants across the AEOP apprenticeship portfolio increased slightly to 3,756, a 13% increase from FY18 (3,275 applicants) and a 10% increase from FY17 (3,384 applications received). Of those applying for apprenticeships in FY19, 563 were selected for participation. The placement rate for apprentice programs overall decreased from 18% in FY18 to 15% in FY19, a placement rate substantially lower than the 27% of applicants who were placed in apprenticeships in FY16 and the 33% of students, who were selected for apprenticeships in FY15, a phenomenon related to the increasing number of applications to apprenticeship programs. The apprenticeships serving high school students (HSAP, REAP, and SEAP) were most competitive, and had a combined placement rate of only 11% in both FY19 and FY18 (305 apprentices placed out of 2,813 applicants in FY19, and 301 apprentices placed out of 2,380 applicants in FY18). This represents a slight decrease in placement rate for high school apprenticeships as compared to FY17 (13%), and a substantial decrease from the 25% placement rate in FY16 (17% placement rate for high school apprenticeships in FY15 and FY14). The placement in undergraduate apprenticeships (CQL and URAP) decreased to 27% (258 apprentices placed out of 943 applicants) as compared to 32% in FY18 (284 apprentices placed out of 895 applicants). The undergraduate apprentice placement rate in FY17 was 24% (288 apprentices placed out of 1,194 applicants). Overall enrollment in apprenticeship program declined by 3% in FY19 (563) as compared to FY18 (582).

Table 16. 2019 AEOP Number of Youth Applications and Placement Rates

		Youth Applicants	Youth Participants	Placement Rate	Change in Youth Participants, FY19 vs. FY18
CII	STEM Enrichment Activity	2,280	2,140	NA†	16%
CQL	STEM Apprenticeship Program (undergrad)	662	204	31%	-5%
eCM	STEM Competition	19,483	17,944	N.A.	-11%
GEMS	STEM Enrichment Activity	5,296	2,985	56%	-9%
HSAP	STEM Apprenticeship Program (high school)	670	29	4%	-66%
JSHS	STEM Competition	4,493	2,651	N.A.	-16%
JSS	STEM Competition	2,224	2,224	N.A.	51%
REAP	STEM Apprenticeship Program (high school)	857	168	20%	18%

SEAP	STEM Apprenticeship Program (high school)	1,286	108	8%	-6%
Unite	STEM Enrichment Activity	807	440	54%	-20%
URAP	STEM Apprenticeship Program (undergrad)	281	54	19%	-24%
	Total	**38,339**	**28,947**	**76%**	**-2%**

† *In 2019, all youth who met registration requirements for CII, eCM, JSHS, and JSS were able to participate.*

The AEOP continued to make progress toward its goal of serving groups underserved in STEM, as mentioned previously, with a 56% U2 population for FY19. AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students who speak English as a second language; first-generation college students; students in rural, frontier, or other federally targeted outreach schools; students who receive free and reduced-price school meals (FARMS) or Pell Grants; and females in certain STEM fields.

Demographic information for students who completed the FY19 evaluation survey are presented in Table 17. Participation of females in the evaluation varied widely among programs (range of 33%-75%). Female participation increased over FY18 levels for six programs (CQL, GEMS, HSAP, JSS, SEAP, Unite), while female participation decreased in two other programs (eCM-NJ&EE, URAP) and stayed approximately the same in eCM overall, JSHS, REAP. The proportion of youth survey respondents identifying themselves as belonging to racial/ethnic minority groups has fluctuated over time and across programs (range of 13%-75%). Students who reported they were eligible for free or reduced-price lunch or were Pell Grant recipients also varied greatly between programs (0%-74%) and differed by year.

Survey evaluation participants also reported on school location (0%-73% rural/urban/frontier), ELL status (0%-21%), and first-generation college status (0%-45%) demographics. These variables were used to calculate underrepresented student classification (U2) by program (12%-94%). Only a few programs had half or more of their evaluation survey participants classified as U2 (eCM, REAP, Unite), while most had less than half (CQL, eCM-NJ&EE, GEMS, HSAP, JSHS, JSS, SEAP, URAP).

Table 17. AEOP Evaluation Survey Participant Demographics														
Program	**Females**		**Racial & Ethnic Minorities**		**Low SES***		**School: Rural/Urban/Frontier**		**ELL**		**College 1st Generation**		**U2**	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
CQL	43%	55%	17%	20%	NA††	32%	NA††	NA††	2%	9%	17%	20%	21%	41%
eCM	51%	48%	42%	35%	36%	43%	43%	51%	13%	4%	9%	14%	28%	53%
eCM-NJ&EE	66%	58%	12%	16%	11%	10%	28%	9%	17%	0%	1%	0%	21%	16%
GEMS	35%	52%	22%	42%	9%	20%	10%	39%	3%	2%	6%	8%	23%	47%
HSAP	41%	61%	35%	39%	3%	21%	32%	73%	14%	17%	3%	17%	43%	44%
JSHS	63%	61%	14%	15%	14%	12%	47%	43%	6%	3%	13%	5%	55%	40%
JSS	26%	37%	33%	13%	12%	44%	27%	38%	2%	2%	7%	18%	48%	33%
REAP	65%	64%	66%	65%	47%	71%	50%	65%	29%	21%	65%	39%	75%	89%
SEAP	51%	75%	12%	13%	11%	0%	23%	0%	3%	13%	0%	0%	29%	12%
Unite	42%	58%	74%	75%	70%	74%	76%	73%	26%	10%	52%	45%	91%	94%
URAP	59%	33%	26%	30%	NA††	NA††	NA††	NA††	3%	20%	18%	10%	24%	22%

*Low Socio-Economic Status (SES) is measured by the number of participants eligible for free or reduced lunch for K-12 students or those who have received the Pell Grant for college students.

† *Data were not provided/collected from the specified program.*

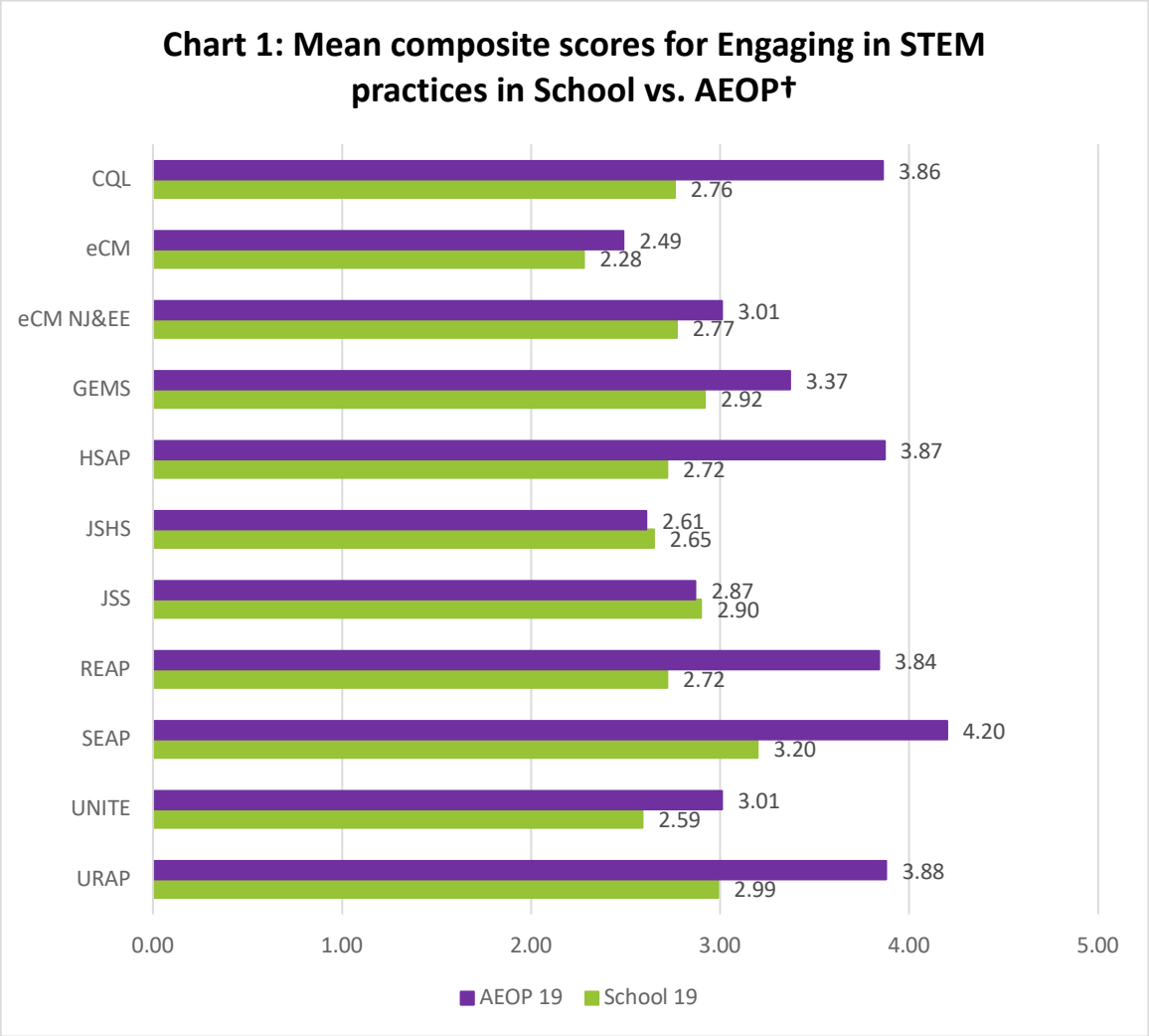
†† *Not applicable – college program.*

Participants were asked about how frequently they engaged in STEM practices during their AEOP experiences compared to experiences in-school. These items were combined into a composite variable shown in Table 18

Table 18. Items that Form the Engaging in STEM Practices in School and Engaging in STEM Practices in AEOP Composites
1. Work with a STEM researcher or company on a real-world STEM research project
2. Work with a STEM researcher on a research project of your own choosing
3. Design my own research or investigation based on my own question(s)
4. Present my STEM research to a panel of judges from industry or the military
5. Interact with STEM researchers
6. Use laboratory procedures and tools
7. Identify questions or problems to investigate
8. Design and carry out an investigation
9. Analyze data or information and draw conclusions
10. Work collaboratively as part of a team
11. Build or make a computer model
12. Solve real world problems

Chart 1 displays FY19 mean composite scores for participant engagement in STEM practices by program. In all programs except JSS and JSHS, student participants reported engaging in STEM practices significantly more frequently in their AEOP programs compared to typical school experiences. Significant differences ranged from medium to extremely large effect sizes.[5] Effect size measurements offer an indication of the magnitude of impact. It is important to note that competition programs (eCM, JSS, and JSHS) may be used as part of students' in-school learning experiences. Thus, students in these programs may not easily distinguish between their AEOP and in-school STEM engagement.

[5][5] Effect sizes: CQL, d = 2.22, extremely large; R-ECM, d = 0.65, medium; N-ECM = 0.66, medium; GEMS, d = 1.01, large; HSAP, d = 3.02, extremely large; REAP, d = 2.11, extremely large; SEAP, d = 2.57, extremely large; Unite, d = 0.46, medium; and URAP, d = 2.05, extremely large



† *Response options for the items forming this composite were: 1 – Not at all, 2 – At least once, 3 – Monthly, 4 – Weekly, 5 – Every day.*

Findings from the 2019 evaluation indicated that AEOPs consistently provided opportunities for participants to engage in authentic STEM activities that are more intensive than those they experience in their typical school settings. This was also reflected in participants' responses to open-ended questionnaire responses and in comments made in focus groups and interviews. Participants' comments included the following:

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

> *"Solving real-world problems using STEM and working as a team are obvious benefits [of eCM] but our students learn so much more in a comprehensive program like this. They not only learn science, they learn many types of technology skills, interpersonal skills, skills for interviews and phone calls, work etiquette with professionals and much more."* (eCM Team Advisor)

"I learned more about STEM than I usually do in school and this program has helped me think more seriously about pursuing a STEM-related career." (GEMS Student)

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

"[Our learning in school is] only in the classroom and the teacher sets up the labs and we do the lab…Being able to do [JSHS], we actually got to come up with the question and figure out how to do it ourselves." (N-JSHS Student)

"Doing [JSS] gave me the chance to get out of my comfort zone and do different things and expand my knowledge." (JSS National Student)

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

"It's invaluable to be allowed into a professional workspace where I am mentored and shown skills I didn't have before. Engineering was a whole new thing for me." (RESET Level II Participant)

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

"Unite taught me different STEM careers as well as allowing me to solve real world problems and perform hands on activities. Additionally, it was very enjoyable and it taught me practical skills that everyone should know, but aren't taught in school." (Unite Student)

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

Research Question #2a - To what extent do participants report increased STEM competencies STEM skills, STEM knowledge, abilities, and confidence?

Participants reported that their AEOP experiences improved their STEM-specific and 21st Century STEM skills competencies. They also reported gains in their abilities to use the science and engineering practices described in the Next Generation Science Standards (NGSS), and reported gains in their STEM confidence and identity.

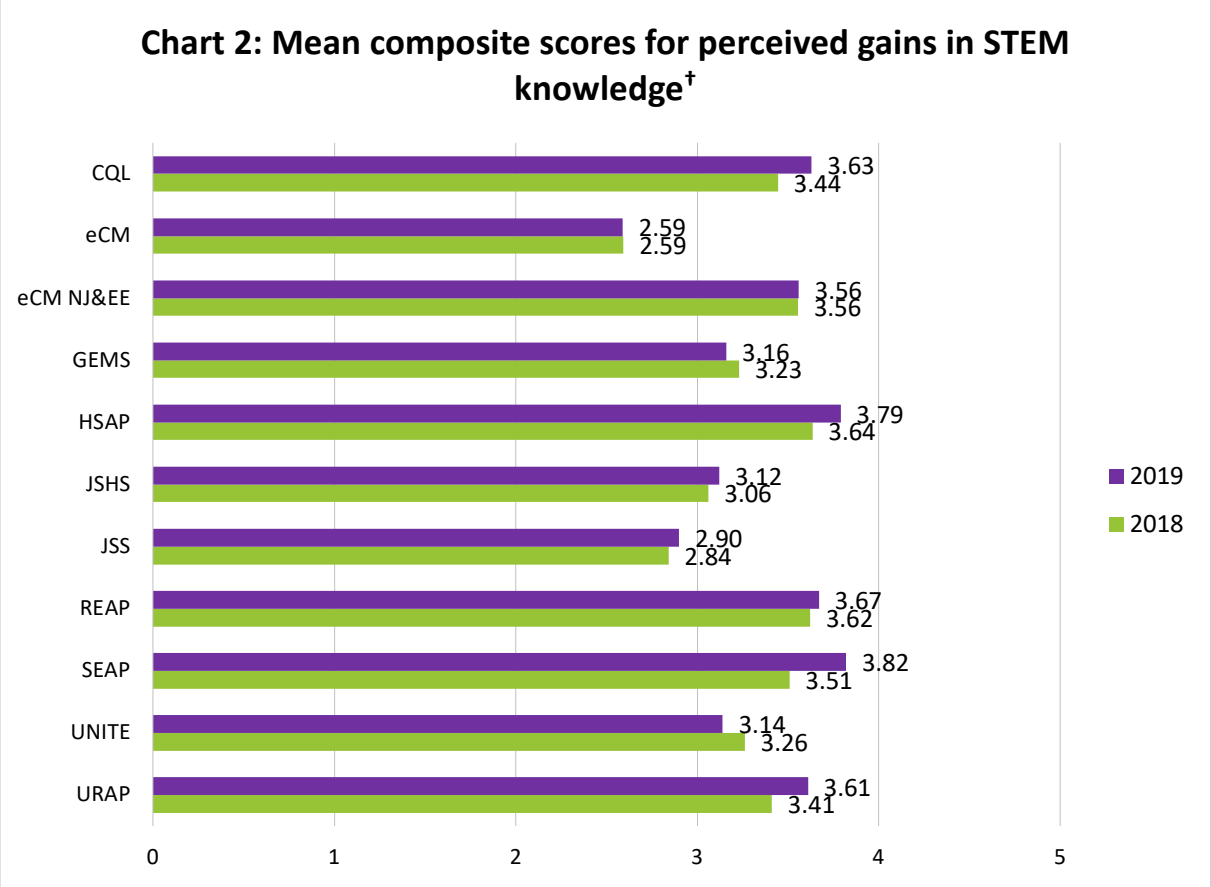
AEOP aims to develop participants' STEM knowledge, skills, and abilities, their 21st Century skills and their abilities to appropriately apply these skills. Because deepening students' and apprentices' STEM knowledge and skills are key factors in increasing the likelihood that they will pursue STEM further in their education and/or careers, the FY19 evaluation examined students' and apprentices' perceptions of gains

in their STEM-specific and 21st Century skills as a result of participating in AEOPs, as well as the impacts of participation on their confidence in STEM and on their STEM identities.[6]

Four or five evaluation survey items were used to assess participants' gains in STEM knowledge (Table 19) on a 4-point rating scale ranging from "no gain" to "large gain". Chart 2 shows participants from all programs reported gains in their STEM knowledge after participating in AEOPs. All programs averaged between "some" and "large" gains, with the exceptions of eCM and JSS which averaged slightly lower ranges ("a little" to "some" gains).

Table 19. Items that form the Perceived Gains in STEM Knowledge Composite
1. Knowledge of how scientists and engineers work on real problems in STEM
2. In depth knowledge of a STEM topic(s)
3. Knowledge of research conducted on a STEM topic or field
4. Knowledge of research processes, ethics, and rules for conduct in STEM†
5. Knowledge of what everyday research work is like in STEM

† *This item was not included on the GEMS version of the survey.*



† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

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

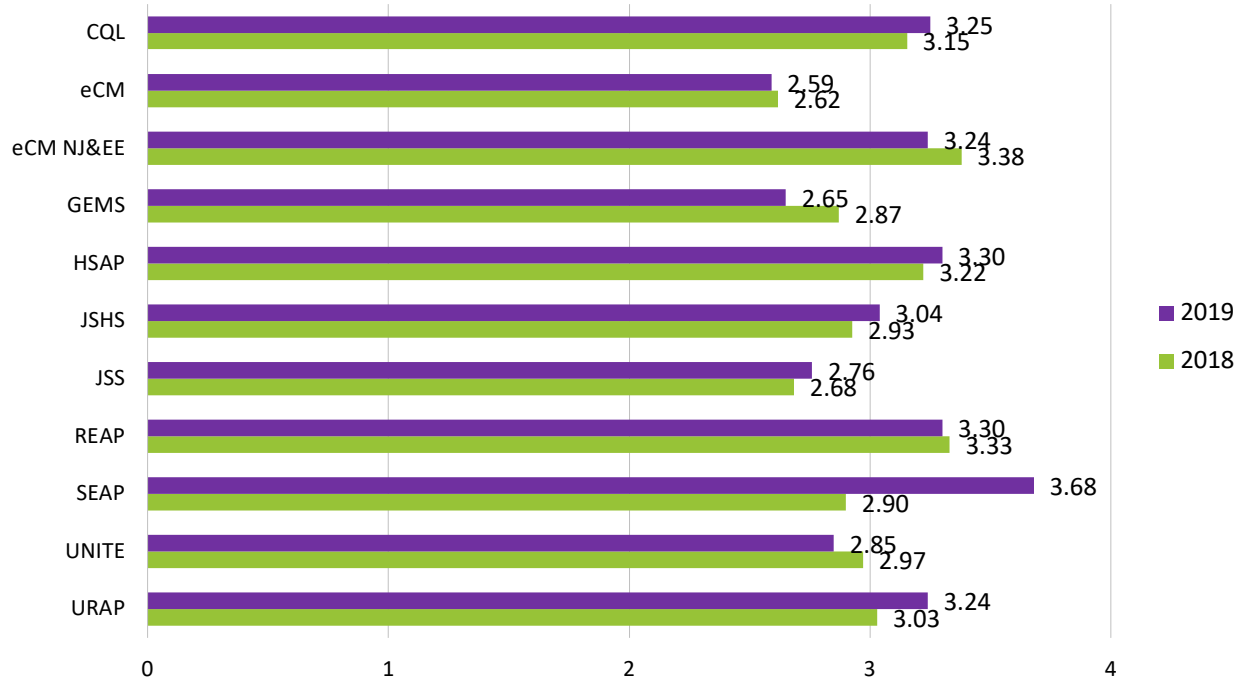
In addition to increasing students' knowledge in STEM, a goal of AEOP is to also provide student participants with opportunities to apply and improve their STEM skills. The FY19 evaluation therefore investigated the impact of AEOPs on participants' abilities to demonstrate STEM competencies described in the Next Generation Science Standards (NGSS)[7]. Table 20 lists evaluation survey items used to assess STEM competency gains. A comparison of findings from 2018 and 2019 are presented in Chart 3. AEOP participants across all programs reported gains in their STEM competencies. Chart 3 shows FY19 gains were slightly greater than those in FY18 for approximately half of the programs (CQL, HSAP, JSHS, JSS, SEAP, URAP).

Table 20. Items that form the Perceived Gains in STEM Competencies Composite
1. Defining a problem that can be solved by developing a new or improved product or process
2. Creating a hypothesis or explanation that can be tested in an experiment/problem†
3. Using my knowledge and creativity to suggest a solution to a problem
4. Making a model to show how something works
5. Designing procedures or steps for an experiment or designing a solution that works†
6. Identifying the limitations of the methods and tools used for collecting data†
7. Carrying out an experiment and recording data accurately
8. Creating charts or graphs to display data and find patterns
9. Considering multiple interpretations of data to decide if something works as intended
10. Supporting an explanation with STEM knowledge†
11. Identifying the strengths and limitations of data or arguments presented in technical or STEM texts
12. Presenting an argument that uses data and/or findings from an experiment or investigation
13. Defending an argument based upon findings from an experiment or other data
14. Integrating information from technical or STEM texts and other media to support your explanation of an experiment or solution to problem

† *These items were not included on the Unite version of the survey.*

[7] http://www.nextgenscience.org/sites/default/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf

Chart 3: Mean composite scores for perceived gains in STEM Practice Competencies†



† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

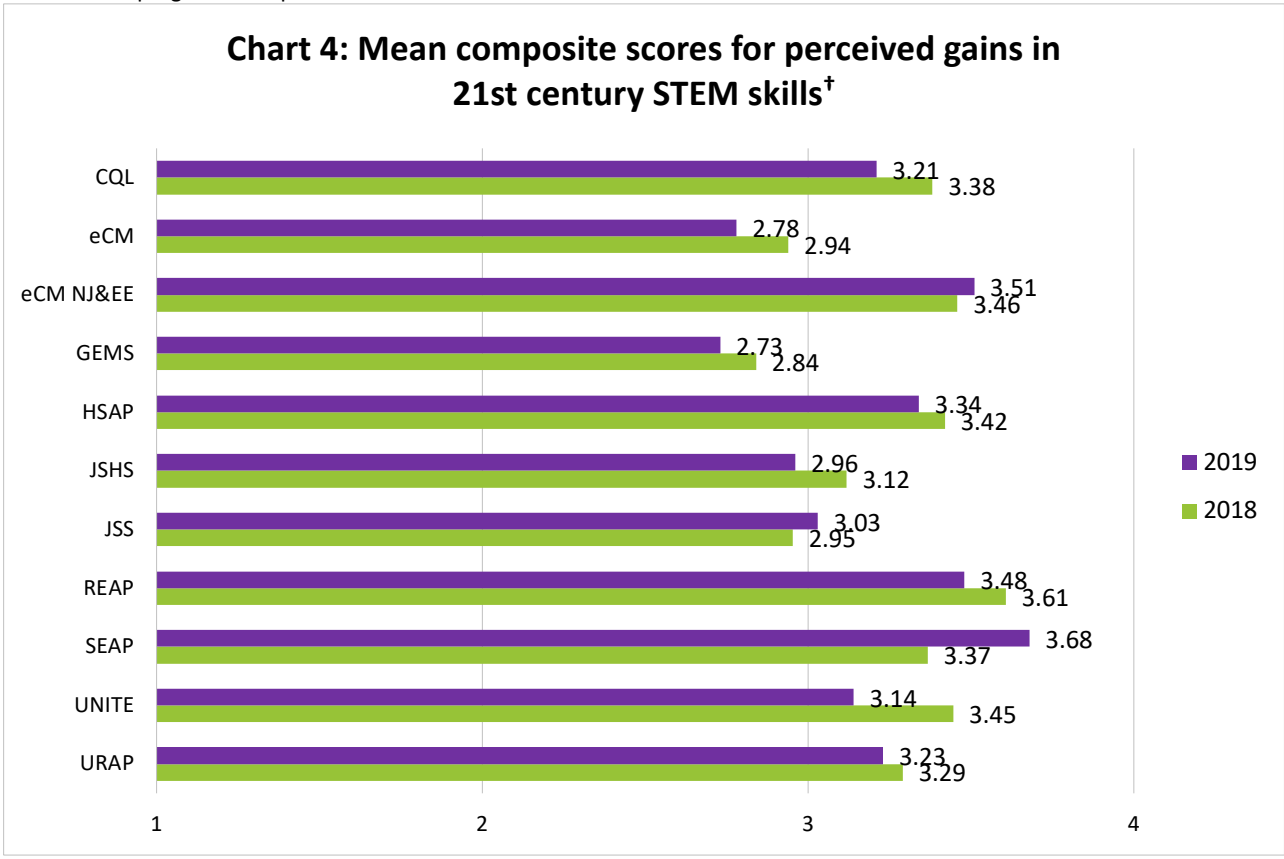
21st Century skills are skills such as collaboration, communication, perseverance, and problem solving that are necessary across a wide variety of fields. AEOP participants were asked about the impact of participating in their program on a variety of 21st Century skills (Table 21a & Table 21b). While Chart 4 findings show that participants in each program reported 21st Century skills gains, most programs reported slightly less gains in FY19 compared to FY18 except for eCM NJ&EE and SEAP which reported slightly greater gains.

