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Army Educational Outreach Program

2017 Summative Evaluation Report

PART 2: Evaluation Findings

May 2018

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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.

2017 Portfolio Overview

This report includes a detailed evaluation of the FY17 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, and collaborating organizations including Army and DoD laboratories. Overall participant data summarized for youth and adults by program are presented in Table 2. Partner participation is outlined in Table 3 including the numbers of collaborating schools, both K-12 and college/universities, as well as Army and DoD laboratories, and S&Es. Program costs are detailed in Table 4.

In FY17, AEOP initiatives served 32,947 participants, an 6% increase over the 30,972 participants, served in FY16. A total of 8,714 adults participated in FY17 AEOP activities, including 2,248 Army S&Es and other adults serving in mentor roles for research apprenticeships (CQL, REAP, SEAP, and URAP), judges for competitions (eCM, JSS, and JSHS), and presenters in STEM enrichment activities (GEMS and Unite) as well as in Army/DoD STEM showcases at competitions (eCM and JSHS). There was a slight increase in adult participants for the AEOP in FY17 as compared to FY16 when 8,063 adults took part in programs, however adult participation remains lower than in FY15 when 9,152 adults participated in AEOP activities.

Table 1. 2017 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 for K-6 students
Number of Participants	1,425
Number of Adults - Teachers & Leadership Interns	112
Number of Sites	17
Number of Army Research Laboratories	11
Total Cost	$337,583
Cost Per Student Participant	$237
College Qualified Leaders (CQL) **Program Administrator: Academy of Applied Science (AAS)**	
Description	STEM Apprenticeship Program – Summer or school year, at Army laboratories with Army S&E mentors
Participant Population	College undergraduate students
Number of Applicants	565
Number of Participants	229
Placement Rate	41%
Total Number of Adults	206
Number of Adults – Army S&E's	206
Number of Army Research Laboratories	12
Number of Colleges/Universities	102
Number of HBCU/MIs	4
Total Cost	$1,874,600
Administrative costs (includes salaries, fringe, indirect, cost share)	$120,154
Participant Stipends	$1,745,018
Other Operational Costs	$9,428
Cost Per Student Participant	$8,186
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 Participants	21,277
Placement Rate	NA (all students who register may participate)
Submission Completion Rate	71%
Total Number of Adults	3,253
Number of Adults - Teachers (Team Advisors)	795
Number of Adults - Army S&Es	1,200
Number of Adults – University P.I.'s/S&E's	120
Number of Adults - Other (Ambassadors, Cyberguides, Virtual Judges)	1,138
Number of Army/DoD Research Laboratories	46
Number of K-12 Schools	776
Number of K-12 Schools – Title I	290
Number of Colleges/Universities	62

Number of DoDEA Students	449
Number of DoDEA Teachers	20
Number of DoDEA Schools	16
Number of Other Collaborating Organizations	12
Total Cost	$2,980,003
Administrative costs (includes salaries, fringe, indirect)	$1,470,332
eCYBERMISISON Mini-Grant Awards	$192,471
National Judging & Educational Event	$322,828
Scholarships and Awards (includes Teacher awards)	$556,746
Other Operational Costs	$437,626
Cost Per Student Participant	$140
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	4,653
Number of Participants	2,845
Placement Rate	61%
Total Number of Adults	510
Number of Adults – Teachers	62
Number of Adults – Army S&E's	281
Number of Adults – Other	167
Number of Army Research Laboratories	15
Number of K-12 Schools	924
Number of K-12 Schools – Title I	315
Number of Colleges/Universities	74
Number of DoDEA Students	27
Number of DoDEA Teachers	0
Number of DoDEA Schools	5
Total Cost	$1,306,404
Administrative costs (includes salaries, fringe, indirect)	$214,212
Participant Stipends	$883,639
Equipment and Supplies	$175,128
Other Operational Costs	$33,425
Cost Per Student Participant	$459
High School Apprenticeship Program (HSAP) **Program Administrator: Academy of Applied Science (AAS)**	
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	629
Number of Participants	54

Placement Rate	9%
Total Number of Adults	40
Number of Adults – University P.I.'s/S&E's	40
Number of K-12 Schools	53
Number of K-12 Schools – Title I	15
Number of Army-Funded College/University Laboratories	36
Number of College/Universities	36
Number of HBCU/MSIs	20
Total Cost	$230,961
Administrative costs (includes salaries, fringe, indirect, cost share)	$49,579
Participant Stipends	$164,355
Other Operational Costs	$17,027
Cost Per Student Participant	$4,277
Junior Science & Humanities Symposium (JSHS) **Program Administrator: Academy of Applied Science (AAS)**	
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	8,900
Number of Participants	5,577 Regional Participants (of whom 230 were selected to attend the National JSHS Symposium)
Placement Rate	65%
Total Number of Adults	3,555
Number of Adults – Teachers	998
Number of Adults – Army S&E's	246
Number of Adults – University P.I.'s/S&E's	2,311
Number of Army/DoD Research Laboratories	37
Number of K-12 Schools	1,024
Number of K-12 Schools – Title I	378
Number of DoDEA Teachers	20
Number of DoDEA Students	246
Number of Colleges/Universities	112
Number of Other Collaborating Organizations	200
Total Cost	$2,019,112
Administrative costs (includes salaries, fringe, indirect, cost share)	$299,732
Regional Site Awards	$747,987
National Program	$497,265
Scholarships and Awards (includes Teacher awards)	$421,000
Other Operational Costs	$53,129
Cost Per Student Participant	$362
Junior Solar Sprint (JSS) **Program Administrator: Technology Student Association (TSA)**	