Table 21a. Items that form the Perceived Gains in 21st Century STEM Skills Composite*
1. Sticking with a task until it is finished
2. Making changes when things do not go as planned
3. Working well with students from all backgrounds
4. Including others' perspectives when making decisions
5. Communicating effectively with others
6. Viewing failure as an opportunity to learn

*eCM NJ&EE items

Table 21b. Items that form the Perceived Gains in 21st Century STEM Skills Composite*
1. Thinking creatively
2. Working creatively with others
3. Using my creative ideas to make a product
4. Thinking about how systems work and how parts interact with each other
5. Evaluating others' evidence, arguments, and beliefs
6. Solving problems
7. Communicating clearly (written and oral) with others
8. Collaborating with others effectively and respectfully in diverse teams
9. Interacting effectively with others in a respectful and professional manner
10. Accessing and evaluating information efficiently (time) and critically (evaluates sources)
11. Using and managing data accurately, creatively and ethically
12. Analyzing media (news) - understanding points of view in the media
13. Creating media products like videos, blogs, social media
14. Use technology as a tool to research, organize, evaluate, and communicate information
15. Adapting to change when things do not go as planned
16. Incorporating feedback on my work effectively
17. Setting goals and utilizing time wisely
18. Working independently and completing tasks on time
19. Taking initiative and doing work without being told to
20. Prioritizing, planning, and managing projects to achieve completion
21. Producing results - sticking with a task until it is finished
22. Leading and guiding others in a team or group
23. Being responsible to others - thinking about the larger community

*Items for all programs except eCM NJ&EE

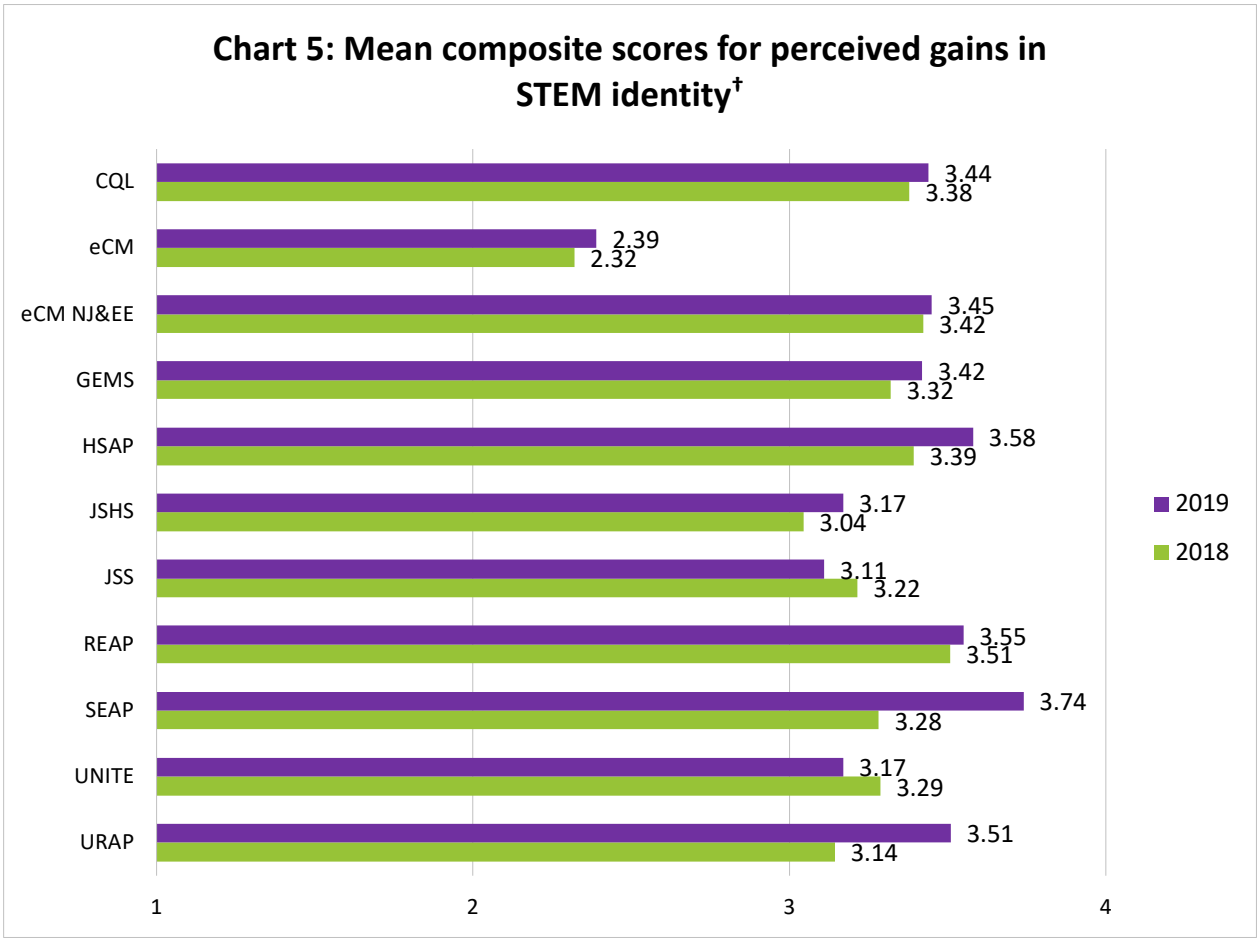


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

STEM identity is a construct similar to self-confidence or self-efficacy that is associated with interest in STEM fields and careers. Participants were asked to report gains in STEM identity as a result of their AEOP participation. Evaluation survey items are presented in Table 22. Participants across AEOPs reported some level of gains in their STEM identities, and these gains were greater in the FY19 evaluation compared to FY18 for all programs except for JSS and Unite.

Table 22. Items that form the Perceived Gains in STEM Identity Composite
1. Interest in a new STEM topic
2. Deciding on a path to pursue a STEM career
3. Sense of accomplishing something in STEM
4. Feeling prepared for more challenging STEM activities
5. Confidence to try out new ideas or procedures on my own in a STEM project*
6. Desire to build relationships with mentors who work in STEM*
7. Connecting a STEM topic or field to my personal values†
8. Thinking creatively about a STEM project or activity†

† *Not included on the Unite, JSHS, CQL, HSAP, URAP, REAP, SEAP versions of the survey*
* *Not included on the GEMS, JSS, or eCM versions of the survey*



† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

AEOP participants were asked to rate their agreement level with items describing program impacts related to their STEM confidence and interest in STEM (Table 23). Approximately half or more of participants (range 48%-100%) agreed their AEOP experience contributed to their increased confidence and/or interest in each item. As seen in past years, students were most likely to agree strongly that AEOP impacted their confidence in their STEM knowledge, skills, and abilities (range 62%-100%).

Table 23. Students Agreeing that the Program Contributed to their STEM Confidence and Interest

	Year	CQL	eCM	eCM NJ&E	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
I am more confident in my STEM knowledge, skills, and abilities.	2018	91%	65%	96%	82%	100 %	89%	79%	95%	97%	90%	94%
	2019	***96%***	***62%***	***97%***	***90%***	***100 %***	***83%***	***89%***	***97%***	***100 %***	***92%***	***97%***
I am more interested in participating in STEM activities outside of school requirements.	2018	81%	47%	90%	80%	90%	82%	76%	87%	86%	87%	71%
	2019	***75%***	***49%***	***88%***	***82%***	***89%***	***74%***	***83%***	***81%***	***91%***	***86%***	***87%***
I am more interested in taking STEM classes in school.	2018	64%	48%	76%	78%	74%	44%	73%	70%	71%	82%	50%
	2019	***64%***	***48%***	***85%***	***76%***	***67%***	***62%***	***73%***	***68%***	***91%***	***83%***	***81%***

In response to the 2019 evaluation, students and apprentices in all programs reported that they had improved their STEM-specific skills and competencies and their 21st Century skills as a result of their AEOP participation. Participants reported gains in the science and engineering practices described in the NGSS and also reported gains in their STEM identities and confidence in their STEM abilities. These gains were apparent both from participants' questionnaire responses and from comments made by youth and adult participants during interviews and focus groups. For example, participants said the following:

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

"I was very happy with my experience in eCYBERMISSION. I think this competition is a great experience for all new researchers to 'dip their toes in the water' of the vast pool that is the world of STEM. As this was my first research competition, I can definitely say that I have a newfound interest in widening my horizons and continuing to explore STEM." (eCM-R Student)

"I really had a fun time at GEMS. and had a good time conducting experiments with friends. I liked learning more about the world's problems today and how we can solve them with science." (GEMS Student)

"I thoroughly enjoyed this experience. I knew I wanted to go in to scientific research before this but I wasn't sure. Now I'm positive that I want to go into research." (HSAP Apprentice)

"I enjoyed my experience at JSHS because I was able to learn from other young STEM researchers and had experience presenting my project under a limited timeframe and answering questions. JSHS also motivated me in writing an abstract and paper for my project, and I appreciate that with the paper being before the talk, JSHS models the research procedure that we would encounter later on in STEM careers." (R-JSHS Student)

"I greatly appreciate JSHS as an educator. It provides an important venue for students to think and interact like professional scientists." (JSHS Mentor)

"I loved participating JSS. It helped me with my problem-solving skills and helped me become more confident. This program also helped me learn a lot about STEM. All in all, I am really satisfied with my JSS experience." (JSS Student)

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

"I had a lot of misunderstandings about what research is. The way that I experienced research is somebody sets up a news story and tries to get me to adjust my lifestyle in an uncomfortable way...In fact, research is a necessary activity if you want the culture to thrive in the world." (RESET Level I Participant)

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

"Overall the Unite program has been amazing. The projects that we did were interesting and mostly hands on. The panel nearing the end of the program was extremely beneficial and the GPS and math class helped my writing and core math skills." (Unite Student)

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

Research Question #2b – To what extent do participants demonstrate use of and growth in 21st Century skills?

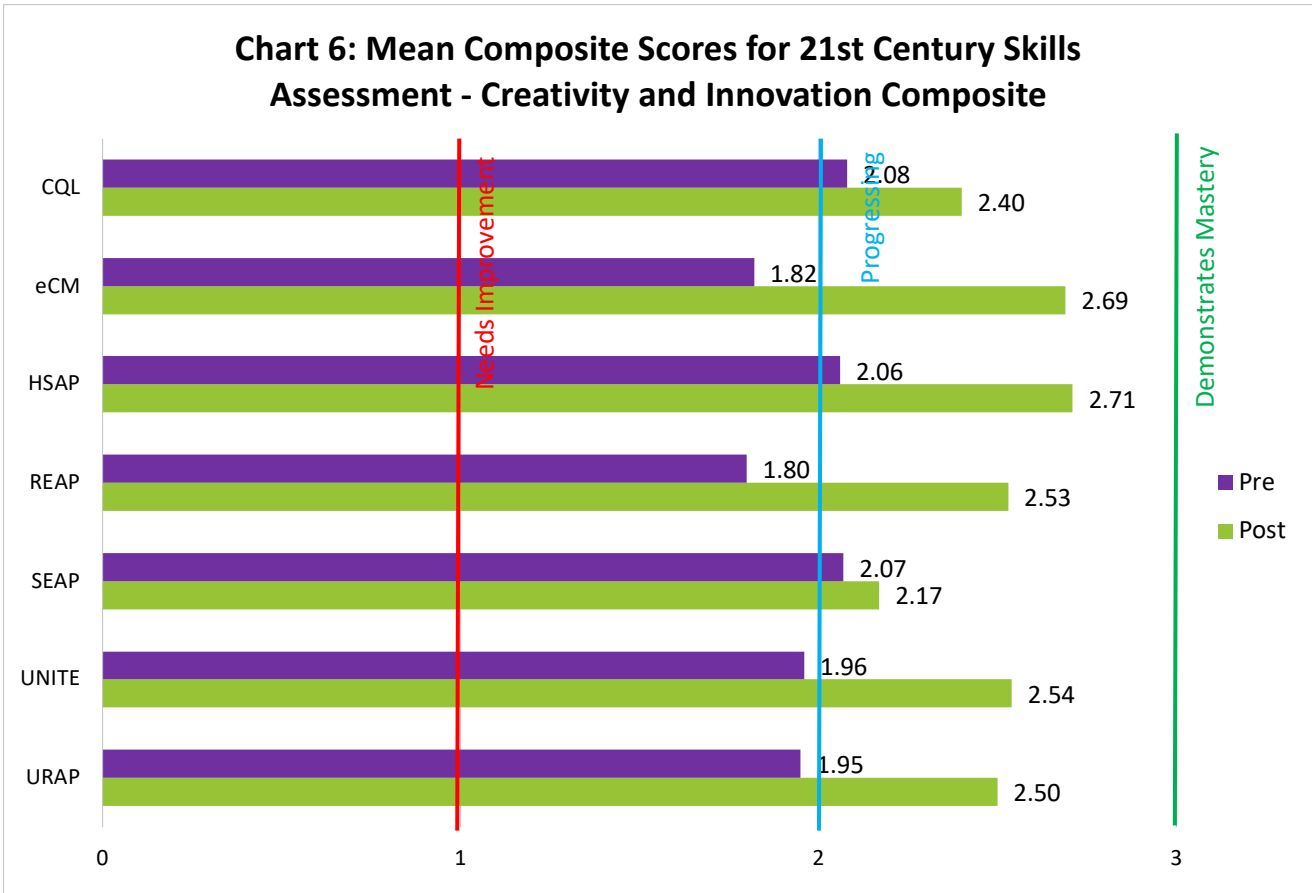
AEOP Apprentices and Unite participants demonstrated growth toward mastery of the 21st Century skills as assessed by their mentors/teachers.

A 21st Century Skills Assessment (Johnson & Sondergeld, 2016) evaluation was completed for a small sample of eCM mini-grant awardees and participants in Unite and in apprenticeship programs. Mentors assessed each participant in a pre/post manner. The first assessment was completed in the first days of the program (pre), and the second assessment was completed at the end of the program (post). The assessment was used to determine the growth toward mastery for each participant during their time in the eCM program. Mentors rated each participant's skills in six domains of 21st Century Skills:

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

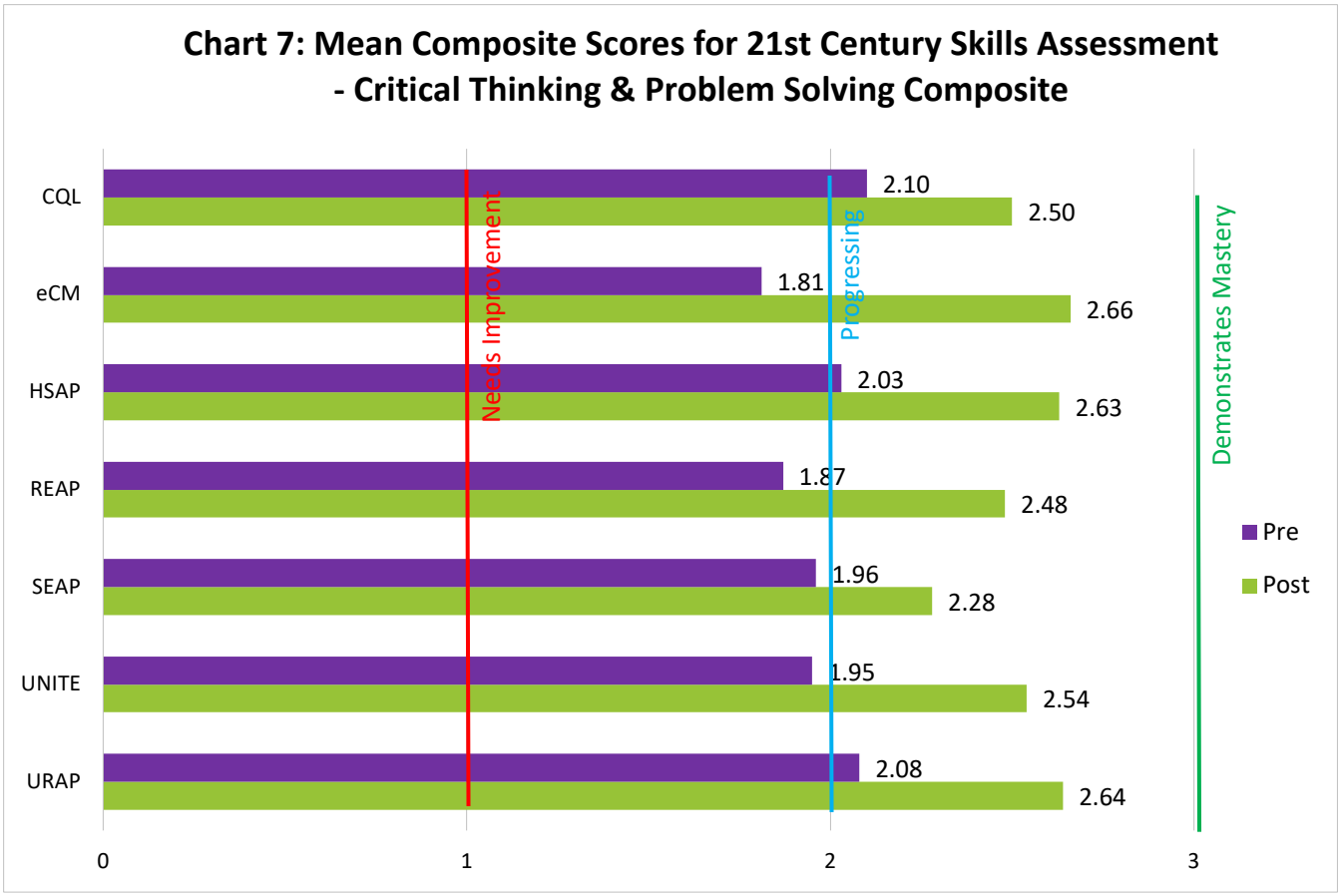
Creativity & Innovation. Table 24 shows all items rated in this skill set. Statistically significant growth in creativity and innovation skills was observed across AEOPs (range +0.48 to +0.87) except for SEAP (+0.13). Chart 6 graphically depicts how participants, on average, began their program rated near the Progressing level and grew to an approaching Demonstrates Mastery level. While all AEOPs showed a significant increase in this area, eCM (+0.87) participants demonstrated the greatest improvement.

Table 24. Items that form the 21st Century Skills Assessment Subscale Composite of Creativity and Innovation
1. Think creatively
2. Work creatively with others
3. Implement innovations



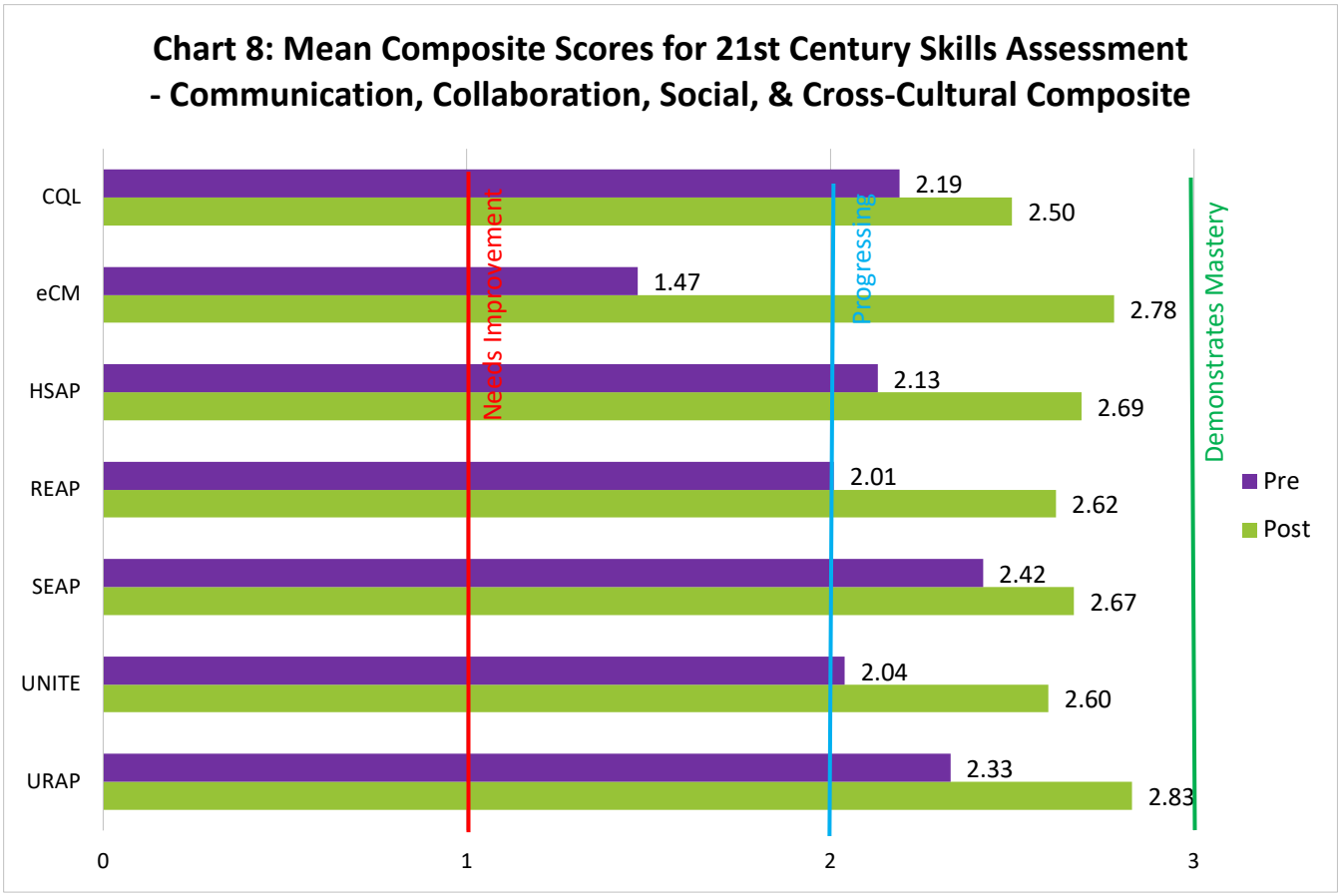
Critical Thinking & Problem Solving. Table 25 lists items rated in this skill set. Significant growth in participant critical thinking and problem solving skills were observed by mentors for all programs (range +0.45 to +0.86) except SEAP (+0.31). On average, participants began their program rated at approaching Progressing or slightly above this level, and by post-observation had grown to an average level between Progressing and Demonstrates Mastery (see Chart 7). eCM students (+0.86) had the greatest increases in this domain.

Table 25. Items that form the 21st Century Skills Assessment Subscale Composite of Critical Thinking & Problem Solving
1. Reason effectively
2. Use systems thinking
3. Make judgments and decisions
4. Solve problems



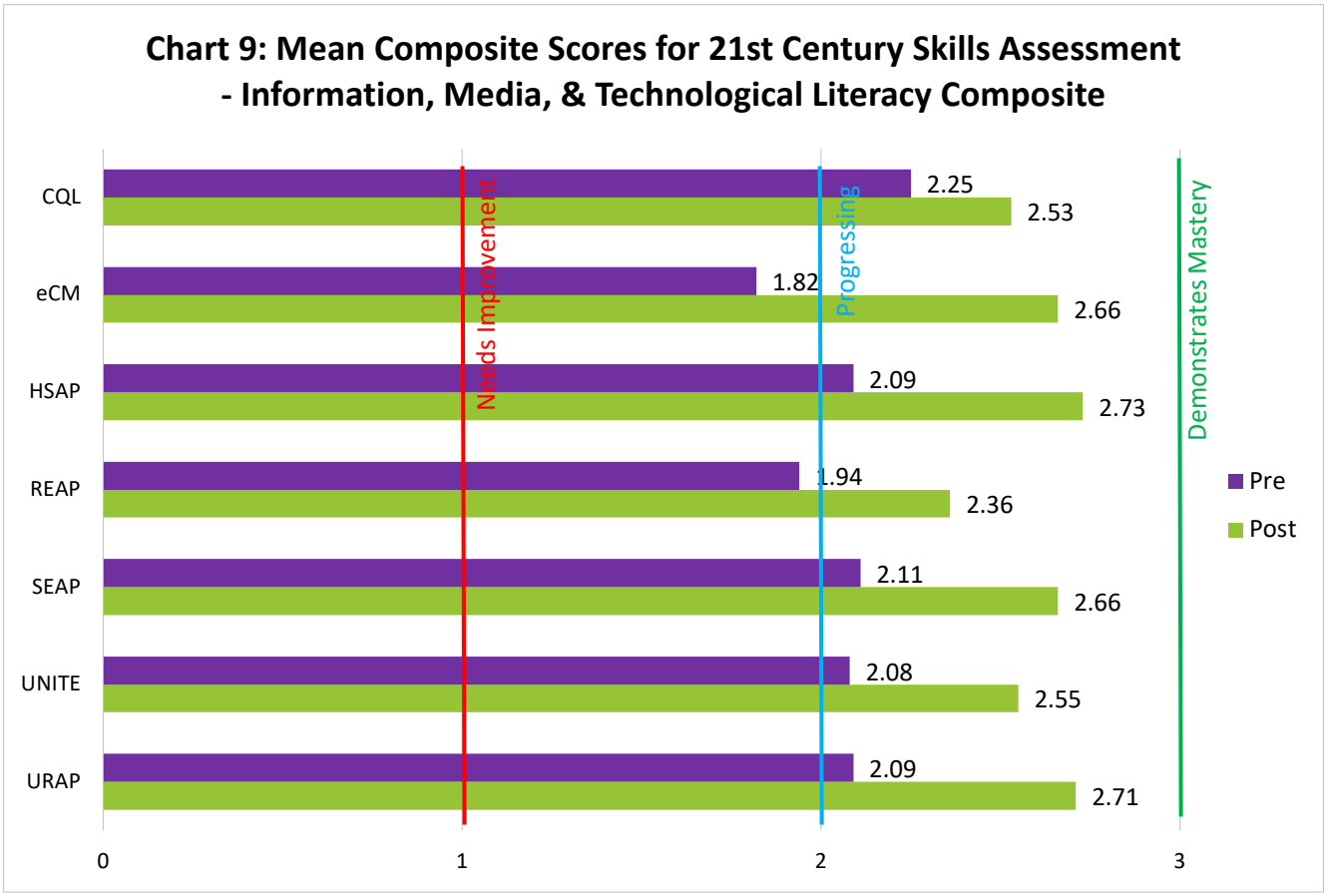
Communication, Collaboration, Social & Cross-Cultural. Table 26 provides items rated in this skill set. With the exception of SEAP (+0.25), students in all programs demonstrated statistically significant growth in communication, collaboration, social, and cross-cultural skills (range +0.34 to +1.31). Except for eCM, participants were rated relatively high on these skills at pre-observation averaging above the Progressing level benchmark of 2.0. By post-observation, participants from all programs had grown to an approaching Demonstrates Mastery level (see Chart 8). Again, eCM students had the greatest growth in this area of 21st Century skills (+1.31).

Table 26. Items that form the 21st Century Skills Assessment Subscale Composite of Communication, Collaboration, Social, & Cross-Cultural
1. Communicate clearly
2. Communicate with others
3. Interact effectively with others



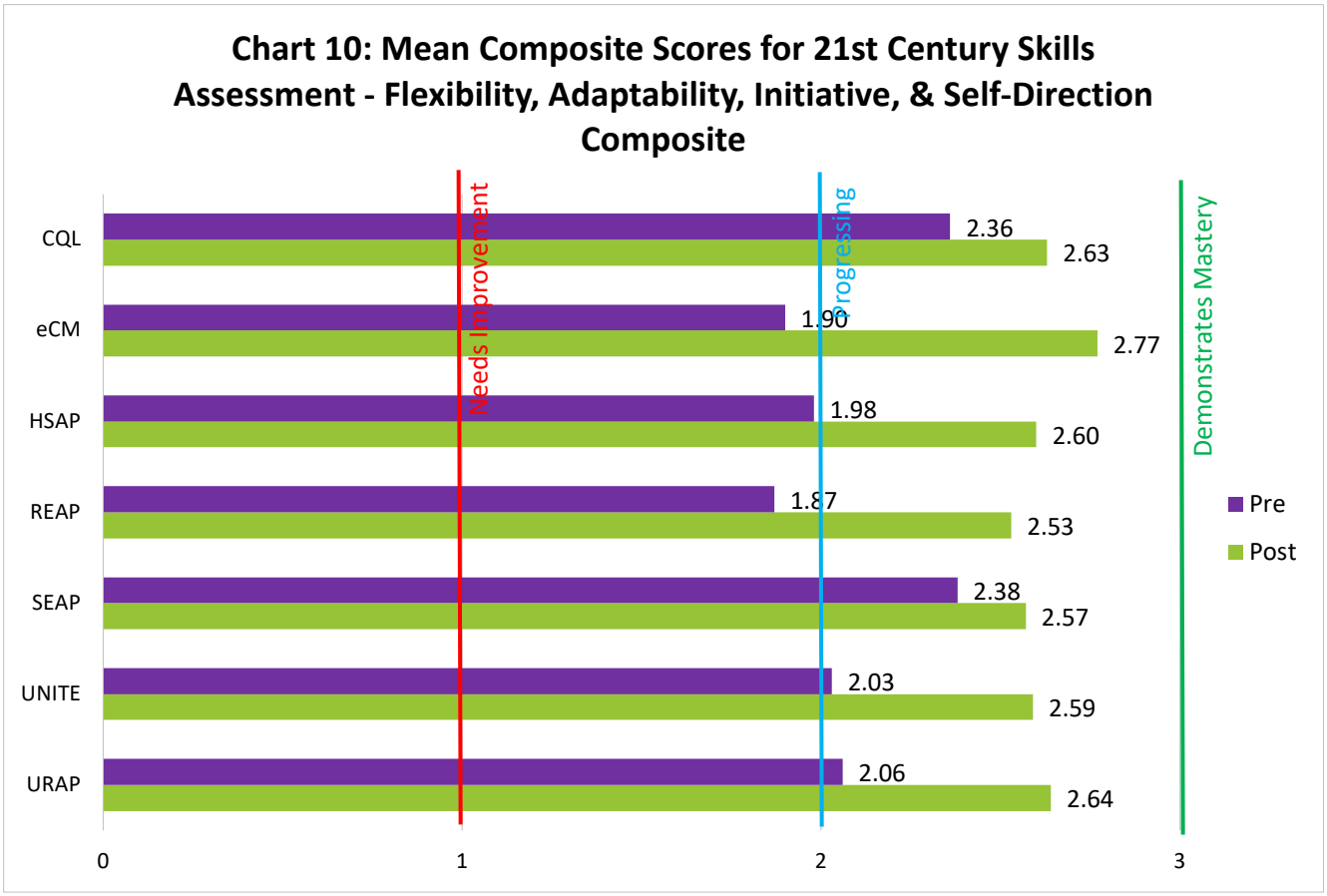
Information, Media, & Technological Literacy. Table 27 shows items rated in this skill set. Participants across all AEOPs averaged significantly positive growth (range +0.50 to +0.84) in their information, media, and technological literacy skills except for CQL (+0.33) (see Chart 9). eCM students (+0.84) demonstrated showed the largest growth in this domain.

Table 27. Items that form the 21st Century Skills Assessment Subscale Composite of Information, Media, & Technological Literacy
1. Access and evaluate information
2. Use and manage information
3. Analyze media
4. Create media products
5. Apply technology effectively



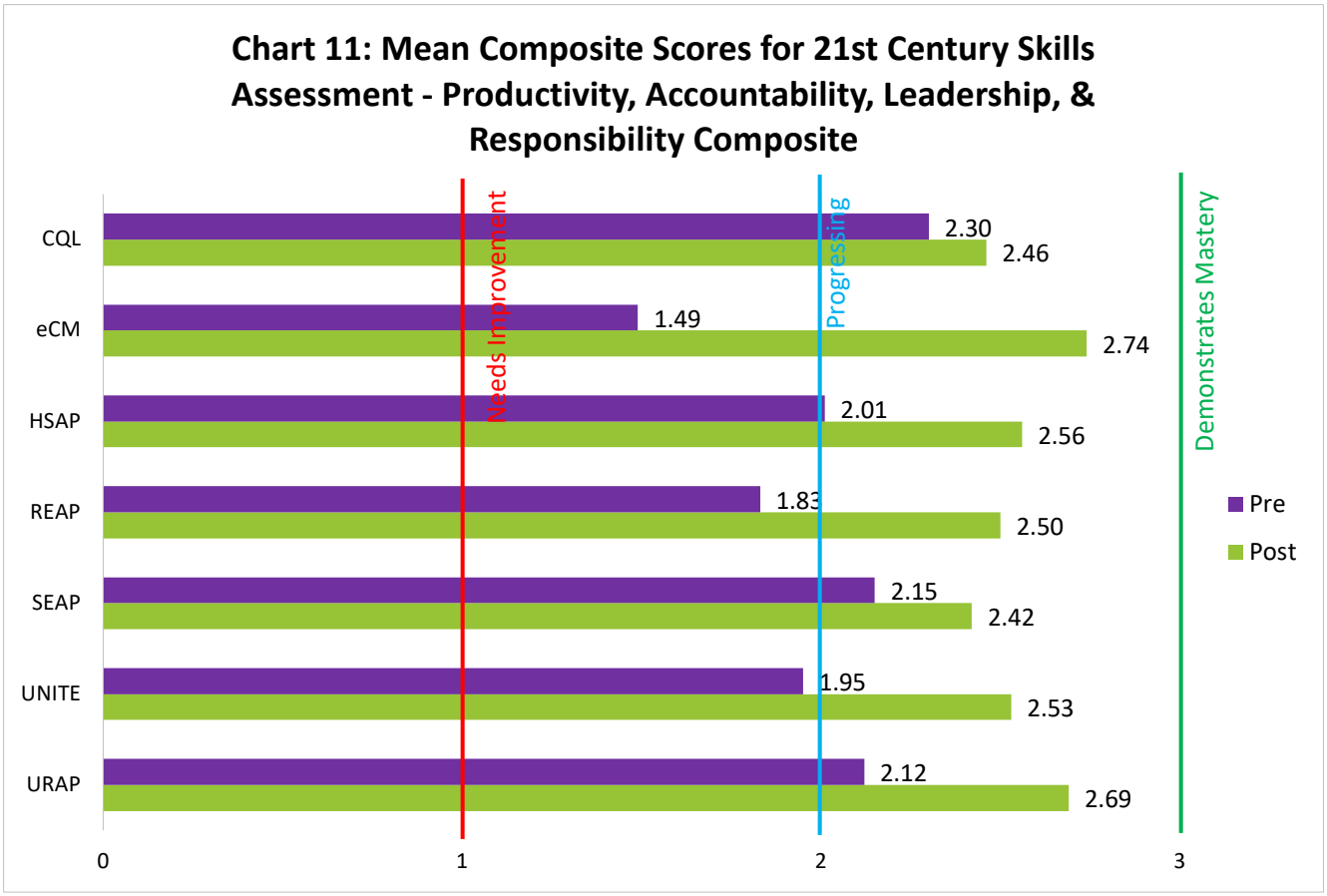
Flexibility, Adaptability, Initiative, & Self-Direction. Table 28 provides items rated in this skill set. Growth in flexibility, adaptability, initiative, and self-direction was found in all AEOPs from pre- to post-assessment, and this growth was statistically significant for all programs (range +0.43 to +0.87) except CQL (+0.30) (see Chart 10). Keeping in mind that CQL is a college-level program, students were observed at pre-assessment with somewhat higher averages than others making it more challenging to show significant improvement. eCM students demonstrated the greatest increase in this area (+0.87).

Table 28. Items that form the 21st Century Skills Assessment Subscale Composite of Flexibility, Adaptability, Initiative, & Self-Direction
1. Adapt to change
2. Be flexible
3. Manage goals and time
4. Work independently
5. Be a self-directed learner



Productivity, Accountability, Leadership, & Responsibility. Table 29 presents items rated in this skill set and Chart 11 graphically depicts findings. Significant growth in productivity, accountability, leadership, and responsibility skills was found from pre- to post-observation for all programs (range +0.50 to +1.25) except for CQL (+0.24) and SEAP (+0.35), programs for which baseline assessments were slightly higher than other programs. As has been shown in all other 21st Century skills domains, eCM students (+1.25) demonstrated the greatest levels of growth in this area.

Table 29. Items that form the 21st Century Skills Assessment Subscale Composite of Productivity, Accountability, Leadership, & Responsibility
1. Manage projects
2. Produce results
3. Guide and lead others
4. Be responsible to others



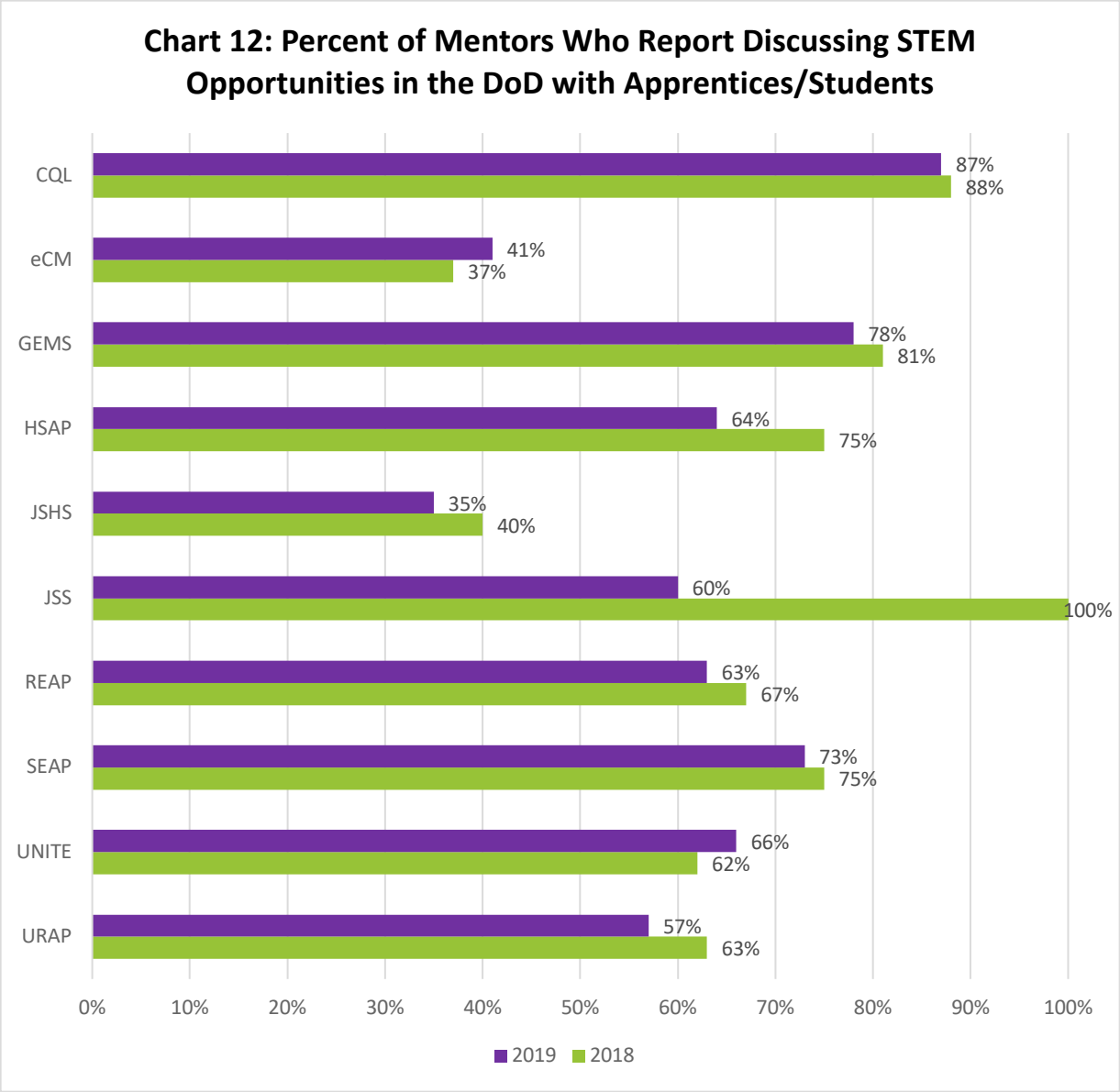
Research Question #4 - To what extent do participants and mentors report increased awareness of and interest in Army/DoD STEM research and careers?

The AEOP's efforts to engage students in and/or expose them to DoD research continues to be a challenge met with mixed results. While students reported positive attitudes toward DoD STEM research and researchers, findings related to mentors discussing DoD STEM research and STEM opportunities in the DoD with apprentices and students varied widely across programs. In FY19 the AEOP continued to highlight DoD STEM research through program activities that engage participants in or provide meaningful exposure to DoD research. Table 30 summarizes some of these efforts.

Table 30. 2019 Participant Engagement in and Exposure to DoD Research	
AEOP	**Engagement in DoD Research**
CQL, SEAP	**312** high school and undergraduate participants (**108 for SEAP, 204 for CQL**) serving as apprentices on DoD research projects at Army or DoD laboratories and centers.
HSAP, URAP	**83** (**29 for HSAP, 54 for URAP**) high school and undergraduate participants serving as apprentices on Army research projects at college/university research laboratories.
GEMS	**2,985** elementary, middle and high school participants, **128** NPMs and **33** K-12 teachers serving as Resource Teachers were engaged in DoD research through GEMS activities hosted by Army laboratories and centers.
AEOP	**Exposure to DoD Research**
eCM	**75** participants and their team advisors (in-service teachers) were exposed to DoD research through the National Judging & Educational Event activities. At least **367** students participated in Cyberguides live chats.
JSHS	**229** participants and their teachers were exposed to DoD research through the National Symposium activities. National JSHS programming included DoD S&Es, who served as national judges, speakers and presenters who highlighted DoD research. **2,651** students were exposed to DoD research through DoD S&Es who engage at regional JSHS symposia.
Unite	**440** high school participants and **366** program mentors participated in experiences including field trips and speakers about the work of DoD STEM personnel and/or DoD research facilities.
JSS	**2,224** participants in regional competitions and **288** participants in the national competition were exposed to DoD research through JSS activities.

Although AEOPs vary in their focus and objectives, all programs share a goal of exposing participants to Army/DoD research and careers. Apprenticeship programs, including CQL, HSAP, REAP, SEAP, and URAP, actively engage participants in DoD research projects by providing apprentices opportunities to work alongside Army and university S&Es make meaningful contributions to research. STEM enrichment activities provide students with hands-on, interactive experiences that are relevant to nearby Army labs and centers. In GEMS, for example, DoD S&Es, or NPMs under the mentorship of S&Es, translate DoD research into grade-level appropriate educational activities, allowing GEMS participants to engage in real-world research through the questions and problems addressed by DoD researchers and their research. A number of AEOP programs also incorporate DoD STEM-expos, laboratory tours, expert panels, and professional development activities linking school curricular topics in efforts to expose participants to the DoD STEM research and careers.

A responsibility of AEOP mentors is to provide students and apprentices with information about the DoD and STEM research within the DoD. Chart 12 shows that there continues to be great variability in evaluation results related to this responsibility from FY18 and FY19. While less than half of eCM mentors (41%) and JSHS mentors (35%) discussed DoD STEM opportunities with students, more than half of mentors in all other programs (range 57%-87%) did have these conversations with students. Mentors in only two programs (eCM and Unite) discussed these opportunities at slightly greater rates than in FY18.



AEOP student participants rated their level of agreement with several positive statements about DoD research and researchers. Results show that participants' attitudes toward these items have remained consistently positive over FY18 and FY19 (see Table 31). With the exception of eCM on two items, more than half of participants in all programs agreed that Army/DoD research and researchers advance science and engineering fields (range 46%-100%); develop new cutting-edge technologies (range 47%-97%); that DoD researchers solve real-world problems (range 52%-100%); and that DoD research is valuable to society (range 52%-100%).

The strongest rates of agreement with these statements (averaging 90% or higher) has consistently been from apprentices at programs hosted at DoD laboratories and centers (CQL and SEAP) and DoD-sponsored college/university laboratories (HSAP and URAP). Participants at programs hosted by non-DoD affiliated college/university laboratories and settings (REAP and Unite) had positive, but somewhat lower, rates of agreement. Competition programs (eCM and JSS) had the lowest rates of agreement averaging two-thirds or below (range 46%-67%). Interestingly, JSHS and eCM NJ&EE averaged over three-quarters (range 77%-99%) agreement across items. Overall, these findings suggest that experiences at DoD laboratories and centers and DoD-sponsored college/university laboratories generated greater understandings of and positive attitudes toward DoD research than those hosted in non-DoD affiliated university laboratories and other settings. While the nature of programs precludes all students from being physically present at DoD labs and centers or DoD-sponsored college/university labs, strategies and experiences utilized by these DoD laboratory-affiliated programs should be examined and, where possible, scaled up and used with other AEOP initiatives to strengthen participant knowledge of DoD STEM research.

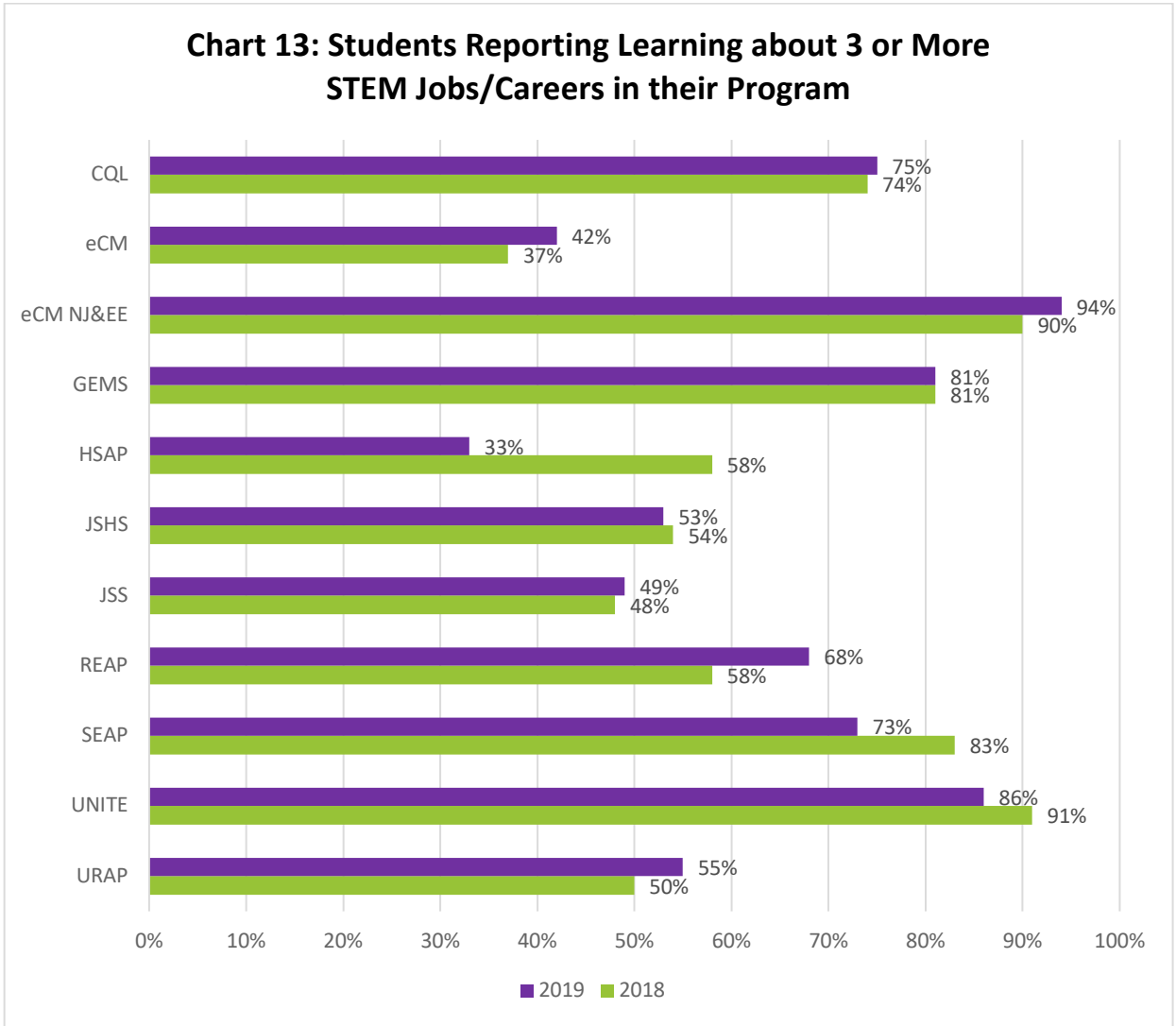
Table 31. AEOP Participants Agreeing with Various Statements about DoD STEM Research

	Year	CQL	eCM	eCM NJ&EE	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
DoD researchers advance science and engineering fields	2018	97%	48%	90%	76%	90%	73%	65%	87%	97%	75%	91%
	2019	***100%***	***46%***	***99%***	***83%***	***95%***	***79%***	***65%***	***84%***	***91%***	***74%***	***94%***
DoD researchers develop new, cutting edge technologies	2018	93%	52%	92%	87%	90%	72%	64%	88%	89%	75%	88%
	2019	***94%***	***47%***	***97%***	***83%***	***95%***	***80%***	***67%***	***87%***	***91%***	***75%***	***97%***
DoD researchers solve real-world problems	2018	97%	56%	93%	87%	95%	74%	67%	87%	97%	78%	91%
	2019	***98%***	***52%***	***97%***	***86%***	***95%***	***81%***	***64%***	***94%***	***100%***	***78%***	***97%***
DoD research is valuable to society	2018	95%	56%	93%	79%	90%	73%	65%	83%	94%	78%	91%
	2019	***98%***	***52%***	***97%***	***84%***	***95%***	***77%***	***46%***	***87%***	***100%***	***77%***	***94%***

Research Question #3 - To what extent do participants and mentors report increased participant interest in STEM research and careers?

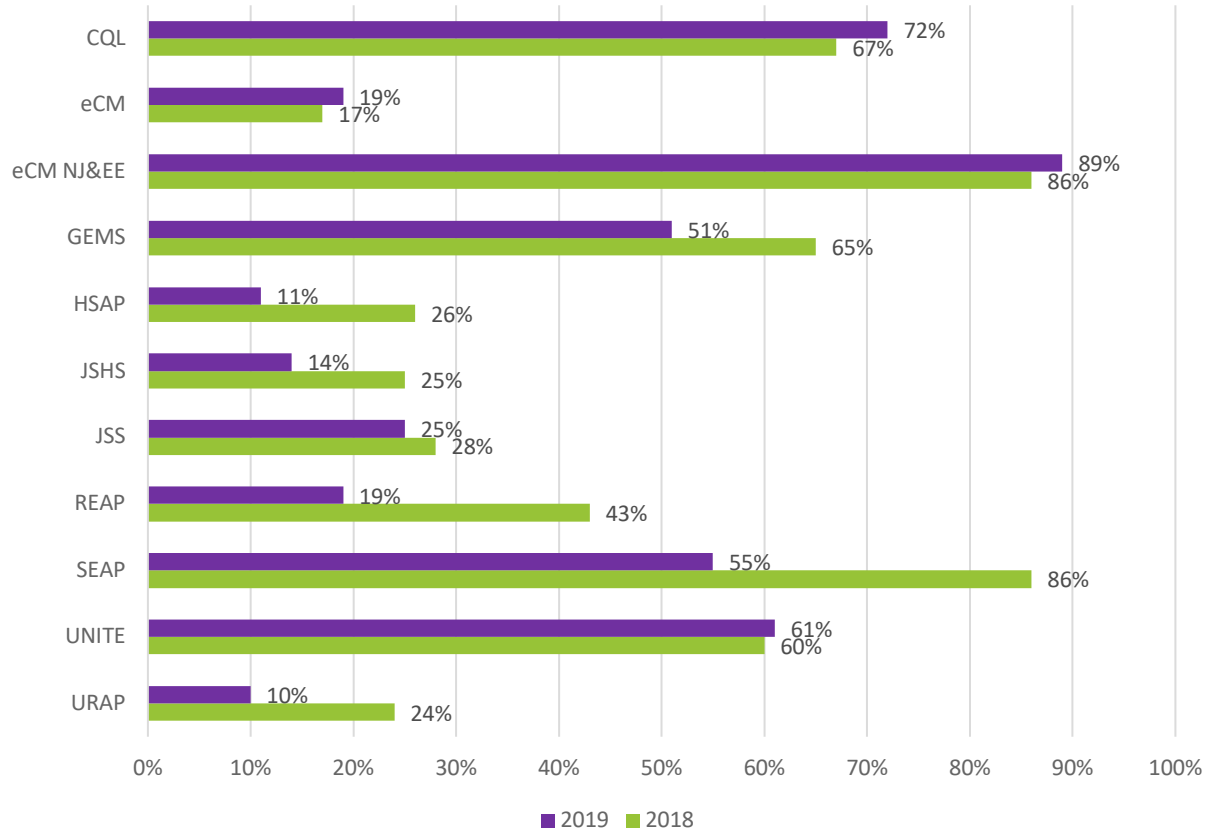
Participants reported increased interest in STEM research and careers after participation in FY19 AEOPs. Evaluation findings showed AEOPs generally exposed participants to STEM careers and more specifically to Army and DoD STEM careers. Further, engaging in AEOPs increased interest in pursuing STEM careers.

Participants were asked to indicate the number of general STEM careers and the number of STEM careers in the Army/DoD they learned about in their AEOP (Chart 13). Results indicate that in all programs except eCM (42%) and HSAP (33%), approximately half or more of participants (range 49%-94%) reported learning about three or more general STEM careers. Slightly larger proportions of students reported learning about three or more STEM careers in FY19 as compared to FY18 in CQL, eCM, eCM NJ&EE, JSS, REAP, and URAP.



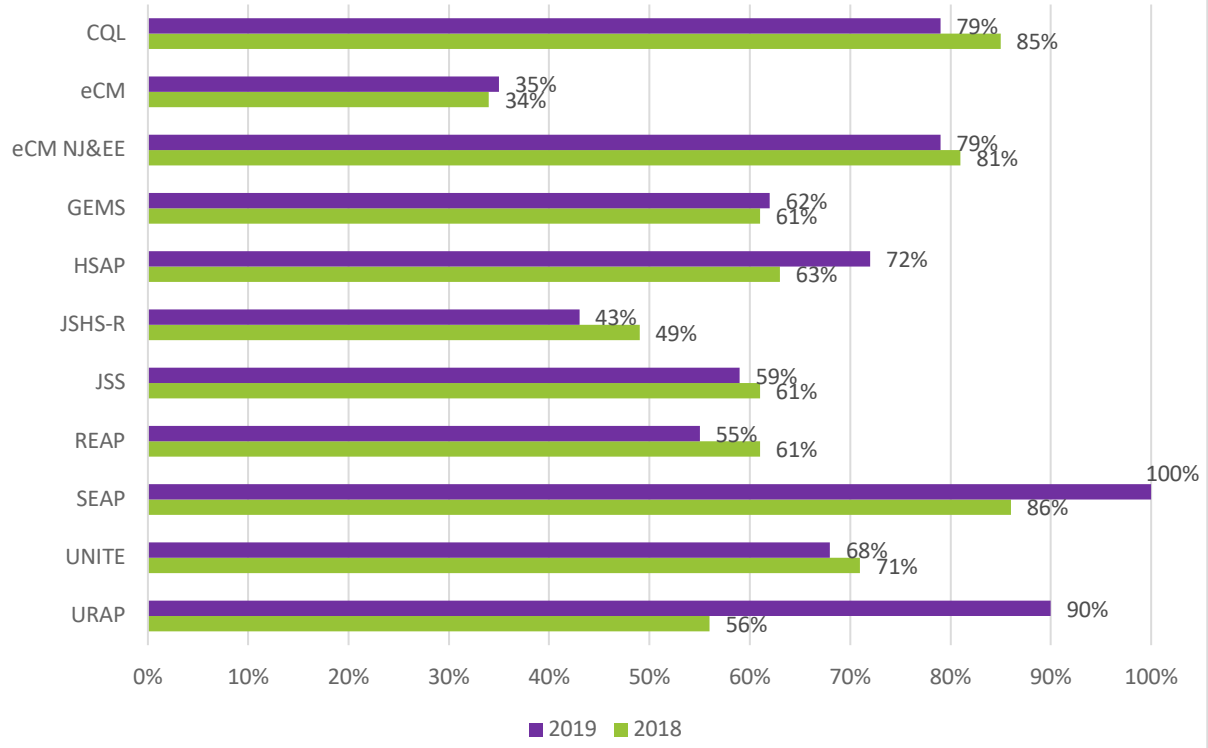
Findings for students who learned about three or more STEM careers within the Army or DoD are presented in Chart 14. Smaller proportions of students (range 10%-89%) had learned about Army/DoD STEM careers as compared with STEM careers more generally (Chart 13). Half or more of students (range 51%-89%) in CQL, eCM NJ&EE, GEMS, SEAP, and Unite reported learning about three or more DoD STEM careers. In FY19 a greater proportion of participants in four programs (CQL, eCM NJ&EE, and Unite) reported having learned about more of these jobs as compared to FY18. As in previous years, comparisons of participants in AEOPs held at Army laboratories and centers (CQL, GEMS, and SEAP), with participants at Army-sponsored university labs (HSAP and URAP), and non-Army affiliated settings (eCM Regional, JSHS, REAP, and Unite) show that, on average, participants at DoD sites learned about more DoD STEM careers. It is important to note, however, that nearly all (89%) of eCM National students and more than half of Unite students (61%) reported learning about three or more DoD STEM careers although they participated in programs at non-Army affiliated settings. Thus, it may be useful to examine practices used by eCM NJ&EE and Unite to determine suitability for implementation in other programs in other non-Army affiliated settings.

Chart 14: Students Reporting Learning about 3 or More DoD STEM Jobs/Careers in their Program



Students and apprentices were asked about the extent to which their AEOP participation impacted their interest in pursuing STEM careers in the Army or DoD (Chart 15). As in previous years, participants in some programs reported their AEOP experiences were more impactful in this area (e.g., SEAP, URAP, CQL and eCM NJ&EE) than did participants in programs such as regional e-CM and JSHS. Programs for which participants tended to report the greatest impact in this area are those in which participants have exposure to Army/DoD STEM researchers and/or facilities during program activities. This suggests that direct engagement is particularly useful for informing participants about specific jobs and careers within the DoD.

Chart 15: Students Indicating AEOP Impacted their Interest in Pursuing a STEM Career with the DoD



Students and apprentices were asked to rate their agreement with various statements related to their interest in and awareness of STEM careers in general and within the DoD (Table 32). With the exception of eCM Regional students (40%), more than half of participants (range 58%-91%) expressed greater interest in pursuing STEM careers after participating in their AEOP. Smaller proportions of students in most programs (range 35%-72%) indicated that their AEOP participation resulted in an increased interest in DoD STEM careers, with the exception of CQL (79%), eCM NJ&EE (79%), URAP (90%), and SEAP (100%)

whose participants reported higher interest in DoD STEM careers compared to STEM careers in general. Approximately two-thirds or more of participants (range 65%-100%) in all programs except eCM Regional (43%) reported being more aware of DoD STEM research and careers after their AEOP. With the exception of eCM Regional (47%), approximately three-quarters or more of participants (73%-100%) reported a greater appreciation of Army or DoD STEM research after their AEOP program. There was greater FY19 agreement with most of these statements than FY18 for the following programs: eCM NJ&EE, JSHS, SEAP, and REAP.

Table 32. Students Agreeing AEOP Affected Their Attitudes Toward STEM Careers

	Year	CQL	eCM	eCM NJ&EE	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
I am more interested in pursuing a career in STEM	2018	76%	39%	72%	90%	79%	67%	72%	82%	83%	79%	68%
	2019	***60%***	***40%***	***81%***	***70%***	***89%***	***58%***	***76%***	***68%***	***91%***	***81%***	***81%***
I am more aware of DoD STEM research and careers	2018	95%	47%	96%	87%	84%	63%	72%	78%	94%	83%	82%
	2019	***96%***	***43%***	***99%***	***79%***	***72%***	***92%***	***68%***	***65%***	***100%***	***82%***	***81%***
I have a greater appreciation of Army or DoD STEM research	2018	88%	52%	94%	88%	95%	65%	76%	86%	100%	84%	85%
	2019	***94%***	***47%***	***97%***	***82%***	***89%***	***89%***	***73%***	***84%***	***100%***	***81%***	***94%***
I am more interested in pursuing a STEM career with the DoD	2018	85%	34%	81%	61%	63%	51%	61%	62%	86%	71%	56%
	2019	***79%***	***35%***	***79%***	***62%***	***72%***	***59%***	***59%***	***55%***	***100%***	***68%***	***90%***

Youth and adult participants in all programs reported that AEOP participation provided students with opportunities to refine, explore, and/or advance their STEM education and career interests. In open-ended questionnaire responses, focus groups, and interviews, students and apprentices indicated that participating in AEOPs affirmed or increased their interest in STEM careers. Likewise, mentors commented that participation in AEOPs provides participants with valuable career information, both in STEM fields generally and in Army/DoD STEM careers more specifically. For example, participants said the following:

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

“Being a [CQL] mentor doesn't stop when they give the presentation. You certainly work on to put [apprentices] in touch with people who can advance their careers.” (CQL Mentor)

“eCYBERMISSION has helped me get a clear vision of what a STEM career and education look like. It was very fun working with my partners trying to solve our problem.” (eCM-R Student)

“ GEMS gives young kids/teens opportunities to experience new careers in STEM.” (GEMS Student)

“Showing [GEMS students] that you can be part of the Department of Defense, and not be in a uniform, and still serve in a way that's meaningful and impactful is really cool. I don't think they realize that exists.” (GEMS Mentor)

“[HSAP] was a wonderful opportunity to gain real-world experience in a true STEM work environment, and allowed me to learn about from industry professionals in the field…the program was an amazing experience and opportunity to be able to work with a lab and contribute to STEM research, and helped me cement my want and direction in working on STEM and, more specifically, computer science research in the future.” (HSAP Apprentice)

“I learned about a lot of science careers that I didn't really know, like certain areas that I didn't know people were actually looking into that I'm definitely interested in.” (N-JSHS Student)

“[JSS] helped me learn new things about STEM careers, how to work with others better, and how to accept if my team doesn't succeed and to not give up and try again. I think this will help me when I grow up.” (JSS Student)

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

"I was not very aware that the DoD employed civilians...I was very surprised. It opened up a new possibility of a career field." (RESET Level II Participant)

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

“This program provides a wonderful opportunity for high school students to experience STEM research at the college level. From my own experience I felt that my students' level of interest in a STEM career was significantly increased due to their participation in this program. Thank you for your support!” (Unite Mentor)

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

Since 2014, the AEOP has focused on supporting mentors with resources to expose participants to DoD STEM careers. As such, mentors were asked to rate the usefulness of various AEOP resources for this purpose. Table 33 shows that across all programs simply participating in the program was chosen most frequently as useful for exposing participants to DoD STEM careers (range 58%-85%). Mentors' reports of the usefulness of other AEOP resources varied by program. For example, while 60% of JSS mentors and 61% of URAP mentors found the AEOP website useful, only 13% of CQL mentors reported similarly about this resource. Additionally, while 60% of JSS mentors found the AEOP brochure useful, none (0%) of the CQL mentors and only 9% of SEAP mentors believed the brochure helped them to expose apprentices to DoD STEM careers. While more than half (range 55%-85%) or mentors from REAP, JSHS, Unite, and GEMS mentors indicated their program administrator or site coordinator was useful, less than half (range 9%-43%) of all other programs felt the same.

Table 33. Resources that Mentors Found Useful for Exposing Apprentices and Students to DoD STEM Careers

Resource	Year	CQL	eCM	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
Program Administrator Website (TSA, ASEE, AAS, etc.)	2018	NA	87%	NA	75%	11%	100%	NA	NA	41%	48%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***47%***	***NA***
AEOP website	2018	41%	38%	50%	100%	15%	68%	60%	20%	56%	56%
	2019	***13%***	***44%***	***37%***	***50%***	***17%***	***60%***	***50%***	***18%***	***55%***	***61%***
AEOP social media	2018	6%	16%	35%	0%	3%	33%	24%	5%	31%	15%
	2019	***0%***	***16%***	***30%***	***21%***	***4%***	***30%***	***35%***	***9%***	***40%***	***14%***
AEOP brochure	2018	12%	20%	46%	50%	15%	68%	51%	5%	49%	33%
	2019	***0%***	***30%***	***44%***	***29%***	***26%***	***60%***	***48%***	***9%***	***58%***	***25%***
Program administrator or site coordinator	2018	41%	41%	89%	75%	65%	100%	72%	35%	70%	56%
	2019	***33%***	***26%***	***85%***	***36%***	***61%***	***40%***	***55%***	***9%***	***71%***	***43%***
Invited speakers or "career" events	2018	65%	20%	65%	25%	34%	0%	NA	50%	66%	26%
	2019	***20%***	***17%***	***82%***	***14%***	***44%***	***10%***	***30%***	***18%***	***70%***	***22%***
Participation in program	2018	82%	83%	85%	75%	80%	100%	87%	65%	75%	78%
	2019	***80%***	***74%***	***85%***	***64%***	***58%***	***70%***	***65%***	***82%***	***72%***	***79%***

Evaluation findings suggest that AEOP mentors in some programs have limited awareness of Army and DoD STEM careers themselves and are therefore unable to effectively share information with student participants. These mentors often report lack of awareness of available resources about these careers and about the range of AEOPs. As a result, some mentors have limited capacity to educate participants about Army and DoD STEM careers and other AEOPs.

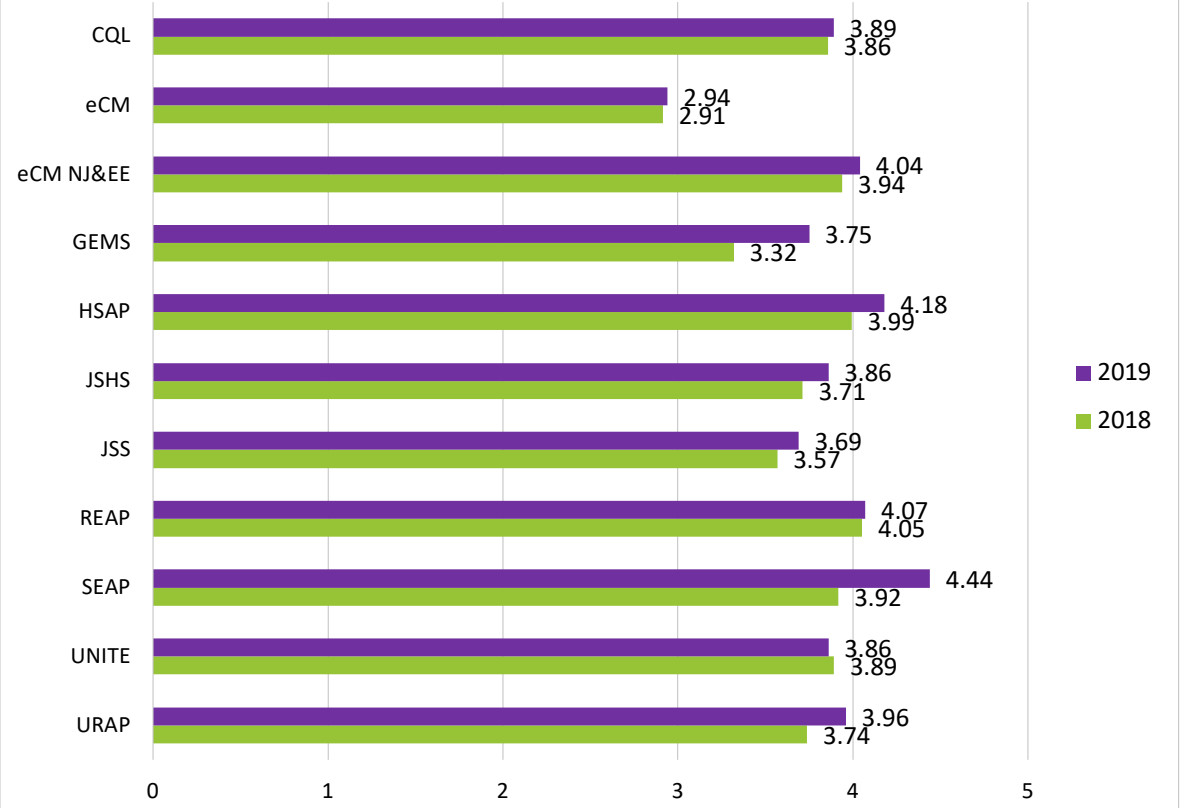
Research Question #5 - To what extent do participants report increased enrollment, achievement, and completion of STEM degree programs?

FY19 AEOP programs served to sustain existing STEM educational and career aspirations of participants and to inspire intentions to pursue post-baccalaureate education. Participants reported gains in interest in pursuing DoD STEM careers as a result of their AEOP participation, although the magnitude of these effects varied across programs.

In order to understand how AEOP participation influenced participants' intentions to engage in STEM activities in the future, AEOP participants were asked to rate the likelihood that they would engage in STEM activities outside of AEOP or scheduled school classes. Table 34 provides evaluation survey items asked for this composite. Chart 16 shows that participants across AEOPs were generally more likely to engage in these types of activities after participating in their AEOP (Chart 16). The greatest impact on participants' intentions to engage in STEM in the future was found in students from the following programs: SEAP (4.44), HSAP (4.18), REAP (4.07), and eCM NJ&EE (4.04).

Table 34. Items that form the Intentions to Engage in STEM Activity Composite
1. Watch or read non-fiction STEM
2. Tinker (play) with a mechanical or electrical device
3. Work on solving mathematical or scientific puzzles
4. Use a computer to design or program something
5. Talk with friends or family about STEM
6. Mentor or teach other students about STEM
7. Help with a community service project that relates to STEM
8. Participate in a STEM camp, club, or competition
9. Take an elective (not required) STEM class
10. Work on a STEM project or experiment in a university or professional setting

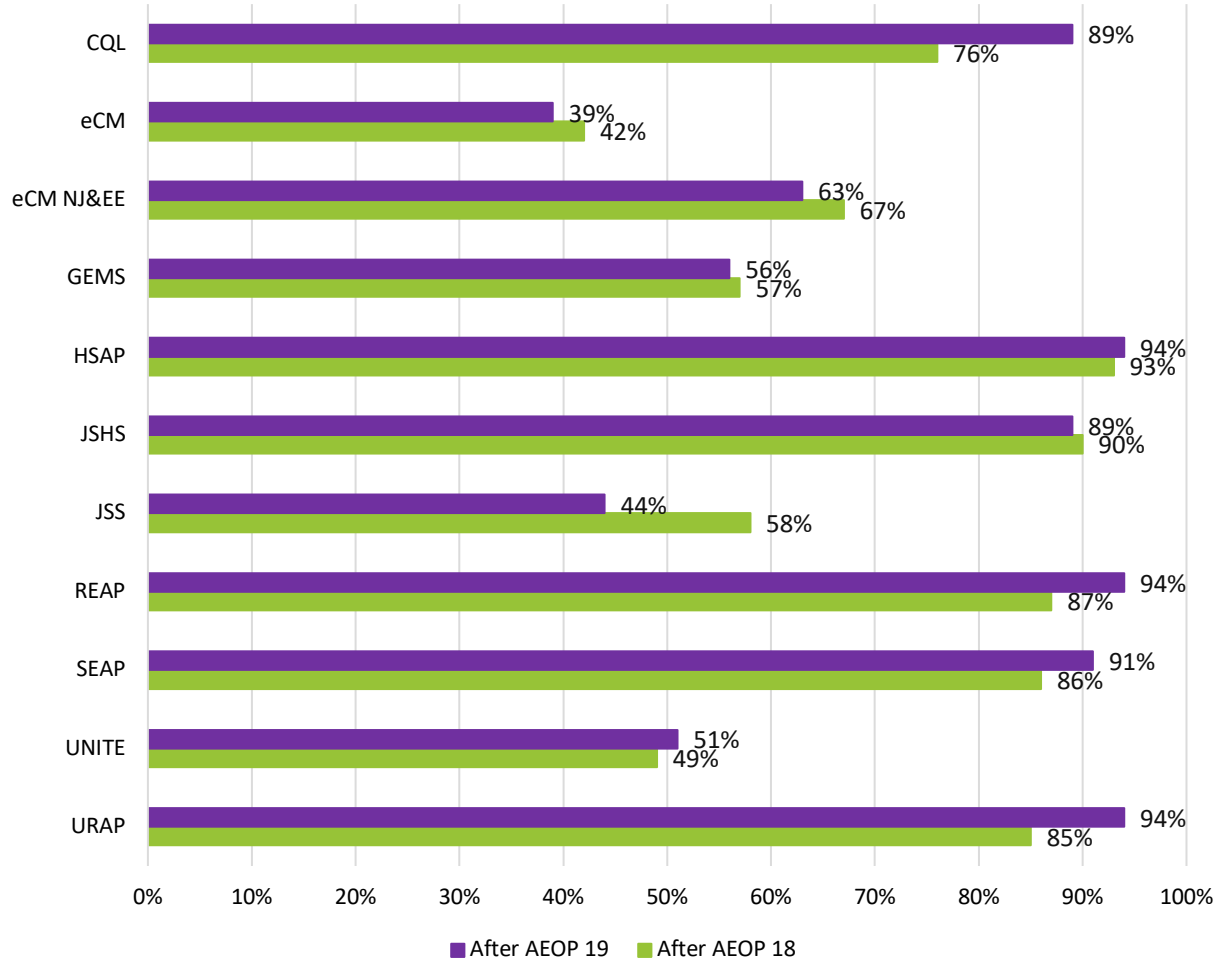
Chart 16: Mean Composite Scores for Intentions to Engage in STEM Activities as a Result of AEOP†



† *Response options for the items forming this composite were: 1 – Much less likely, 2 – Less likely, 3 – About the same before and after, 4 – More likely, 5 – Much more likely.*

AEOP participants were asked to share their educational aspirations after engaging in their program. Chart 17 presents FY18 and FY19 responses for student and apprentices planning to continue their education beyond a bachelor's degree. Half or more (range 51%-94%) of participants in all programs indicated wanting to at least earn a bachelor's degree, with the exception of eCM regional (39%) and JSS (44%). Comparing FY18 findings to FY19, there was a slight decrease in proportions of participants with these educational aspirations for several programs (eCM, eCM NJ&EE, GEMS, & JSS), while numbers of apprentices with post-bachelor's aspirations increased for CQL, HSAP, REAP, SEAP, Unite, and URAP.

Chart 17: Percent of Students Planning to Continue their Education Beyond a Bachelor's Degree



Priority Two: STEM Savvy Educators

Mentors play a critical role in the AEOP program, designing and facilitating learning activities, delivering content through instruction, supervising and supporting collaboration and teamwork, providing one-on-one support, chaperoning, advising on educational and career paths, and generally serving as STEM role models. The 2019 AEOP evaluation examined the extent to which adults serving in these capacities used research-based strategies for mentoring, as well as the extent to which apprentices and students were satisfied with their mentors.

Research Question #6 - What is the impact of Scientists and Engineers (S&E) Mentors on AEOP participants?

Most AEOP mentors reported using a range of effective mentoring strategies in FY19, including establishing the relevance of learning activities, supporting the diverse needs of students as learners, supporting student development of interpersonal and collaboration skills, supporting student engagement in authentic STEM activities, and supporting student STEM educational and career

pathways. The extent to which mentoring strategies were implemented varied across programs, although a majority of mentors across programs reported using each mentoring strategy they were asked about. Regardless of program, mentors were most likely to indicate they implemented strategies to engage students in authentic STEM activities (range 75%-98%) and support the development of collaboration and interpersonal skills (range 75%-93%). Mentors across programs were least likely to note using strategies to support students' STEM educational and career pathways (range 51%-81%).

Since mentors play a key role in AEOPs, inspiring and sustaining students' and apprentices' interest in STEM and STEM careers, the nature and quality of mentoring provided is an important factor in participants' AEOP experiences. Mentors were therefore asked as a part of the FY19 evaluation to report on their use mentoring strategies with participants. These strategies comprised five main areas of effective mentoring:[8]

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

Composite variables were created for each mentoring domain. Items composing the Establishing the Relevance of Learning Activities composite are listed in Table 35 and mean composite scores for this variable are provided in Chart 18. Approximately two-thirds or more of mentors (range 64%-89%) reported using these strategies across AEOPs. On average, the proportion of mentors reportedly using these strategies is slightly lower than FY18 (range 71%-93%). However, in FY19, slightly more mentors in eCM, GEMS, JSHS, JSS, REAP, Unite, and URAP reported using these strategies compared to FY18 (see Table 36).

Table 35. Items that form the Establishing the Relevance of Learning Activities Composite
1. Become familiar with my student(s) background and interests at the beginning of the program
2. Giving students real-life problems to investigate or solve
3. Selecting readings or activities that relate to students' backgrounds
4. Encouraging students to suggest new readings, activities, or projects
5. Helping students become aware of the role(s) STEM plays in their everyday lives
6. Helping students understand how STEM can help them improve their community
7. Asking students to relate real-life events or activities to topics covered in the program

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

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

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

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

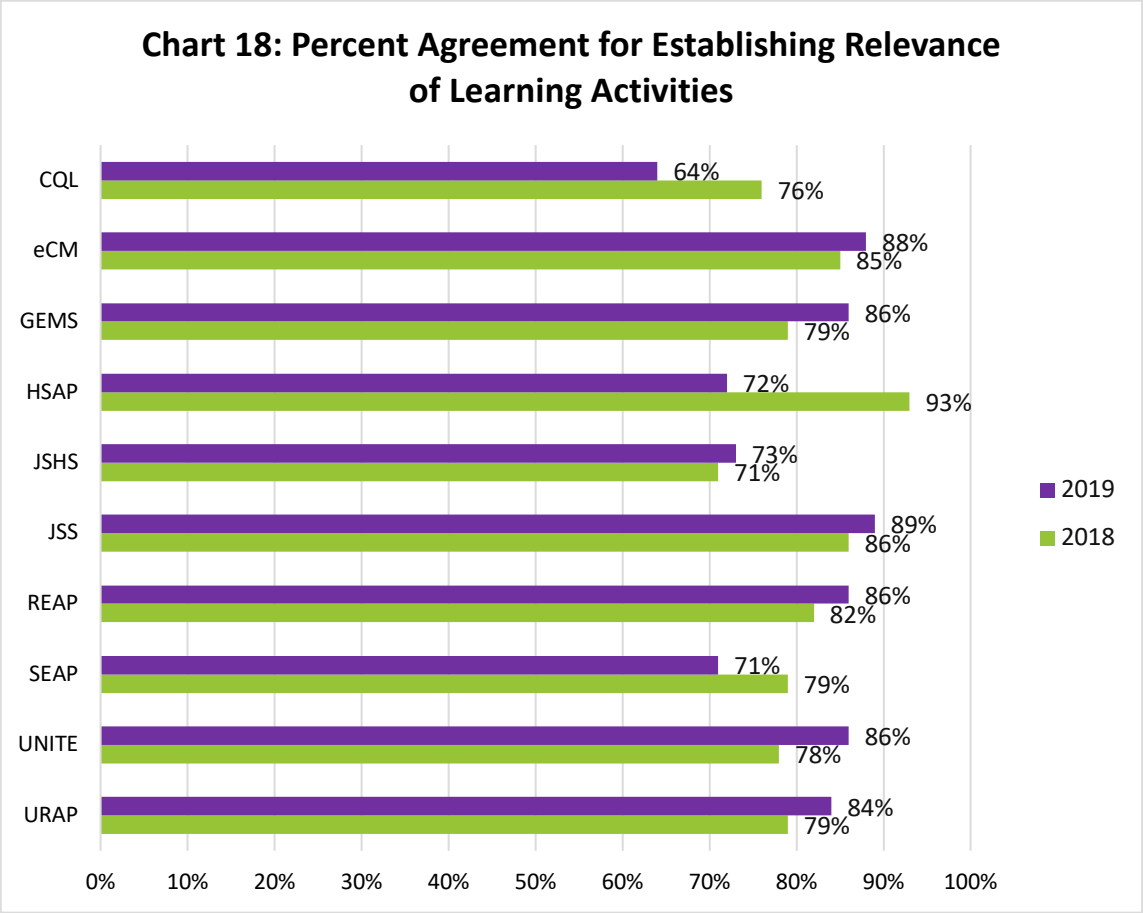


Table 36. Mentor Overall Percent Agreement for Establishing the Relevance of Learning Activities		
Program	**2018 Composite % Agreement**	**2019 Composite % Agreement**
CQL	76%	64%
eCM	85%	88%
GEMS	79%	86%
HSAP	93%	72%
JSHS	71%	73%
JSS	86%	89%
REAP	82%	86%
SEAP	79%	71%
Unite	78%	86%
URAP	79%	84%

Items making up the Supporting the Diverse Needs of Students as Learners composite are shown in Table 37, and mean composite scores are depicted in both Chart 19 and Table 38. More than half of mentors (range 55%-91%) indicated implementing these mentoring strategies. In comparison to FY18, many of the programs reported a slight increase in FY19 strategy use: eCM, GEMS, JSS, REAP, Unite, URAP.

Table 37. Items that form the Supporting the Diverse Needs of Students as Learners Composite
1. Identify the different learning styles that my student(s) may have at the beginning of their program
2. Interact with students and other personnel the same way regardless of their background
3. Use a variety of teaching and/or mentoring activities to meet the needs of all students
4. Integrating ideas from education literature to teach/mentor students from groups underserved in STEM
5. Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills
6. Directing students to other individuals or programs for additional support as needed
7. Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM

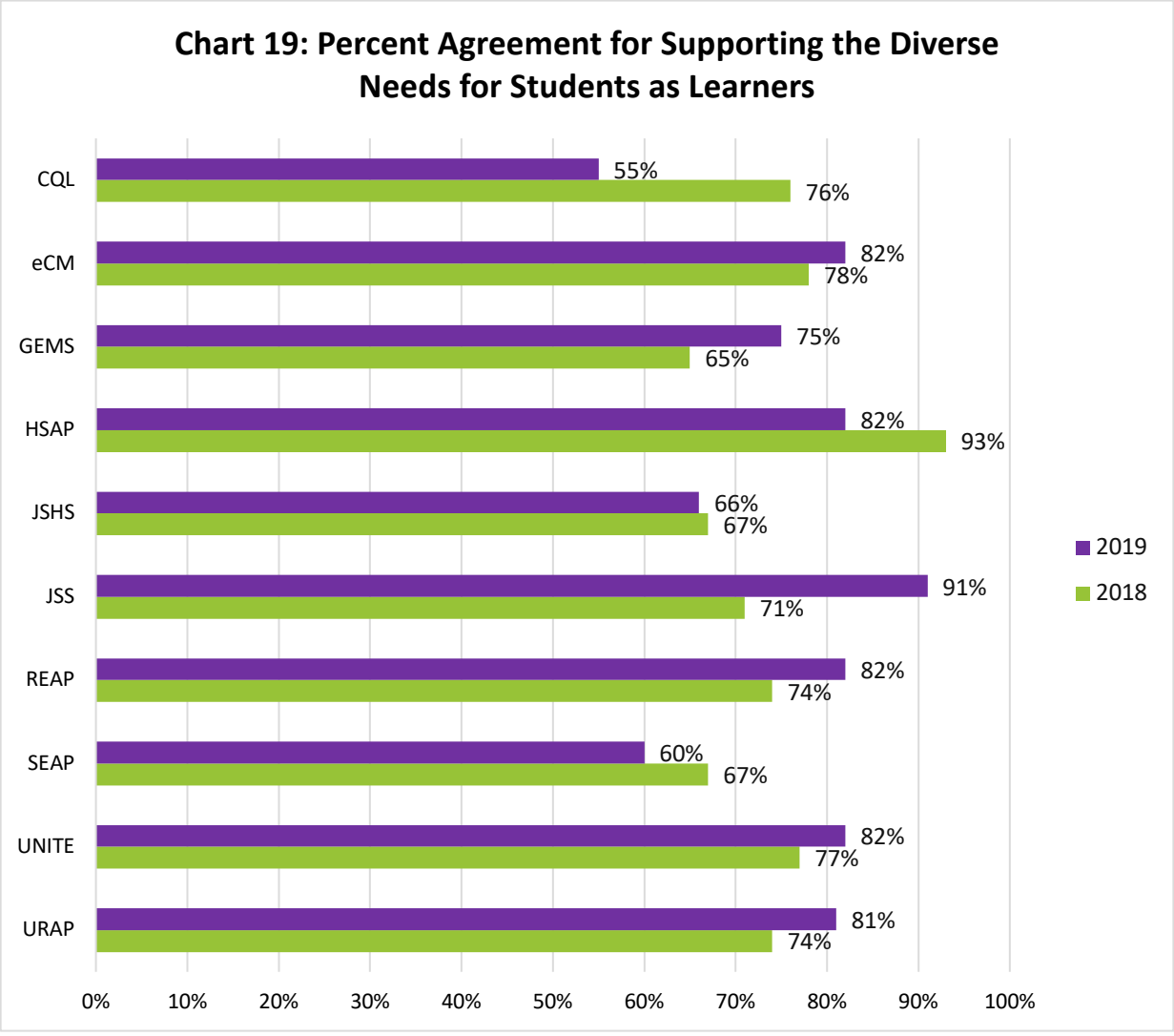


Table 38. Mentor Overall Percent Agreement for Supporting the Diverse Needs of Students as Learners		
Program	**2018 Composite % Agreement**	**2019 Composite % Agreement**
CQL	76%	55%
eCM	78%	82%
GEMS	65%	75%
HSAP	93%	82%
JSHS	67%	66%
JSS	71%	91%
REAP	74%	82%
SEAP	67%	60%
Unite	77%	82%
URAP	74%	81%

Composite items for Supporting Student Development of Collaboration and Interpersonal Skills strategies are listed in Table 39. Three-quarters or more (range 75%-93%) of mentors across all AEOPs reported using these strategies (Chart 20 and Table 40). Proportions of mentors using these strategies increased slightly from FY18 levels for REAP, Unite, and URAP.

Table 39. Items that form the Supporting Student Development of Collaboration and Interpersonal Skills Composite
1. Having student(s) tell others about their backgrounds and interests
2. Having student(s) explain difficult ideas to others
3. Having student(s) listen to the ideas of others with an open mind
4. Having student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own
5. Having student(s) give and receive constructive feedback with others
6. Having my student(s) work on collaborative activities or projects as a member of a team[†]
7. Allowing my student(s) to resolve conflicts and reach agreement within their team[†]

[†] *These items were not included on the eCM and JSHS versions of the survey.*

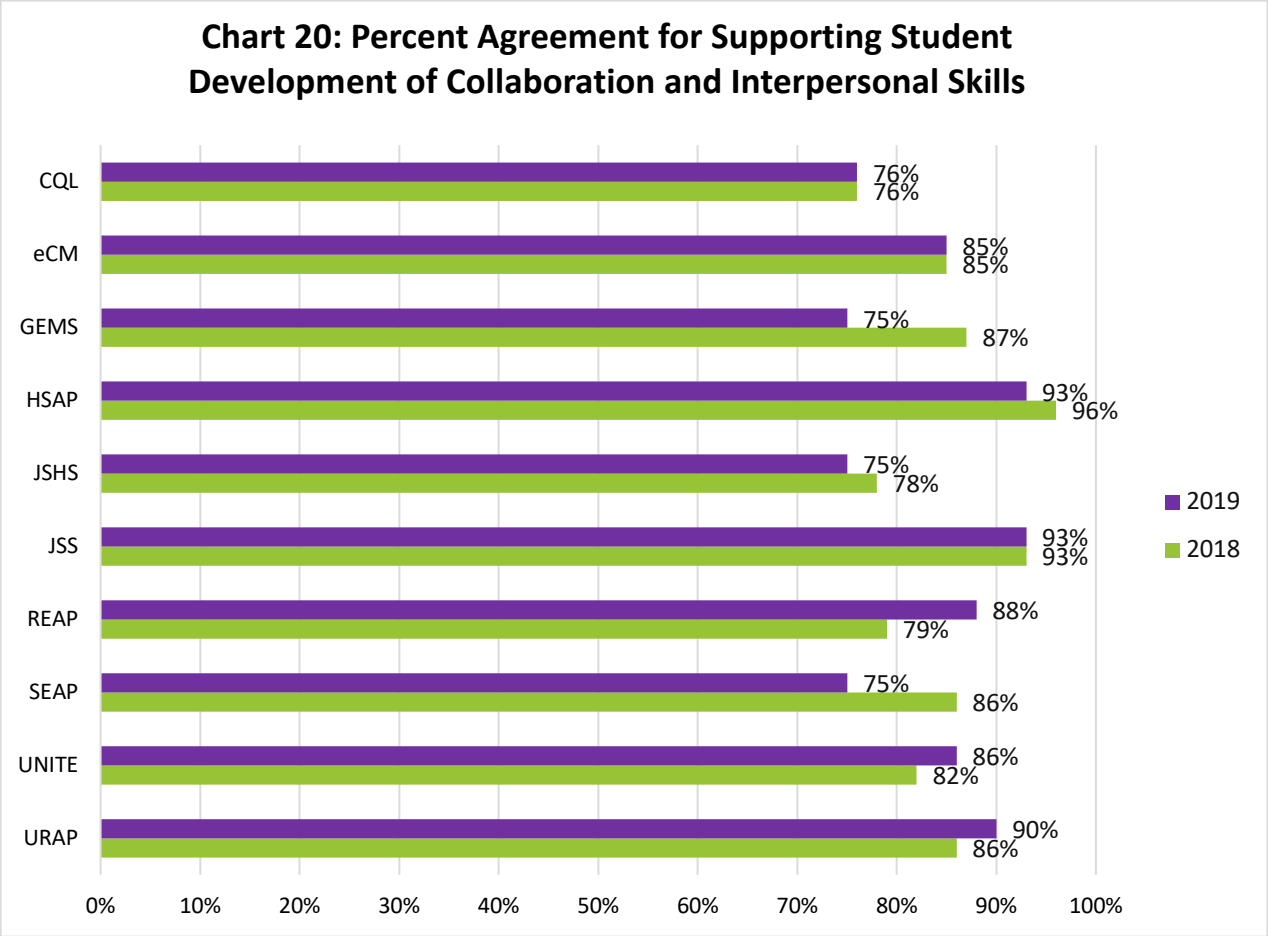


Table 40. Mentor Overall Percent Agreement for Supporting Student Development of Collaboration and Interpersonal Skills		
Program	**2018 Composite % Agreement**	**2019 Composite % Agreement**
CQL	76%	76%
eCM	85%	85%
GEMS	87%	75%
HSAP	96%	93%
JSHS	78%	75%
JSS	93%	93%
REAP	79%	88%
SEAP	86%	75%
Unite	82%	86%
URAP	86%	90%

Mentoring strategy items focused on supporting student engagement in "Authentic" STEM Activities are listed in Table 41. Mean composites in Chart 21 and Table 42 show three-quarters or more of mentors

(range 75%-98%) across AEOPs indicated they implemented these strategies. Compared to FY18, use of these strategies increased slightly for CQL, eCM, REAP, SEAP, and URAP in FY19.

Table 41. Items that form the Supporting Student Engagement in "Authentic" STEM Activities Composite
1. Teaching (or assigning readings) about specific STEM subject matter
2. Having my student(s) search for and review technical research to support their work
3. Demonstrating laboratory/field techniques, procedures, and tools for my student(s)
4. Supervising my student(s) while they practice STEM research skills
5. Providing my student(s) with constructive feedback to improve their STEM competencies
6. Allowing students to work independently to improve their self-management abilities
7. Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.) †
8. Encouraging students to seek support from other team members†

† *These items were not included on the eCM and JSHS versions of the survey.*

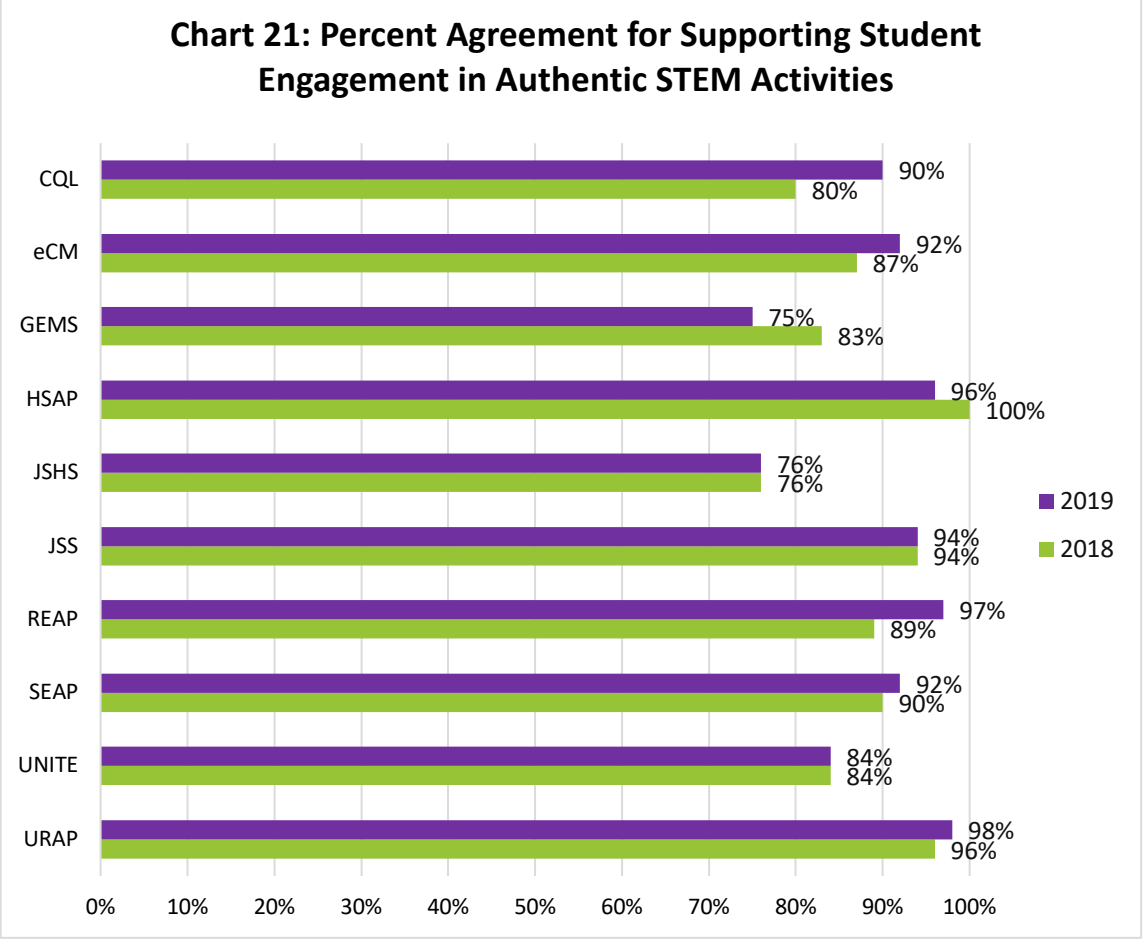


Table 42. Mentor Overall Percent Agreement for Supporting Student Engagement in Authentic STEM Activities		
Program	**2018 Composite % Agreement**	**2019 Composite % Agreement**
CQL	80%	90%
eCM	87%	92%
GEMS	83%	75%
HSAP	100%	96%
JSHS	76%	76%
JSS	94%	94%
REAP	89%	97%
SEAP	90%	92%
Unite	84%	84%
URAP	96%	98%

Mentoring strategies focused on supporting students' STEM Educational and Career Pathways are listed in Table 43. Mean composite scores are presented in Chart 22 and Table 44. Fewer mentors reported using these strategies compared to other mentoring strategies, although half of mentors across AEOPs noted their use (range 51%-81%). Slightly more mentors reported using these strategies in FY19 compared to FY18 for eCM, REAP, Unite, and URAP.

Table 43. Items that form the Supporting Student STEM Educational and Career Pathways Composite
1. Asking my student(s) about their educational and/or career goals
2. Recommending extracurricular programs that align with students' goals
3. Recommending Army Educational Outreach Programs that align with students' educational goals
4. Providing guidance about educational pathways that would prepare student(s) for a STEM career
5. Discussing STEM career opportunities within the DoD or other government agencies
6. Discussing STEM career opportunities in private industry or academia
7. Discussing the economic, political, ethical, and/or social context of a STEM career
8. Recommending student and professional organizations in STEM to my student(s)
9. Helping students build a professional network in a STEM field
10. Helping my student(s) with their resume, application, personal statement, and/or interview preparations

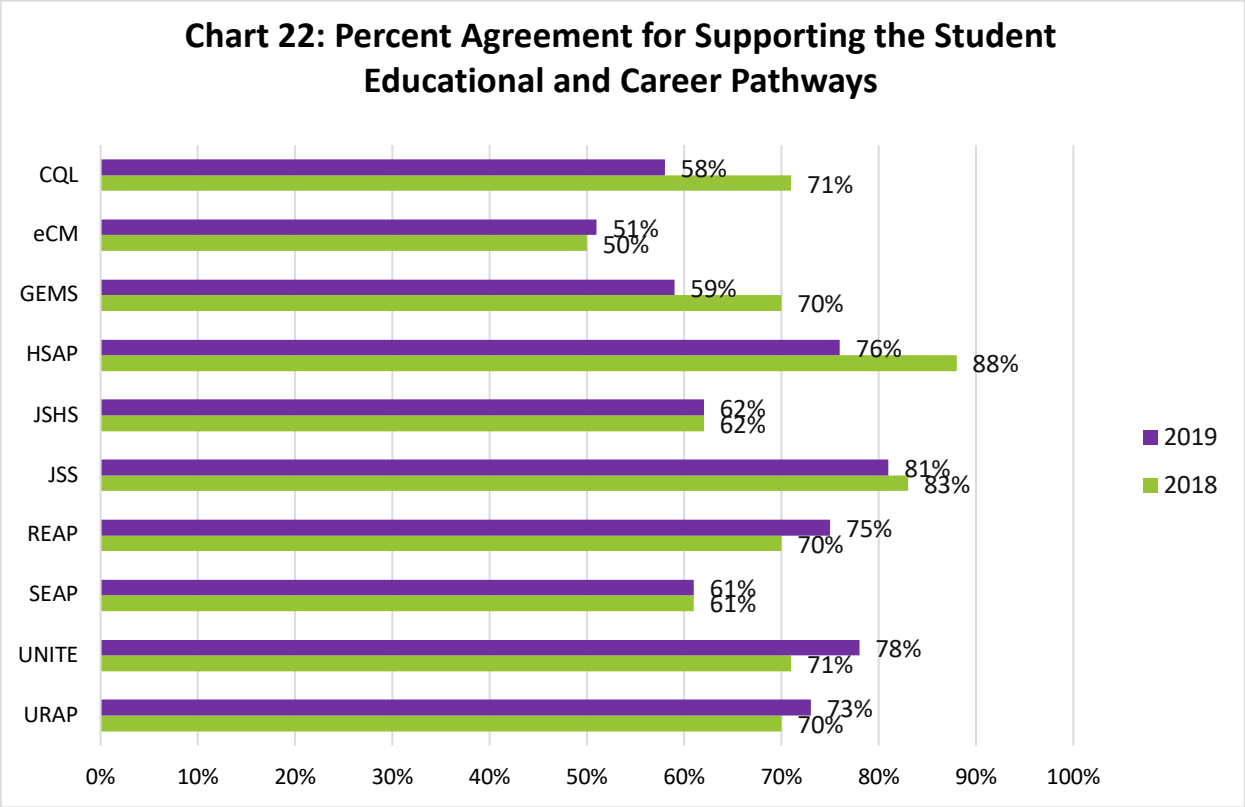
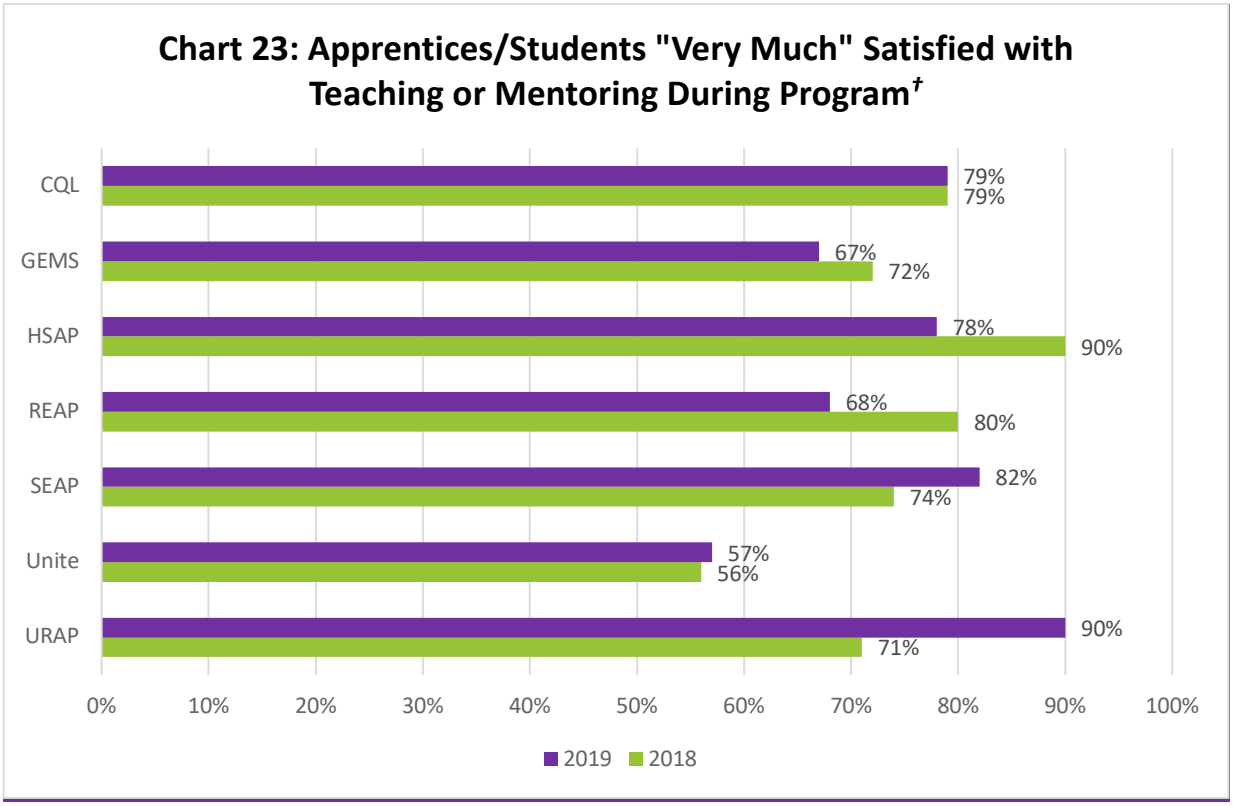


Table 44. Mentor Overall Percent Agreement for Supporting Student STEM Educational and Career Pathways		
Program	**2018 Composite % Agreement**	**2019 Composite % Agreement**
CQL	71%	58%
eCM	50%	51%
GEMS	70%	59%
HSAP	88%	76%
JSHS	62%	62%
JSS	83%	81%
REAP	70%	75%
SEAP	61%	61%
Unite	71%	78%
URAP	70%	73%

In sum, mentors were least likely to report using mentoring strategies related to supporting their students' educational and career pathways. This is a finding that raises particular concern when considered in conjunction with findings that mentors face challenges in exposing students to and engaging them in DoD research (Priority 1, Finding #5) and mentors' mixed perceptions of the usefulness of resources for exposing students to DoD STEM careers (Priority 1, Finding #6). This is an area that should be addressed across the portfolio of AEOPs, possibly with additional training and orientation and a close examination of the availability of and usefulness of resources provided to mentors.

Participant satisfaction with mentorship acts as a proxy for student perceptions of mentoring quality, with quality mentoring conceptualized as a positive relationship that will result in a more meaningful and impactful experience and that may be sustained after program participation ends. Chart 23 and Table 45 shows student responses for those who indicated they were "very much" satisfied with the mentoring or instruction during their FY18 and FY19 AEOPs. More than half of students across AEOPs reported high levels of satisfaction with their mentors and the quality of instruction they received (range 57%-90%). Compared to FY18, levels of satisfaction with mentorship were slightly higher in FY19 for SEAP, Unite, and URAP and were unchanged for CQL. However, levels of satisfaction with mentors in GEMS, HSAP, and REAP were lower than in FY18.



† *Only programs who work directly with a mentor (non-teacher) were asked this question.*

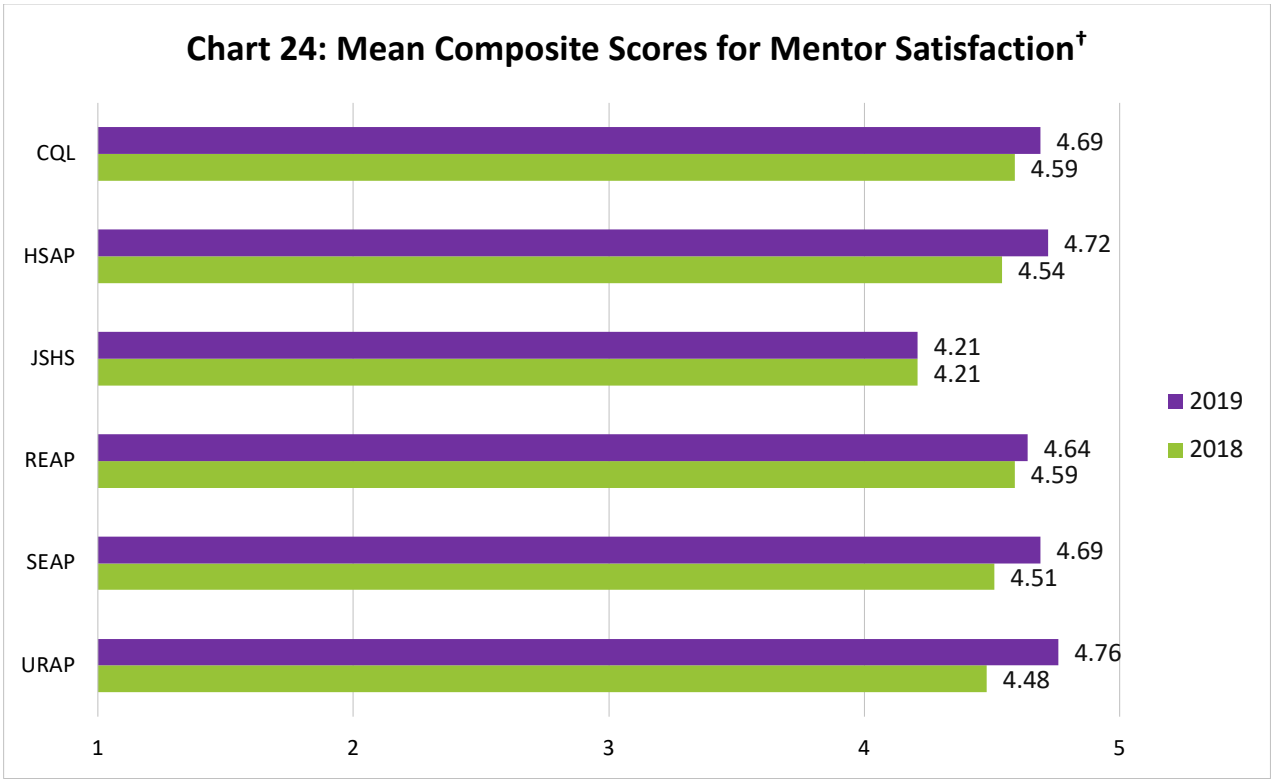
Table 45. Participants "Very Much" Satisfied with Teaching or Mentorship During Program

Program	2018	2019
CQL	79%	79%
GEMS	72%	67%
HSAP	90%	78%
REAP	80%	68%
SEAP	74%	82%
Unite	56%	57%
URAP	71%	90%

Apprenticeship program (CQL, HSAP, REAP, SEAP, and URAP) participants and JSHS students rated their satisfaction with several aspects of their mentoring and overall research experiences (Table 46). Chart 24 shows average satisfaction remained uniformly high across programs in FY19 and increased for all programs except JSHS which remained the same. This indicates apprentices and students were highly satisfied with the mentoring quality they experienced.

Table 46. Items that form the Mentor Satisfaction Composite for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. My working relationship with my mentor
2. My working relationship with the group or team[†]
3. The amount of time I spent doing meaningful research
4. The amount of time I spent with my research mentor
5. The research experience overall

[†] *This question was not included on the JSHS survey.*



[†] *Response options for the items forming this composite were: 1 – Did not experience, 2 – Not at all, 3 – A little, 4 – Somewhat, 5 – Very much.*

Research Question #7 – To what extent do teacher participants report increased use of new approaches to teaching research concepts within STEM practices, and infusion of careers?

Launched in 2016, Research Experiences for STEM Educators and Teachers (RESET) program is an AEOP specifically designed to support STEM educators' content knowledge and to provide them with research experiences that they can translate into enhanced STEM curricula and learning experiences in their classrooms. Interviews with participants indicate that RESET supported the AEOP's objective of supporting and empowering educators with Army research and technology resources. Participants who spent time in

Army labs or centers valued their exposure to Army/DoD research and the skills and knowledge they gained. Both on-site and on-line participants also appreciated having opportunities to collaborate with other educators and learn about the scientific research process. RESET participants participating in interviews cited a number of ways that their learning from RESET and their research experiences could be incorporated into their classroom teaching practice. Participants said, for example:

> *"[After RESET], I am literally teaching my students how to do a research project. I'm in the initial phase where I'm helping them refine their research topic…I wouldn't have gotten to that point unless I had done RESET this year."* (RESET Level II Participant)

> *"I do use what I have learned from [RESET] in my classrooms, but I also use it in my professional development. I have used a couple of the literature pieces provided through the online component to inform some of the PD that I've given to some colleagues."* (RESET Level II Participant)

> *"I was involved in a biochemistry project. I struggled with it openly. That helps me appreciate what I want my student to be able to do...They're having to relate new information to their lives."* (RESET Level II Participant)

Priority Three: Sustainable Infrastructure

Findings from the FY19 AEOP evaluation reveal some progress toward achieving a sustainable infrastructure. Major trends that support the achievement of this AEOP priority along with evidence from assessment data that inform the findings are presented below by associated research question(s).

Research Question #8 - To what extent do participants report growth in awareness of and/or interest in AEOP opportunities?

As found in FY18, personal connections, including friends, teachers and or professors, or someone who works at the university or school the participant attends continue to be the most frequently cited means of participant information about programs (Table 47). As in FY18, a third or more of participants from some programs reported learning about the program through a past participant: GEMS (45%), JSHS (30%), and SEAP (38%). More than a third of CQL (43%) and SEAP (63%) apprentices learned about AEOP from someone who works for the DoD. Approximately a quarter or more of participants in HSAP (22%), REAP (29%), JSHS (34%), Unite (34%), JSS (35%), and URAP (40%) indicated they heard about AEOP through a school or university newsletter, email, or website.

Mentors were asked how they had learned about AEOP as well (Table 48). Most frequently reported sources of information were a past participant of the program, someone who works with the DoD, a colleague or friend, and the AEOP website, although these findings varied broadly across programs. Past participants were a key source of information for GEMS mentors (61%), as well as for approximately a third of JSHS (30%), Unite (31%), eCM (32%), SEAP (36%), and JSS (40%) mentors. A quarter or more of mentors in URAP (25%), GEMS (30%), and HSAP (36%) reported that someone who works with the DoD was a source of AEOP information. Twenty percent or more of mentors learned about AEOP through the AEOP website from JSS (20%), REAP (28%), URAP (32%), and HSAP (43%).

Table 47. How Students Learned About their AEOP Program											
	Year	**CQL**	**eCM**	**GEMS**	**HSAP**	**JSHS**	**JSS**	**REAP**	**SEAP**	**Unite**	**URAP**
Website: AEOP	2018	28%	2%	12%	41%	4%	0%	18%	23%	5%	0%
	2019	***16%***	***1%***	***24%***	***28%***	***8%***	***0%***	***21%***	***25%***	***3%***	***13%***
AEOP social media	2018	0%	1%	2%	6%	<1%	0%	3%	0%	0%	0%
	2019	***0%***	***1%***	***4%***	***0%***	***<1%***	***0%***	***0%***	***0%***	***0%***	***3%***
School or university newsletter, email, or website	2018	15%	<1%	16%	24%	26%	63%	38%	23%	24%	47%
	2019	***9%***	***<1%***	***15%***	***22%***	***34%***	***35%***	***29%***	***13%***	***34%***	***40%***
Past participant of program	2018	30%	12%	58%	35%	17%	0%	15%	31%	9%	3%
	2019	***18%***	***<1%***	***45%***	***6%***	***30%***	***4%***	***21%***	***38%***	***12%***	***3%***
Friend	2018	25%	8%	28%	12%	13%	13%	18%	20%	16%	6%
	2019	***23%***	***9%***	***37%***	***0%***	***22%***	***15%***	***7%***	***13%***	***18%***	***3%***
Family member	2018	30%	3%	35%	24%	7%	0%	18%	54%	12%	3%
	2019	***27%***	***4%***	***37%***	***17%***	***10%***	***4%***	***7%***	***75%***	***16%***	***10%***
Teacher or someone who works at school/ university I attend	2018	15%	35%	4%	59%	52%	63%	24%	11%	29%	59%
	2019	***25%***	***87%***	***9%***	***61%***	***66%***	***46%***	***39%***	***38%***	***28%***	***60%***
Someone who works with the program	2018	32%	NA	5%	0%	4%	0%	18%	6%	25%	15%
	2019	***16%***	***NA***	***4%***	***17%***	***4%***	***0%***	***25%***	***13%***	***20%***	***17%***
Someone who works with the Department of Defense	2018	43%	<1%	7%	6%	<1%	0%	3%	51%	1%	3%
	2019	***43%***	***<1%***	***13%***	***6%***	***2%***	***0%***	***4%***	***63%***	***0%***	***3%***
Community group or program	2018	2%	2%	4%	6%	3%	0%	3%	3%	15%	3%
	2019	***0%***	***1%***	***5%***	***6%***	***4%***	***8%***	***4%***	***0%***	***11%***	***0%***
Choose not to report	2018	2%	4%	0%	0%	6%	0%	3%	0%	9%	0%
	2019	***0%***	***8%***	***0%***	***0%***	***11%***	***15%***	***4%***	***0%***	***6%***	***0%***

Table 48. How Mentors Learned about AEOP											
	Year	**CQL**	**eCM**	**GEMS**	**HSAP**	**JSHS**	**JSS**	**REAP**	**SEAP**	**Unite**	**URAP**
Website: AEOP	2018	24%	33%	32%	0%	5%	17%	4%	0%	16%	22%
	2019	***18%***	***12%***	***17%***	***43%***	***6%***	***20%***	***28%***	***18%***	***14%***	***32%***
Social media	2018	0%	0%	0%	0%	<1%	0%	21%	0%	4%	0%
	2019	***0%***	***<1%***	***9%***	***0%***	***1%***	***0%***	***8%***	***0%***	***3%***	***0%***
School, university, or professional organization newsletter, email, or website	2018	6%	0%	11%	0%	12%	0%	7%	0%	12%	0%
	2019	***0%***	***4%***	***26%***	***14%***	***15%***	***0%***	***13%***	***9%***	***31%***	***21%***
Past participant	2018	29%	0%	42%	100%	33%	33%	0%	14%	32%	11%
	2019	***12%***	***32%***	***61%***	***21%***	***30%***	***40%***	***15%***	***36%***	***31%***	***14%***
A colleague or friend	2018	24%	17%	21%	0%	32%	17%	32%	14%	12%	4%
	2019	***41%***	***34%***	***26%***	***0%***	***24%***	***20%***	***33%***	***18%***	***8%***	***18%***
Family member	2018	NA	0%	42%	0%	NA	0%	NA	0%	8%	NA
	2019	***NA***	***NA***	***57%***	***NA***	***NA***	***NA***	***NA***	***NA***	***3%***	***NA***
Site host, director, or someone who works with program	2018	6%	0%	32%	0%	18%	0%	33%	14%	32%	4%
	2019	***6%***	***5%***	***22%***	***7%***	***23%***	***0%***	***23%***	***0%***	***28%***	***7%***
Someone who works with the Department of Defense	2018	35%	17%	26%	0%	0%	17%	36%	29%	4%	19%
	2019	***0%***	***<1%***	***30%***	***36%***	***3%***	***10%***	***5%***	***0%***	***3%***	***25%***
Community group or program	2018	0%	17%	0%	0%	NA	0%	NA	0%	8%	NA
	2019	***NA***	***NA***	***9%***	***NA***	***NA***	***NA***	***NA***	***NA***	***6%***	***NA***
Choose Not to Report	2018	0%	17%	0%	0%	0%	0%	0%	14%	8%	0%
	2019	***0%***	***NA***	***0%***	***0%***	***0%***	***NA***	***0%***	***0%***	***3%***	***0%***

A goal of the AEOP is to build a pipeline of initiatives for students in STEM beginning in the elementary grades and continuing across their high school and post-secondary studies. In support of this goal, efforts have been made over the past several years to strengthen communication about AEOPs to prospective and current participants. The FY19 evaluation asked students about their past AEOP participation (Table 49). Results show very few

students reported past participation in any AEOP other than the one in which they were currently enrolled. Two exceptions to this are the 23% of CQL apprentices who reported they had participated previously in GEMS, and the 38% of SEAP participants who reported having participated in GEMS. These findings suggest there is a relatively robust pipeline relationship between GEMS and the CQL and SEAP programs.

Table 49. AEOP Participants Reporting Having Participated in Other AEOPs

Current Program	Year	eCM	JSS	JSHS	GEMS	Unite	HSAP	REAP	SEAP	URAP	CQL
CQL	2018	0%	0%	2%	15%	2%	0%	0%	19%	0%	26%
	2019	***2%***	***0%***	***0%***	***23%***	***0%***	***0%***	***0%***	***4%***	***0%***	***11%***
eCM	2018	25%	1%	0%	2%	0%	0%	0%	0%	0%	0%
	2019	***39%***	***8%***	***0%***	***6%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***
GEMS	2018	0%	0%	0%	63%	0%	0%	0%	0%	0%	0%
	2019	***2%***	***2%***	***<1%***	***55%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***
HSAP	2018	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%
	2019	***0%***	***0%***	***5%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***
JSHS	2018	2%	1%	26%	<1%	<1%	<1%	<1%	<1%	0%	0%
	2019	***1%***	***<1%***	***23%***	***0%***	***<1%***	***<1%***	***<1%***	***<1%***	***0%***	***0%***
JSS	2018	4%	39%	0%	9%	NA	NA	NA	NA	NA	NA
	2019	***5%***	***81%***	***2%***	***3%***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***
REAP	2018	0%	0%	0%	5%	21%	0%	5%	0%	0%	0%
	2019	***0%***	***0%***	***0%***	***4%***	***11%***	***0%***	***14%***	***0%***	***0%***	***0%***
SEAP	2018	9%	3%	0%	37%	0%	0%	0%	20%	0%	0%
	2019	***0%***	***13%***	***0%***	***38%***	***0%***	***0%***	***0%***	***25%***	***0%***	***0%***
Unite	2018	0%	0%	0%	0%	19%	0%	<1%	0%	0%	0%
	2019	***0%***	***0%***	***1%***	***0%***	***29%***	***1%***	***0%***	***1%***	***0%***	***0%***
URAP	2018	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2019	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***3%***	***0%***

Students were also asked about their level of interest in participating in AEOPs for which they currently are or will be eligible in the future (Table 50). Some degree of interest in future AEOP participation was expressed by students from all programs. If eligible to participate in the same AEOP again, half or more of participants in the following programs indicated they would be interested or very interested: eCM (50%), Unite (77%), GEMS (80%), URAP (81%), CQL (85%), JSS (89%), and JSHS (91%). The AEOP initiative with the most interest was SMART with the following programs having nearly half or more of their participants interested: URAP (45%), Unite (46%), REAP (58%), HSAP (61%), CQL (70%), and SEAP (91%).

Table 50. AEOP Participants Reporting Interest in Participating in Other AEOPs														
Current Program	**Year**	**eCM**	**JSS**	**JSHS**	**GEMS**	**Unite**	**HSAP**	**REAP**	**SEAP**	**URAP**	**CQL**	**SMART**	**NDSEG**	**GEMS-NPM**
CQL	2018	NA	NA	NA	NA	NA	NA	NA	NA	54%	91%	72%	54%	33%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***30%***	***85%***	***70%***	***47%***	***30%***
eCM	2018	89%	45%	54%	76%	45%	57%	65%	53%	51%	50%	51%	38%	57%
	2019	***50%***	***16%***	***15%***	***19%***	***12%***	***15%***	***19%***	***19%***	***16%***	***15%***	***22%***	***17%***	***13%***
GEMS	2018	38%	37%	35%	89%	33%	39%	41%	44%	35%	32%	46%	40%	73%
	2019	***24%***	***27%***	***24%***	***80%***	***20%***	***30%***	***32%***	***35%***	***26%***	***26%***	***38%***	***28%***	***57%***
HSAP	2018	NA	NA	NA	NA	NA	NA	NA	NA	74%	16%	63%	21%	21%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***83%***	***39%***	***61%***	***50%***	***56%***
JSHS	2018	NA	NA	88%	NA	NA	31%	33%	33%	30%	26%	36%	27%	24%
	2019	***NA***	***NA***	***91%***	***NA***	***NA***	***33%***	***33%***	***35%***	***34%***	***26%***	***38%***	***28%***	***25%***
JSS	2018	11%	64%	15%	2%	0%	8%	9%	11%	6%	6%	NA	11%	4%
	2019	***21%***	***89%***	***16%***	***25%***	***14%***	***22%***	***18%***	***21%***	***16%***	***24%***	***24%***	***22%***	***22%***
REAP	2018	22%	NA	35%	NA	NA	NA	NA	NA	49%	31%	46%	39%	43%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***61%***	***39%***	***58%***	***39%***	***29%***
SEAP	2018	NA	NA	NA	NA	NA	NA	NA	NA	43%	54%	63%	32%	37%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***82%***	***91%***	***91%***	***73%***	***73%***
Unite	2018	NA	NA	38%	49%	76%	46%	58%	51%	42%	38%	52%	43%	40%
	2019	***NA***	***NA***	***40%***	***42%***	***77%***	***44%***	***49%***	***46%***	***35%***	***35%***	***46%***	***33%***	***32%***
URAP	2018	NA	NA	NA	NA	NA	NA	NA	NA	56%	15%	44%	29%	15%
	2019	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***81%***	***13%***	***45%***	***45%***	***16%***

As in previous evaluations, the FY19 evaluation findings suggests that youth participants and mentors across the AEOP have limited awareness of AEOPs other than those in which they are currently participating. Students and apprentices expressed interest in participating in other AEOPs in the future, however, suggesting that strategic efforts to disseminate information about AEOPs has potential to strengthen the pipeline of programs. Program administrators should continue their efforts to educate site and event coordinators, mentors, and other volunteers about AEOP opportunities so that all participants leave with a clear understanding of the AEOPs available to them.

Mid to Long-Term Evaluation

The FY19 AEOP evaluation included an alumni survey. This portion of the evaluation is used to capture near-term and mid-to long-term outcomes of AEOP participation.

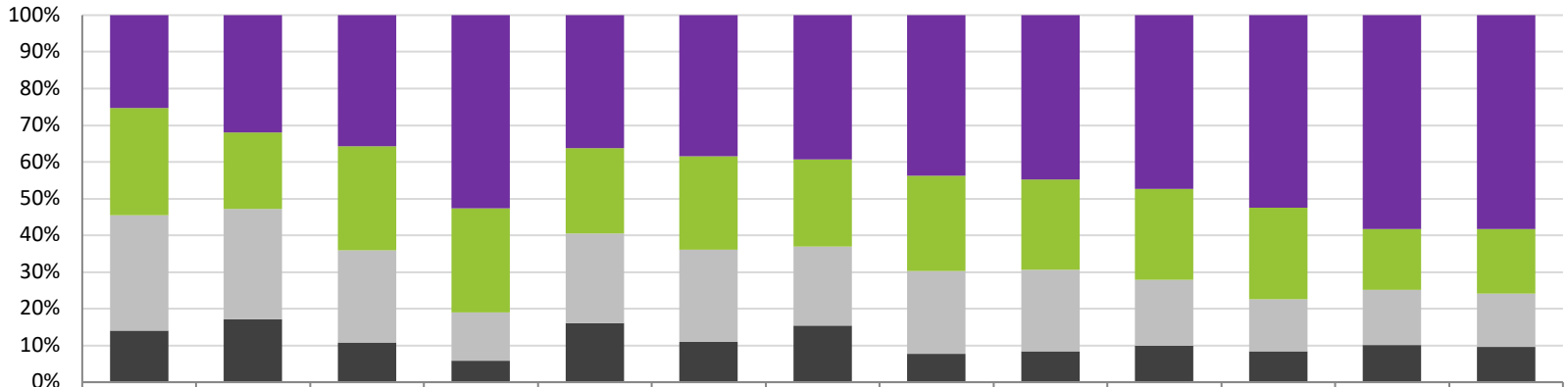
PRIORITY ONE: STEM Literate Citizenry

Research Question #1 - To what extent do alumni report positive, sustained interest and engagement in STEM?

Alumni completing the survey reported on their current interest in STEM activities (Chart 25). AEOP alumni indicated strong interest in STEM, with a majority reporting they were at least somewhat interested in participating in all STEM activities about which they were asked. Specific activities in which nearly all (90% or more) reported at least some interest were the following: ;earning about new STEM things (94%); participating in STEM community service projects (92%); participating in STEM camps, clubs, or competitions (92%); participating in STEM projects at universities/professional settings (92%); taking STEM electives (90%); earning a STEM degree (90%); and pursuing a STEM career (90%).

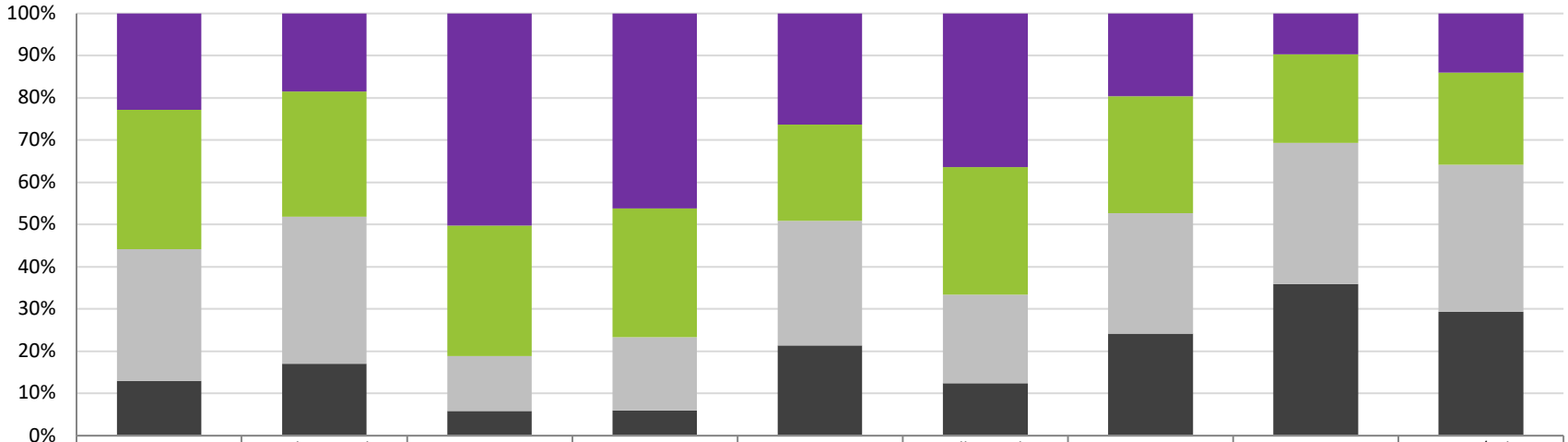
Alumni reported on their current engagement in STEM activities (Chart 26). Three-quarters or more of alumni reported sometimes or frequently engaging in activities such as learning about new things in STEM (81%) and solving math/science puzzles (77%). Additionally, half or more of alumni reported engaging in STEM sometimes or frequently by reading/watching STEM non-fiction (56%) and talking with friends/family about STEM (66%)

Chart 25: Alumni Interest in STEM Activities (*n* = 343-347)



	Reading/Watching STEM Non-Fiction	Tinkering with Mechanical/Electrical Device	Solving Math/Science Puzzles	Learning about New STEM Things	Computer Design/Programming	Talking with Friends/Family about STEM	Mentoring/Teaching Others about STEM	Participation in STEM Community Service Project	Participate/Volunteer STEM Camp, Club, or Competition	Taking STEM Electives	STEM Project/Experiment in University/Professional Setting	Earning a STEM degree	Pursuing STEM career
Very Interested	25%	32%	36%	53%	36%	38%	39%	44%	45%	47%	52%	58%	58%
Interested	29%	21%	28%	28%	23%	26%	24%	26%	25%	25%	25%	17%	18%
Somewhat Interested	31%	30%	25%	13%	24%	25%	22%	22%	22%	18%	14%	15%	14%
Not Interested	14%	17%	11%	6%	16%	11%	15%	8%	8%	10%	8%	10%	10%

Chart 26: Alumni Engagement in STEM Activities (*n* = 340-347)



	Reading/Watching STEM Non-Fiction	Tinkering with Mechanical/Electrical Device	Learning about New STEM Things	Solving Math/Science Puzzles	Computer Design/Programming	Talking with Friends/Family about STEM	Mentoring/Teaching Others about STEM	Participation in STEM Community Service Project	Participate/Volunteer STEM Camp, Club, or Competition
Frequently	23%	18%	50%	46%	26%	36%	20%	10%	14%
Sometimes	33%	30%	31%	31%	23%	30%	28%	21%	22%
Not Often	31%	35%	13%	17%	29%	21%	29%	34%	35%
Never	13%	17%	6%	6%	21%	12%	24%	36%	29%

Table 51 shows that AEOP alumni are active in STEM activities with 45% reporting that they are currently taking a STEM elective course. Over a quarter (27%) indicated they are currently pursuing a STEM degree, and 14% reported that they are already working in a STEM career.

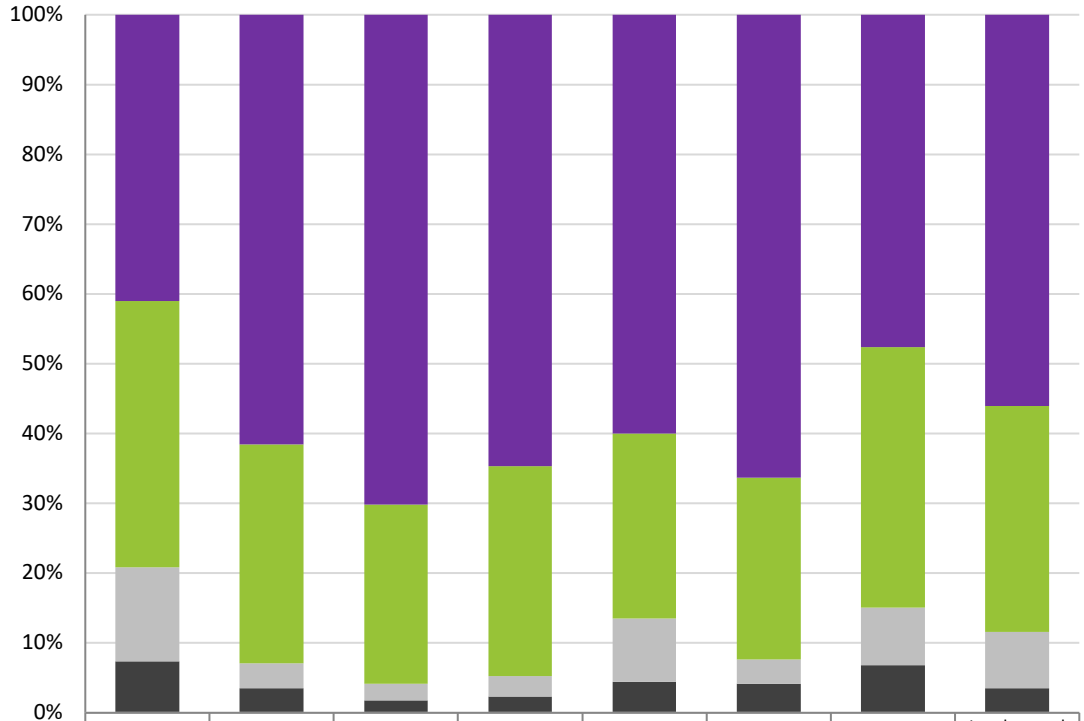
Table 51. Alumni Current STEM Activities (*n* = 358)

Item	Percentage
Taking a STEM elective	45%
Working on STEM project/experiment in university/professional setting	25%
Pursuing a STEM degree	27%
Working in a STEM career	14%

Research Question #2 - To what extent do alumni report positive attitudes toward STEM, and particularly Army/DoD STEM?

Working to create a STEM literate society is an AEOP priority and fostering positive youth attitudes toward STEM is an important component of this goal. Accordingly, alumni responded to items regarding their attitudes toward STEM in general and specifically related to Army/DoD STEM. Chart 27 shows that AEOP alumni hold extremely positive perceptions toward STEM in general with more than three-quarters at least somewhat agreeing with all items. More than 90% of participants agreed with the following items: enjoying solving real-world problems (96%); using STEM to help improve their community (95%); feeling successful in STEM classes (92%); and the belief that there are STEM careers that are a good fit with their interests (92%).

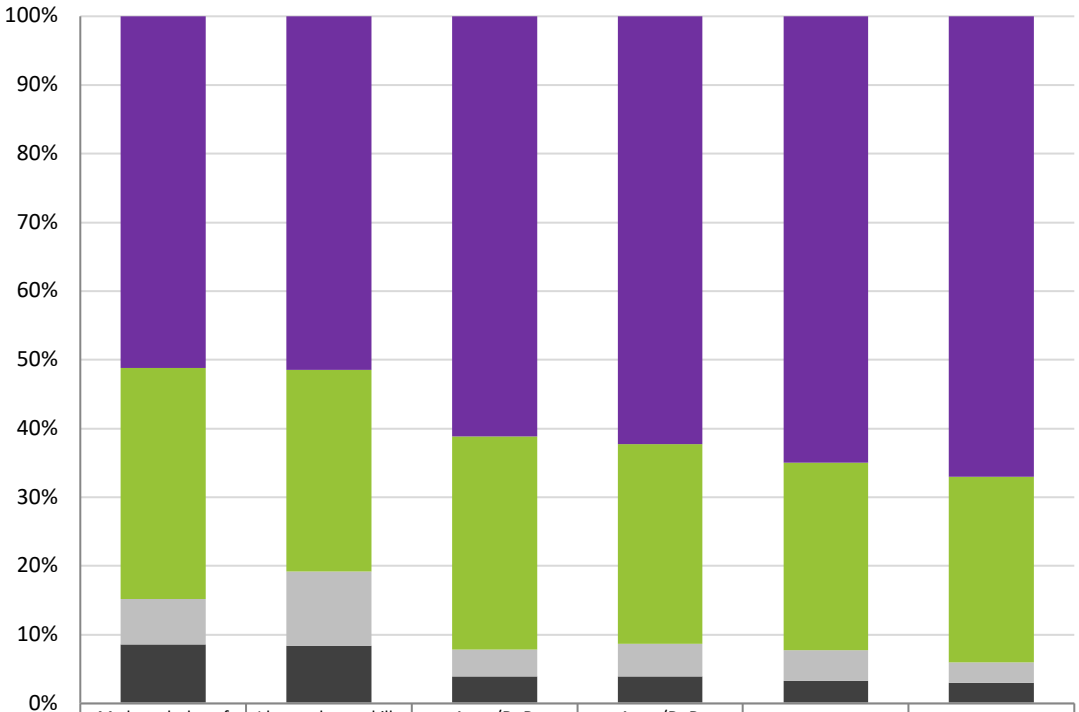
Chart 27: Alumni Attitudes Regarding STEM (*n* = 337-341)



	All people can be successful in STEM	I feel successful in STEM classes	I enjoy solving real-world problems	I can use STEM to help improve my community	I enjoy working on team projects and activities	There are STEM careers that are a good fit with my interests	I understand how STEM research is conducted	I understand how scientists and engineers work on real problems in STEM
Agree	41%	62%	70%	65%	60%	66%	48%	56%
Somewhat Agree	38%	31%	26%	30%	26%	26%	37%	32%
Somewhat Disagree	13%	4%	2%	3%	9%	4%	8%	8%
Disagree	7%	4%	2%	2%	4%	4%	7%	4%

Regarding alumni beliefs specifically related to the AEOP and Army/DoD STEM, alumni expressed highly positive views with more than 80% at least somewhat agreeing with all items (Chart 28). Nearly all alumni indicated feeling Army/DoD research is valuable to society (94%), solves real-world problems (93%), advances STEM fields (92%), and develops new, cutting edge technologies (91%).

Chart 28: Alumni Attitudes Regarding AEOP and Army/DoD STEM (*n* = 332-336)



	My knowledge of STEM increased through participating in AEOP	I learned new skills that I can use to solve STEM problems in my AEOP program	Army/DoD researchers advance science and engineering fields	Army/DoD researchers develop new, cutting edge technologies	Army/DoD researches solve real-world problems	Army/DoD research is valuable to society
Agree	51%	51%	61%	62%	65%	67%
Somewhat Agree	34%	29%	31%	29%	27%	27%
Somewhat Disagree	7%	11%	4%	5%	4%	3%
Disagree	9%	8%	4%	4%	3%	3%

Research Question #3 - To what extent do alumni report pursuit of and achievement in STEM courses in secondary school, post-secondary STEM degrees, STEM careers, and Army/DoD STEM careers?

Large numbers of AEOP alumni indicated completion of STEM coursework in high school (Table 52). Between one- and two-thirds of alumni reported having completed higher level STEM classes such as AP Math (32%), Calculus (36%), AP Science (40%), Physics (51%), and Chemistry (72%).

Table 52. Alumni Reported STEM High School Coursework Completed (*n* = 358)

HS STEM Course	Percentage
Algebra I	85%
Algebra II	75%
AP Math	32%
AP Science	40%
Biology	86%
Calculus	36%

Chemistry	72%
Computer Science	28%
Earth Science	30%
Engineering	20%
Environmental Science	26%
Geometry	81%
Human Anatomy	17%
Intro Chemistry and Physics	27%
Physics	51%
Pre-Calculus	55%

AEOP alumni reported on their enrollment in post-secondary STEM degree programs (Table 53). While more than half of alumni completing the survey were still in high school, a third (33%) of AEOP alumni indicated that they were enrolled in STEM post-secondary education (Certificate – 5%, Associate – 7%, Bachelor's – 21%). Further, 7% reported that they were post-secondary STEM degree graduates.

Table 53. STEM Degree at College or University

Degree Level	Percentage
Associate (*n* = 350)	
Yes	7%
No	39%
Still in High School	54%
Bachelor's (*n* = 350)	
Yes	21%
No	24%
Still in High School	55%
Graduate (*n* = 353)	
Yes	7%
No	38%
Still in High School	55%
STEM Certificate/Training (*n* = 349)	
Yes	5%
No	41%
Still in High School	54%

Alumni in post-secondary programs were most likely to be enrolled in engineering-focused programs (12%) (Table 54). This was followed by physical science (5%), technology/computer science (3%), life science (3%), and medicine (2%). Less than 1% of alumni reported pursuing a teaching degree. Most alumni in college reported having completed credits toward a STEM degree (Table 55).

Table 54. STEM Degree Program Enrolled In (*n* = 358)	
STEM Degree Program	**Percentage**
Business	<1%
Engineering	12%
Environmental science	<1%
Life science	3%
Mathematics or statistics	<1%
Medicine	2%
Physical science	5%
Teaching	<1%
Technology/Computer science	3%
Other	5%
Not enrolled	62%
Missing data	6%

Table 55. AEOP Alumni College Credit Hours Completed in STEM Degree Program (*n* = 358)	
STEM Credits	**Percentage**
0-30 Credits	10%
31-60 Credits	4%
61-90 Credits	4%
91-120 Credits	6%
121+ Credits	5%
Not enrolled in classes	25%
Not enrolled in STEM	4%
Still in High School	38%
Missing data	4%

Table 56 shows AEOP alumni-reported current grade point averages (GPAs). Approximately a third of alumni (30%) indicated they held a 4.0 or higher GPA. Three-quarters of alumni (75%) indicated they held a GPA of 3.0 or higher.

Table 56. AEOP Alumni College Student Current GPA (*n* = 358)	
GPA	**Percentage**
4.0 or better	30%
3.75 - 3.9	22%
3.50 - 3.74	12%
3.0 - 3.49	11%
2.5 - 2.9	3%
2.0 - 2.49	<1%
Lower than 2.0	<1%
Not enrolled	18%
Missing data	4%

A smaller subset of AEOP alumni indicated they had already completed a post-secondary STEM degree program (Table 57). Among those reporting having earned a STEM degree, approximately one-third had earned either a STEM Certificate (33%) or bachelor's degrees (29%). Fewer had earned master's degrees (19%), doctorate (10%), or associate's degrees (10%) in STEM.

Table 57. STEM Degree Program Completed	
Degree Level	**Percentage**
Associate (*n* = 358)	
Yes	4%
No	25%
Missing data	71%
Bachelor (*n* = 358)	
Yes	12%
No	21%
Missing data	67%
Master (*n* = 358)	
Yes	8%
No	16%
Missing data	76%
Doctoral (*n* = 358)	
Yes	4%
No	16%
Missing data	80%
STEM Certificate/Training (*n* = 358)	
Yes	14%
No	14%
Missing data	72%

Of the 102 questionnaire respondents who provided a title for their degree programs, 85 (83%) listed degree programs in STEM fields. Among the STEM majors, most reported being in engineering programs (49%) followed by physical science (16%), technology/computer science (12%), life science (12%), medicine (7%), mathematics or statistics (3%), and environmental science (1%).

Among the 63 questionnaire respondents who included a description of their employment in STEM-focused jobs, most reported being K-12 teachers (35%). After this were research scientists (21%), engineers (14%), STEM-related positions within the DoD (11%), technology-related (10%), university faculty (5%), and mathematics-oriented fields (4%).

Research Question #4 - To what extent do alumni report awareness of and interest in STEM research and careers overall and for the Army/DoD specifically?

Alumni were asked about general STEM research topics they had learned through AEOP as well as STEM research within the DoD. Additionally, alumni were asked to identify up to 3 Army/DoD STEM careers they had learned about in their programs.

Alumni provided a variety of responses about STEM research they learned about during their AEOP experiences. Responses included:

- 3D Printing
- Actuarial Science
- Aerospace
- Agriculture Science
- Animal Testing/Dosing
- Antenna Positioning Systems
- Artificial Intelligence
- Autonomous Vehicles
- Bacterial Cellulose
- Biochemistry
- Biological Engineering
- Biology
- Biomedical Engineer
- Biostatistics
- Biotechnology
- Cancer research
- Chemical Engineering
- Chemistry
- Computer Engineering
- Coral Reefs
- Cybersecurity
- Defense Systems
- Earth Science
- Electrical Engineering
- Electronics
- Engineering
- Environmental Science
- Food Packaging Technologies
- Genomics
- Haptics
- Health
- Materials Science
- Mechanical Engineering
- Microbiology
- Multifunctional Materials
- Nano chemistry
- Nanotechnology
- Nanoscience
- Neurobiology
- Neuroscience
- Oceanography
- Parallel Programming with GPUs
- Particle Physics
- Pharmacy
- Robotics
- Technology
- Water Research
- Wind Turbine Research
- Wireless Communications

When asked about areas of Army/DoD STEM research they had learned about during AEOP, alumni indicated the following:

- Aerospace Research
- Applied Materials Science
- Biology
- Biomechanics
- Bioscience
- Cancer
- Chem Bio Defense
- Communications
- Computer Science
- Cybersecurity
- Defense Systems
- Detection Technology
- Developing Supercomputers
- Drug Discovery/Virology
- Electronics
- Engineering
- Entomology
- Environment
- Epidemiology
- Flood Control
- Fluid Dynamics
- Forensic Biology
- High Power Lasers
- Immunology and Virology
- Infectious Diseases
- Mechanical Engineering
- Microbiological Research
- Multifunctional Materials
- Nanoparticle Fabrication
- Neuroscience
- Particle Physics
- Prototype Building
- Robotics
- Two-Dimensional Materials
- Water Purification
- Weapons
- Wireless Communications

Alumni also listed a variety of Army/DoD STEM careers they had learned about during their AEOP experiences. These included:

- Actuarial Science
- Aeronautical Engineer
- Architect
- Behavioral Analysis Specialist
- Biochemist
- Biologist
- Biomedical Engineer
- Broadcast Engineer
- Chemical Engineer
- Chemist
- Civilian Scientists
- Combat Engineer
- Computer Engineering
- Computer Science and Information Technology
- Cryptologic Engineer
- Cybersecurity Specialist
- Doctor
- Drone Scientist
- Electronics Engineer
- Forensics Scientist
- General Engineer
- Geologist
- Histologist
- Industrial Engineer
- Marine Scientists
- Material Scientists
- Mechanical Engineering
- Mechanical Engineers
- Medical Scientists
- Missile Defense Contractor
- Molecular Biologist
- Nano chemist
- Neuroscientist
- Physicist
- Radar/SONAR Engineers
- Research Scientists
- Resource Management
- Safety Engineer

- Fire Protection Engineer
- Food Scientist
- Structural Engineer
- Systems Engineers
- Urban Planner

Research Question #5 – To what extent do alumni report an increase in STEM career participation and success overall, as well as within the Army/DoD specifically?

Alumni reported on their awareness and interest in participating in STEM careers within and outside of the DoD/Army (Table 58). In general, nearly 90% of alumni were interested in pursuing a STEM career (87%). Approximately two-thirds indicated they were aware of Army/DoD STEM careers (64%), and 73% of alumni indicated they would be interested in learning more about Army/DoD STEM careers. More than half (59%) of alumni indicated that they were currently interested in pursuing an Army/DoD STEM career.

Table 58. Alumni Awareness and Interests (*n* = 339)	
Item	**Somewhat Agree/Agree**
I am aware of Army or DoD STEM careers	64%
I am interested in pursuing a career in STEM	87%
I am interested in pursuing a DoD/Army STEM career	59%
I am interested in learning more about Army/DoD careers focused on STEM research	73%

AEOP alumni reported on their STEM career plans (Table 59). Approximately three-quarters (78%) of alumni noted they plan to seek a STEM-focused career in the future. Some alumni have already applied for STEM-focused jobs (27%) or currently have a STEM-focused career (20%). More than two thirds (41%) of AEOP alumni indicated they plan to seek an Army/DoD STEM-focused career in the future, and 6% already have such a position.

Table 59. Alumni STEM Career Focus (*n* = 334)	
Item	**Yes**
I have applied for STEM-focused job positions	27%
My current job is in a STEM-focused career	20%
I plan to seek a STEM-focused career position in the future	78%
My current position is an Army/DoD STEM focused position	6%
I plan to seek an Army/DoD STEM-focused career position in the future	41%

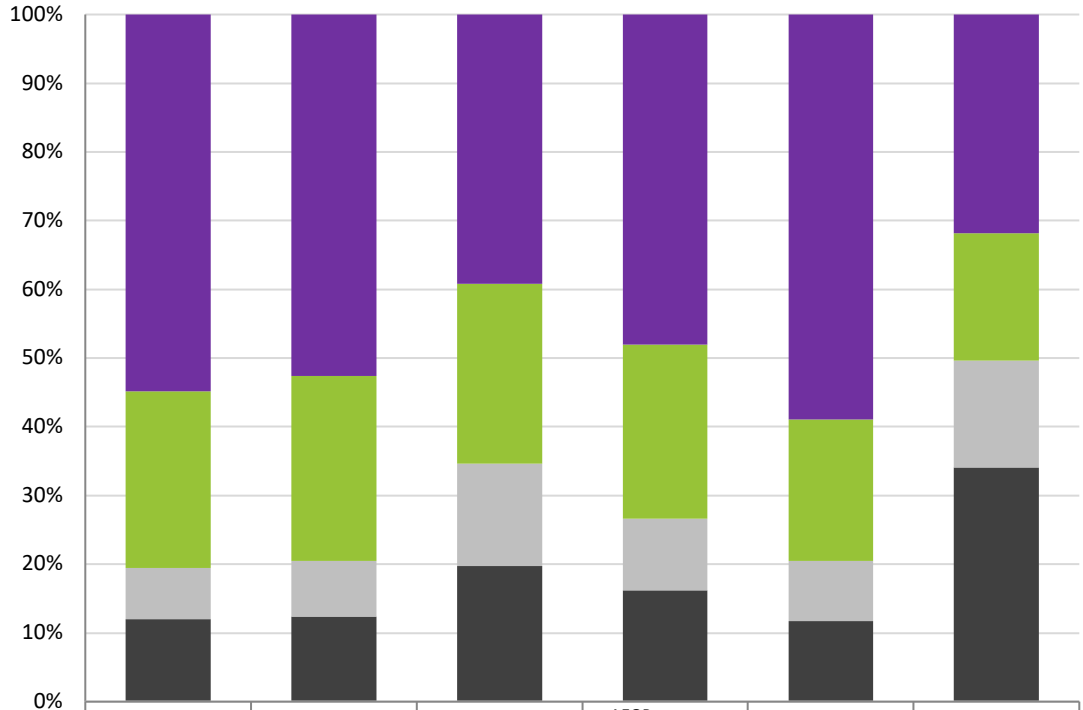
PRIORITY TWO: STEM Savvy Educators

Research Question #6 - What is the impact of Scientists and Engineers (S&E) Mentors on AEOP alumni?

AEOP alumni reported on their perceptions of the mentoring they received while in their program (Chart 29). More than three-quarters felt their mentoring experience was very positive (81%), enhanced their learning (80%), and was a valuable aspect of their AEOP (80%). Many alumni also believed their AEOP

mentor helped influence their future academic career decisions (73%) and helped them learn about Army/DoD careers (65%). While the reported mentoring relationships appeared to be strong, only half (51%) reported staying in touch with their AEOP mentor after the program.

Chart 29: Alumni Perceptions of AEOP Mentoring Received (*n* = 307-309)



	Had very positive experience working with AEOP mentors	Learning enhanced with AEOP mentor	Learned more about Army/DoD careers & research from AEOP mentor	AEOP mentors helped influence/inform my future academic & career decisions	Mentoring aspect of AEOP programs is valuable	I stayed in touch with my mentor after the AEOP program
Agree	55%	53%	39%	48%	59%	32%
Somewhat Agree	26%	27%	26%	25%	21%	19%
Somewhat Disagree	7%	8%	15%	10%	9%	16%
Disagree	12%	12%	20%	16%	12%	34%

Research Question #7 – Are there measurable changes in teacher approaches to teaching research concepts within STEM practices, and careers after participation in AEOP (RESET)?

There are no findings to report on this research question in FY19.

PRIORITY THREE: Sustainable Infrastructure

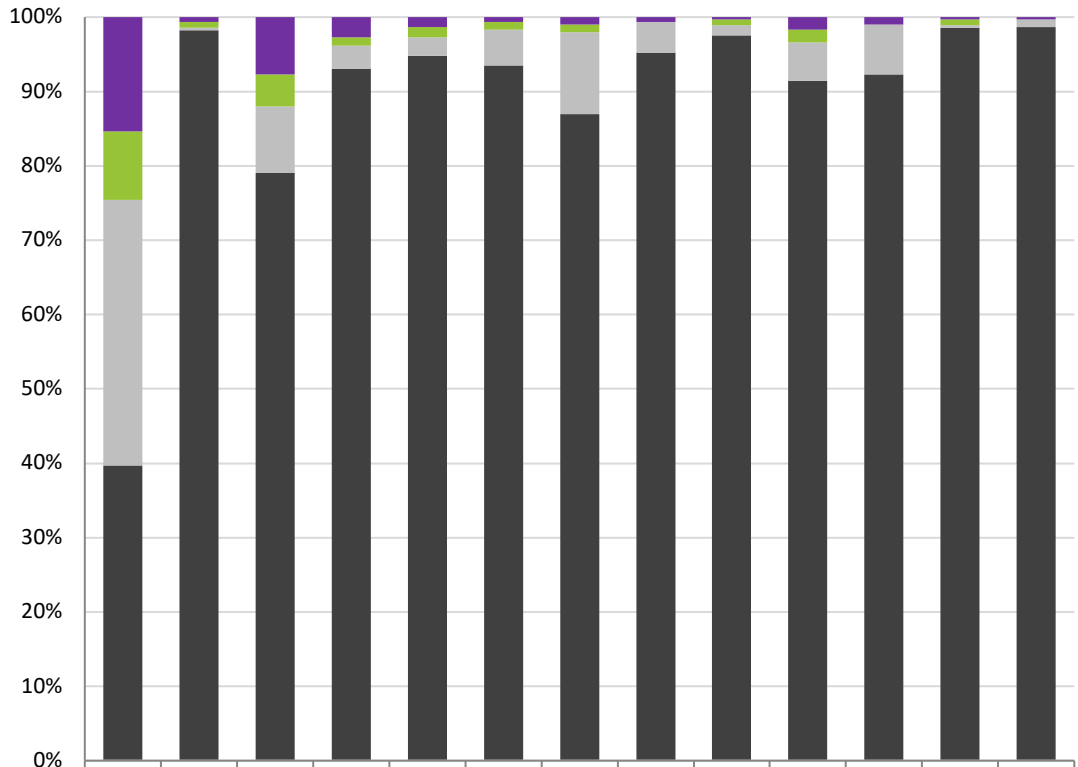
Research Question #8 - To what extent do alumni report increased awareness of and/or interest in AEOP opportunities?

AEOP alumni reported on their awareness of and interest in other AEOPs. More than half of alumni (54%) indicated that they were familiar with other AEOPs, and 75% reported being interested in participating in other AEOPs.

Research Question #9 - To what extent do alumni report participation in an AEOP program multiple times, in other AEOP elements, or in other DoD workforce development programs?

Alumni reported on past participation in AEOPs (Chart 30). While alumni participants represented all programs, eCM had the strongest representation with 60% of respondents reporting to have participated in this AEOP at least once. GEMS (21%) and REAP (13%) also had strong representation among alumni survey participants. Further, alumni survey participants reported receiving each of the AEOP scholarships: SMART (1%) and NDSEG (1%).

Chart 30: Alumni Participation in AEOP Programs (n = 287-325)



	eCybermission	JSS	GEMS	UNITE	JSHS	SEAP	REAP	HSAP	GEMS Near Peer Mentors	CQL	URAP	SMART College Scholarship	NDSEG
Three or more times	15%	1%	8%	3%	1%	1%	1%	1%	0%	2%	1%	0%	0%
Twice	9%	1%	4%	1%	1%	1%	1%	0%	1%	2%	0%	1%	0%
Once	36%	0%	9%	3%	2%	5%	11%	4%	1%	5%	7%	0%	1%
Never	40%	98%	79%	93%	95%	94%	87%	95%	98%	91%	92%	99%	99%

7 | Summary of Findings

The 2019 AEOP evaluation collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to outcomes aligned with AEOP and program objectives. A summary of findings is provided in Tables 60 and 61.

Table 60. 2019 Summary of Findings - Near Term

Priority 1: STEM Literate Citizenry *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base.*	
Finding #1	**Decline in overall student participation.** A total of 28,947 youth participated in AEOPs in 2019, a 4.5% decrease from 2018 when 30,311 youth participated and a 12% decrease as compared to 2017 when 32,947 youth participated in AEOPs. This continues the downward trend in enrollments since 2014 that was reversed in FY17 (41,802 in FY14; 38,039 in FY15; 30,972 in FY16; 32,947 in FY17; 30,311 in FY18; 28,947 in FY19). Enrollment increased in three programs (CII – 16%, JSS – 51%, and REAP – 17%), compared to enrollment increases in seven programs in FY18. The slight increases in enrollment in these four programs were offset by enrollment decreases in CQL (-5%), eCM (-11%), GEMS (-9%), HSAP (-66%), JSHS (16%), SEAP (-6%), Unite (-20%), and URAP (-24%).
	Decline in overall and adult participation. A total of 6,138 adults, including K-12 teachers and Army and DoD S&Es, engaged in AEOPs. Adult participation decreased by 37% as compared to FY18 (9,774) and 29% as compared to FY17 (8,607).
Finding #2	**Slight decline in participation for apprenticeship programs.** While participation in REAP grew in FY19 as compared to FY18 (18% increase), overall enrollment in apprenticeships decreased by 3% as compared to FY18 due to the enrollment decreases in all other apprenticeship programs noted above.
Finding #3	**Slight decline in number of applications to participate in AEOPs while placement rates remained similar to FY18.** The various AEOPs received a total of 38,339 applications in FY19, a 3% decrease from the 39,325 applications received in FY18, and a 21% decrease from the 48,419 applications received in FY17, but an increase of 2% over the 37,399 applications received in FY16. The overall placement rate across AEOPs for FY19 was similar to that of FY18 (76% in FY19, 77% in FY18), but higher than the 68% placement rate in FY17. All programs except for REAP had decreases in placement rates as compared to FY18 and most as compared to FY17. REAP placement increased to 20% (15% in FY18 and 17% in FY17): • CQL placed 31% of applicants in FY19 compared to 37% in FY18, and 41% FY17 • GEMS placed 56% of applicants in FY19 compared to 61% in both FY18 and FY17

	• HSAP placed 4% of applicants as compared to 9% in both FY18 and FY17 • SEAP placed 8% of applicants in FY19 as compared to 13% in both FY18 and FY17 • Unite placed 54% of applicants, a decrease compared to the 59% of applicants who were placed in FY18, but an increase over FY17 when 45% of Unite applicants were placed • URAP placed 19% of applicants in FY19, a slight decrease from the 20% who were placed in FY18 but an increase from the 9% placed in FY17. The placement rate for apprentice programs overall decreased from 18% in FY18 to 15% in FY19.
Finding #4	**AEOPs continued to serve underserved populations and served a larger proportion of U2 students in FY19 as compared to FY18.** The AEOPs continued to prioritize the participation of students from traditionally underserved groups, per the AEOP definition of underserved (U2): *AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to racial and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other federally targeted outreach schools; females in certain STEM fields.* Overall, 56% of AEOP youth participants in FY19 met the AEOP definition of U2, an increase from FY18 when 46% of youth participants met the definition of U2. REAP and UNITE served a population of students that was comprised of over 90% U2 participants. JSS, HSAP, and eCM each had more than 50% U2 participants. GEMS, JSHS, CQL and SEAP had between 30% and 45% U2 participation. One apprenticeship program (URAP) included less than 30% U2 students.
Finding #5	**Participants reported engaging in STEM practices significantly more in their AEOP programs as compared to in their typical school experiences for most programs.** In all programs except JSS and JSHS, student participants reported engaging in STEM practices significantly more frequently in their AEOPs compared to in their typical school experiences, indicating that AEOPs exposed participants to more intensive engagement in STEM than they typically experience in school. Significant differences ranged from medium to extremely large effect sizes. It is important to note that competition programs (eCM, JSS, and JSHS) may be used as part of students' in-school learning experiences. Thus, students in these programs may not easily distinguish between their AEOP and in-school STEM engagement.
Finding #6	**Participants reported increased STEM competencies, STEM skills, STEM knowledge, STEM practices, and confidence in STEM after participating in AEOPs.** • Participants from all programs reported gains in their STEM knowledge after participating in AEOPs. All programs averaged between "some" and "large" gains, with the exceptions of eCM and JSS which averaged slightly lower gains ("a little" to "some" gains). • AEOP participants across all programs reported gains in their STEM competencies. FY19 gains were slightly greater than those in FY18 for approximately half of the programs (CQL, HSAP, JSHS, JSS, SEAP, URAP).

	• Participants in each program reported gains in their 21st Century skills. Most programs reported slightly lower gains in FY19 compared to FY18 except for eCM NJ&EE and SEAP which reported slightly greater gains. • Participants across AEOPs reported some level of gains in their STEM identity, and these gains were greater in the FY19 evaluation compared to FY18 for all programs except for JSS and Unite. • Approximately half or more of participants across programs (range 48%-100%) agreed their AEOP experience contributed to their increased confidence and/or interest in each item. As in past years, students were most likely to agree strongly that AEOP impacted their confidence in their STEM knowledge, skills, and abilities (range 62%-100%).
Finding #7	**Participants demonstrated increased attainment toward mastery of 21st Century skills across their participation in the AEOPs.** Participants from apprenticeship programs (CQL, SEAP, REAP, URAP, HSAP) and STEM programs and competitions (Unite and eCM mini-grant) demonstrated growth in their 21st Century skills as measured by their mentors using the 21st Century Skills Assessment from baseline (first days of program) to the end of the program. This growth was significantly significant in most cases: • Statistically significant growth in creativity and innovation skills was observed for all programs (range +0.48 to +0.87) except for SEAP (+0.13). • Statistically significant growth in participant critical thinking and problem-solving skills was observed for all programs (range +0.45 to +0.86) except SEAP (+0.31). • Statistically significant growth in communication, collaboration, social, and cross-cultural skills was observed for all programs (range +0.34 to +1.31) except SEAP (+0.25). • Statistically significant growth in information, media, and technological literacy skills was observed for all programs (range +0.50 to +0.84) except for CQL (+0.33). • Statistically significant growth in flexibility, adaptability, initiative, and self-direction was observed for all programs (range +0.43 to +0.87) except CQL (+0.30). • Statistically significant growth in productivity, accountability, leadership, and responsibility skills was found for all programs (range +0.50 to +1.25) except for CQL (+0.24) and SEAP (+0.35), programs for which baseline assessments were slightly higher than other programs.
Finding #8	**Participants reported positive attitudes toward Army/DoD STEM Research.** A majority of participants across programs agreed that Army/DoD research and researchers advance science and engineering fields. With the exception of eCM on two items, more than half of participants in all programs agreed that Army/DoD research and researchers advance science and engineering fields (range 46%-100%); develop new cutting-edge technologies (range 47%-97%); that DoD researchers solve real-world problems (range 52%-100%); and that DoD research is valuable to society (range 52%-100%). The strongest rates of agreement with these statements (averaging 90% or higher) continues to be from apprentices at programs hosted at DoD laboratories and centers (CQL and SEAP) and DoD-sponsored college/university laboratories (HSAP

	and URAP). Participants at programs hosted by non-DoD affiliated college/university laboratories and settings (REAP and Unite) had positive, but somewhat lower, rates of agreement. Competition programs (eCM and JSS) had the lowest rates of agreement, averaging two-thirds or below (range 46%-67%), however JSHS and eCM NJ&EE averaged over three-quarters (range 77%-99%) agreement across items.
Finding #9	**Evaluation findings indicated that the AEOP exposed participants to STEM careers generally and to Army and DoD STEM careers, and indicated that participating in AEOPs increased participants' interest in pursuing STEM careers.** In all programs except eCM (42%) and HSAP (33%), approximately half or more of participants (range 49%-94%) reported learning about three or more general STEM careers. Smaller proportions of students (range 10%-89%) had learned about Army/DoD STEM careers as compared with STEM careers more generally). Half or more of students (range 51%-89%) in CQL, eCM NJ&EE, GEMS, SEAP, and Unite reported learning about three or more DoD STEM careers. Half or more of students (range 51%-89%) in CQL, eCM NJ&EE, GEMS, SEAP, and Unite reported learning about three or more DoD STEM careers. In FY19 a greater proportion of participants in four programs (CQL, eCM NJ&EE, and Unite) reported having learned about these jobs as compared to FY18. As in previous years, comparisons of participants in AEOPs held at Army laboratories and centers (CQL, GEMS, and SEAP), with participants at Army-sponsored university labs (HSAP and URAP), and non-Army affiliated settings (eCM Regional, JSHS, REAP, and Unite) show that, on average, participants at DoD sites learned about more DoD STEM careers. It is important to note, however, that nearly all (89%) of eCM National students and more than half of Unite students (61%) reported learning about three or more DoD STEM careers although they participated in programs at non-Army affiliated settings. As in previous years, more participants in some programs reported their AEOP experiences were impactful in this area (e.g., SEAP – 100%, URAP – 90%, CQL – 79% and eCM NJ&EE – 79%) than did participants in programs such as regional e-CM (35%) and JSHS (43%). Programs for which participants tend to report the greatest impact in this area are those in which participants have exposure to Army/DoD STEM researchers and/or facilities during program activities.
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	
Finding #1	**Adult participants (i.e. mentors, S&E's, Team Advisors, teachers) reported use of effective mentoring strategies in varying degrees across the AEOPs in FY19.** A majority of mentors across programs reported using strategies associated with each area of effective mentoring. Across programs, mentors were most likely to indicate they implemented strategies to engage students in authentic STEM activities (range 75%-98%) and support the development of collaboration and interpersonal skills (range 75%-93%). Mentors were least likely to report using strategies to support students' STEM educational and career pathways (range 51%-81%).

Finding #2	**In FY19, participants continued to be satisfied with the support received from their mentors/S&Es/Team Advisors/teachers.** More than half of students across AEOPs reported high levels of satisfaction with their mentors and the quality of instruction they received (range 57%-90%). Compared to FY18, levels of satisfaction with mentorship were slightly higher in FY19 for SEAP, Unite, and URAP and were unchanged for CQL. However, levels of satisfaction with mentors in GEMS, HSAP, and REAP were lower than in FY18.
Priority 3: Sustainable Infrastructure *Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.*	
Finding #1	**The primary means of learning about AEOPs and associated opportunities continues to be personal connections, school/university connections, past participants, or someone connected directly with AEOPs.** A continued strength of AEOP is the expansive network of connections to local communities that serves as a continued means of recruitment for the program, suggesting that program alumnae and those who work for the DoD often act as informal ambassadors for these programs. For REAP, GEMS, SEAP, and HSAP, about a fifth or more of youth participants (21%-28%) reported that the AEOP website was a source of information about AEOPs. The same was true for adult participants (20%-43%) in JSS, REAP, URAP, and HSAP. Overwhelmingly, participants and mentors reported that AEOP social media was much less frequently used as a means for introducing them to the AEOP.
Finding #2	**Despite limited past participation and awareness of AEOP opportunities on the part of both participants and mentors, FY19 participants reported interest in participating in AEOP initiatives in the future.** Very few participants had ever participated in any AEOP other than the one in which they were currently enrolled with the exception of the 23% of CQL apprentices who reported they had participated previously in GEMS, and the 38% of SEAP participants who reported having participated in GEMS. These findings suggest there is a relatively robust pipeline relationship between the Unite and REAP and GEMS and SEAP programs. Findings suggest that youth participants and mentors across the AEOP continue to have limited awareness of AEOPs other than those in which they are currently participating. Participants primarily expressed interest in repeating participation in the AEOP in which they were currently enrolled (range of 50%-91%), but also expressed interest in participating in other AEOPs. The most interest was expressed in SMART, a program for which nearly half or more of participants in the following programs expressed interest: URAP (45%), Unite (46%), REAP (58%), HSAP (61%), CQL (70%), and SEAP (91%).
Finding #3	**Participation rates in the AEOP evaluation increased overall for FY19 but room for improvement remains.** Participation in the evaluation questionnaire increased overall from 12% in FY18 to 16% in FY19. Rates of response in six programs increased: GEMS (students), HSAP (apprentices and mentors), JSHS (regional and national students and mentors), JSS (mentors), Unite (students), URAP (apprentices and mentors). All Unite students (100%) responded to the questionnaire in FY19. Participation for all programs and groups other than those mentioned above declined slightly for FY19, with substantial declines in the

	participation of REAP apprentices and mentors (19% and 30% respectively in FY19 compared to 48% and 57% in FY18). Questionnaire participation rates were particularly low for JSS (3.5% for students and 3% for mentors) and for mentors in CQL (8%), GEMS (7%), and SEAP (9%).

Table 61. 2019 Summary of Findings - Mid to Long Term	
Priority 1: STEM Literate Citizenry *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base.*	
Finding #1	**AEOP alumni report sustained interest and engagement in STEM.** A majority of AEOP alumni reported being interested in participating in a wide variety of STEM activities. Nearly all alumni (90% or more) reported at least some interest in the following activities: learning about new things in STEM (94%); participating in STEM community service projects (92%); participating in STEM camps, clubs, or competitions (92%); participating in STEM projects at universities/professional settings (92%); taking STEM electives (90%); earning a STEM degree (90%); and pursuing a STEM career (90%).
Finding #2	**Alumni are engaged in pursuing STEM opportunities and careers.** Nearly half (45%) of alumni reported that they were currently taking a STEM elective course. Over a quarter (27%) indicated they were currently pursuing a STEM degree, and 14% reported that they were already working in a STEM career.
Finding #3	**AEOP Alumni participate in other STEM-related activities.** Three-quarters or more of alumni reported either sometimes or frequently engaging in activities such as learning about new things in STEM (81%) and solving math/science puzzles (77%). Additionally, half or more of alumni reported engaging in STEM sometimes or frequently by reading/watching STEM non-fiction (56%) and talking with friends or family about STEM (66%).
Finding #4	**Alumni hold positive views toward the AEOP and Army/DoD STEM.** More than three-quarters of alumni indicated that their AEOP participation had impacted their knowledge of STEM (85%) and problem-solving skills (80%). Nearly all alumni indicated that they believe Army/DoD research is valuable to society (94%), solves real-world problems (93%), advances STEM fields (92%), and develops new, cutting edge technologies (91%).
Finding #5	**Alumni report awareness of and interest in STEM careers generally, as well as with the Army/DoD specifically.** Nearly 90% of alumni indicated that they were interested in pursuing a STEM career (87%). Approximately two-thirds indicated they were aware of Army/DoD STEM careers (64%), and 73% of alumni indicated they would be interested in learning more about Army/DoD STEM careers. More than half (59%) of alumni indicated that they were currently interested in pursuing an Army/DoD STEM career.

Finding #6	**AEOP Alumni reported completing STEM coursework and being enrolled in STEM degree programs.** Between one- and two-thirds of alumni reported having completed higher level STEM classes in high school such as AP Math (32%), Calculus (36%), AP Science (40%), Physics (51%), and Chemistry (72%). While more than half of alumni completing the survey were still in high school, a third (33%) indicated that they were enrolled in STEM post-secondary education (Certificate – 5%, Associate – 7%, Bachelor's – 21%). Alumni currently enrolled in post-secondary programs were most likely to be enrolled in engineering-focused programs (12%), followed by physical science (5%), technology/computer science (3%), life science (3%), and medicine (2%). Less than 1% of alumni reported pursuing a teaching degree. Most alumni in college reported having completed credits toward a STEM degree. A small number of alumni respondents (7%) reported that they were post-secondary STEM degree graduates. Among those, approximately one-third had earned either a STEM Certificate (14%) or bachelor's degrees (29%). Fewer had earned master's degrees (19%), doctorates (10%), or associate's degrees (10%) in STEM.
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	
Finding #1	**Alumni reported very positive impacts of their mentors and agreed mentoring is a valuable aspect of AEOPs.** More than three-quarters of alumni reported that their AEOP mentoring experience was very positive (81%), enhanced their learning (80%), and was a valuable aspect of their AEOP (80%). Many alumni also believed their AEOP mentor helped influence their future academic career decisions (73%) and helped them learn about Army/DoD careers (65%). While the reported mentoring relationships appeared to be strong, only half (51%) reported staying in touch with their AEOP mentor after the program.
Priority 3: Sustainable Infrastructure *Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.*	
Finding #1	**Alumni reported strong interest in participating in other AEOPs, although alumni familiarity with other AEOPs is still limited** More than half of alumni (54%) indicated that they were familiar with other AEOPs (53% in FY18), and 75% reported being interested in participating in other AEOPs (77% in FY18).

What AEOP Participants are saying…..

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

*"Having been a participant in **CQL** and the **SMART** program myself, I wouldn't be here without the AEOP and everyone behind it. Thank you. Now today as a researcher, I couldn't do my job without the CQL*

program, specifically. It's the easiest and best way that I can get the best talent to work with me here at the lab." (CQL Mentor)

*"I was very happy with my experience in **eCYBERMISSION**. I think this competition is a great experience for all new researchers to 'dip their toes in the water' of the vast pool that is the world of STEM. As this was my first research competition, I can definitely say that I have a newfound interest in widening my horizons and continuing to explore STEM."* (eCM-R Student)

*"I've participated in **eCYBERMISSION** for 17 years and absolutely LOVE this competition. The experience is unmatched in the middle school competition-world for benefits to students and the quality of the competition. From the high-quality interactions with cyber guides and NSTA personnel to the process itself, eCM can't be beaten... Solving real-world problems using STEM and working as a team are obvious benefits but our students learn so much more in a comprehensive program like this. They not only learn science, they learn many types of technology skills, interpersonal skills, skills for interviews and phone calls, work etiquette with professionals and much more."* (eCM Team Advisor)

*"My **GEMS** experience was great. I got to meet new people and learn how to do things I can do at home…My mentors were very nice and helped me whenever I needed them to. The [speakers] they brought in were really cool and showed us a lot of cool stuff."* (GEMS Student)

*"I really enjoyed participating in **GEMS** as a mentor. I feel like I had the opportunity to impact a lot of kids lives because of this program. I hope that I was able to share my love for science with the kids and that they also developed a love for STEM overall. I also felt like I learned a lot through this program. I hope to be back again next year."* (GEMS NPM)

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

*"I enjoy it when you see the smile when the students learn a new thing. There's these wow moments and light bulb moments... I will benefit from [the **HSAP** and **URAP**] network…it's a mutual educational benefit."* (HSAP Mentor)

*"I had an amazing time at **JSHS**. The biggest takeaway for me is that I want to look into research opportunities for the DoD. Meeting the judges and researchers at the competition inspired me to potentially pursue going into STEM research to help defend our country."* (N-JSHS Student)

*"I greatly appreciate **JSHS** as an educator. It provides an important venue for students to think and interact like professional scientists."* (JSHS Mentor)

*"**JSS** has helped me learn new creative skills, leadership, and participation abilities I hope to use in the future."* (JSS Student)

"*I am very satisfied with the **JSS** experience. I am so grateful for having this opportunity with my students. I want to say THANK YOU to TSA and everyone who was involved in this unforgettable event. Thank you!"* (JSS Team Advisor)

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

"*[**REAP**] is one of the most meaningful activities I participate in during the year.. It is amazing to see the transformation of these students, who are wonderful and talented to begin with, throughout the summer. They gain confidence, build both technical and communication skills and become team members within their labs…The project is so beneficial to our faculty too. Thank you for allowing my campus participate!*" (REAP Mentor)

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

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

*"[**Unite**] gave me the opportunity to be ahead of my classes, meet new people, come out of my comfort zone and express and project my voice... Also It gave me the feeling and view of college - what it would be like, classes and how professors really teach."* (Unite Student)

*"The [**Unite**] program continues to be an excellent means for introducing high school students to STEM fields that they might not otherwise be exposed to."* (Unite Mentor)

*"This summer [in **URAP**] I gained a new perspective and appreciation for the research process. I was able to work in a completely new field and learn about my strengths and weaknesses in research…I was able to start refining my research interests. Overall, this summer was extremely impactful in allowing me to realize that with time and dedication I can conduct scientific research."* (URAP Apprentice)

*"For me, [serving as a **URAP** mentor] has meant giving opportunities to these students whom I care about, and showing them research, what it should be, and how the Army fits into the picture of basic research."* (URAP Mentor)

Recommendations for FY20 Program Improvement/Growth

AEOP had another very successful year in FY19 of program implementation. Thousands of students in K-12 schools were engaged in STEM programs, competitions, and apprenticeships including a growing percentage of underserved students (56% for FY19 compared to 46% in FY18). Post-secondary students were also engaged in apprenticeships with university and Army researchers. As in previous years, much can be learned from the experiences of our participants and partners. The evaluation team has synthesized FY19 evaluation findings to provide recommendations for FY20 and beyond that will drive continuous program improvement and those are shared in alignment with the AEOP Priorities below:

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

Increase and broaden participation in selected AEOP programs. AEOP continued to engage thousands of participants in FY19 (29,847) and CII, JSS, and REAP all experienced individual program growth. However, there was a slight decrease in participants (4.5%) for the year overall. Some can be attributed to some programs having fewer sites who participated this year. HSAP had the greatest decrease in numbers, dropping 66% followed URAP at 24% and Unite at 20%. It is recommended that in FY20 and beyond that programs which have the capacity to grow utilize new and innovative means to market and communicate opportunities to new audiences. This may include new initiatives to engage a larger group of teachers though webinars and other forms of virtual communication due to COVID-19 challenges. A majority of participants in AEOP programs are recruited by a teacher or the school that they attend.

Examine means for increasing infrastructure to grow placement rates in JSHS and apprenticeship programs. Placement rates in FY19 remained steady compared to FY18 at around 76% indicating that AEOP programs overall have not been able to grow their capacity of students served. It is understood that most programs do not have the financial or structural means to grow the number of participants. However, there remains a much greater demand for AEOP programming than the current consortium is positioned to meet. This presents an opportunity for strategic investments in new efforts to engage more people if the Army is interested in doing so.

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

As in FY17, continue to focus on strengthening role of adults in mentoring and instruction. In FY18, most program mentors reported 75-98% use of the various effective mentoring strategies with their participants. In FY19 the area that emerged as the most challenging for mentors and less frequently used were strategies to support students' STEM educational and career pathways. It is recommended that the Army and AEOP consortium consider developing resources for mentors that could be used across programs to engage students in learning more about the possibilities for their future in STEM degree programs and careers. This can also include an emphasis on DoD and Army STEM careers.

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

Increase awareness of AEOP programs. The impact of AEOP participation is significant on AEOP Alumni. However, in the FY19 evaluation, Alumni expressed strong interest in participation in other AEOP's despite very little familiarity with what was available. It is recommended that more effort be expended to provide resources to all current AEOP participants regarding AEOP programming. Further, a communication plan for alumni should be implemented that includes more frequent and varied ways of connecting information about programs with alumni.

Participation in AEOP evaluation. As in FY18, there were some programs that had less than desired engagement in the evaluation activities – including student participants (JSS), and low mentor participation (CQL, GEMS, and SEAP). Undoubtedly these challenges will continue with COVID-19 impacts on programming for FY20. It is recommended that the AEOP programs continue to communicate the importance of participation in the evaluation and provide multiple reminders across the duration of their program at strategic times to make completion of the tasks a bit easier for staff.