Description	STEM Competition - Solar car competition regional events at 3 Army laboratories and at 17 TSA state events, 1 national event hosted in conjunction with the TSA national conference
Participant Population	5th-8th grade students
Number of Applicants/Participants	1200 total registered applicants; 892 participants
Placement Rate	NA (all students who register may participate)
Total Number of Adults	327
Number of Adults – Teachers	255
Number of Adults - Army S&Es	37
Number of Army/DoD Research Laboratories	NA
Number of Adults – Other	35
Number of K-12 Schools	312
Number of K-12 Schools – Title I	92
Number of DoDEA Students	124
Number of DoDEA Schools	3
Number of Other Collaborating Organizations	3 (SAME, Sullivan Solar Company, Florida Governor's Council on Indian Affairs Tribal Affairs)
Total Cost	$50,000
Administrative Cost to TSA	$106,422
Other Operational Costs	$25,670
Cost Per Student Participant	$168
Research & Engineering Apprenticeship Program (REAP) **Program Administrator: Academy of Applied Science (AAS)**	
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	709
Number of Participants	118
Placement Rate	17%
Total Number of Adults	119
Number of Adults – Army S&E's	118
Number of College/Universities	41
Number of HBCU/MSIs	24
Total Cost	$390,924
Administrative costs (includes salaries, fringe, indirect, cost share)	$126,814
Participant Stipends	$251,000
Other Operational Costs	$13,110
Cost Per Student Participant	$3,313
Research Experiences for STEM Educators and Teachers (RESET)	
Description	RESET provides a summer research experience at participating Army Laboratories and on-line for

	teachers and educators from "high need" areas across the nation. The goal is to reinforce teachers' content knowledge through research experiences and interactions with Army and DoD scientists and engineers and to support teacher participants as they translate this knowledge and experience into enhanced STEM research curricula for use in their classroom.
Participant Population	Middle school and high school STEM educators
Number of Applicants/Teachers	25 full, 128 partial
Number of Participants (Teachers)	20
Placement Rate (percentage)	80%
Submission Completion Rate	100%
Total Number of Adults	23
Number of Adults - Army S&Es	3
Number of Army/DoD Research Laboratories	3
Number of K–12 Schools	19
Number of K–12 Schools — Title I	10
Number of Colleges/Universities	1
Number of Other Collaborating Organizations	7
Total Cost	$141,661
Administrative costs (includes salaries, fringe, indirect, cost share)	$55,200
Participant Stipends	$83,068
Other Operational Costs	$3,393
Cost Per Participant	$7,083
Science & Engineering Apprentice Program (SEAP) **Program Administrator: Academy for Applied Science (AAS)**	
Description	STEM Apprenticeship Program – Summer, at Army laboratories with Army S&E mentors
Participant Population	9th-12th grade students
Number of Applicants	852
Number of Participants	113
Placement Rate	13%
Total Number of Adults	119
Number of Adults - Army S&E's	119
Number of Army Research Laboratories	11
Number of K-12 Schools	55
Number of K-12 Schools – Title I	14
Total Cost	$419,955
Administrative costs (includes salaries, fringe, indirect, cost share)	$59,180
Participant Stipends	$356,132
Other Operational Costs	$4,643
Cost per student participant	$3,717
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	782
Number of Participants	358
Placement Rate	45%
Total Number of Adults	402
Number of Adults – Teachers	65
Number of Adults - Army S&Es	38
Number of Adults – University P.I.'s/S&E's	92
Number of Adults – Other	207
Number of Army DoD Research Laboratories	2
Number of K-12 Schools	149
Number of K-12 Schools – Title I‡	110
Number of Colleges/Universities	18
Number of HBCU/MSIs	13
Total Cost	$662,000
Administrative costs (includes salaries, fringe, indirect)	$128,533
Unite site awards	$500,148
Other Operational Costs	$33,319
Cost Per Student Participant	$1,849
Undergraduate Research Apprenticeship Program (URAP) Program Administrator: Academy of Applied Science (AAS)	
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	239
Number of Participants	59
Placement Rate	38%
Total Number of Adults	49
Number of University P.I.'s/S&E's	49
Number of Army-Funded College/University Laboratories	41
Number of College/Universities	41
Number of HBCU/MSIs	17
Total Cost	$246,405
Administrative costs (includes salaries, fringe, indirect, cost share)	$54,091
Participant Stipends	$172,525
Other Operational Costs	$19,789
Cost Per Student Participant	$4,176

† *College/universities or Army/DoD Research Laboratories served as host sites for the AEOP element.*

‡ Data from Unite reflects the number of participants from Title I schools rather than the number of Title I schools.
† College/universities or Army/DoD Research Laboratories served as host sites for the AEOP element.
‡ Data from Unite reflects the number of participants from Title I schools rather than the number of Title I schools.

Youth and adult participation data for individual programs are presented in Table 2. A total of 32,947 youth and 8,714 adults participated in AEOPs in FY17, a 6% and 9% increase respectively compared to FY16 when 30,973 youth and 8,063 adults participated. Of the 2017 participants, 855 students and 40 teachers were from 46 DoDEA schools (participating in eCM, JSS, GEMS, and JSHS). The majority of adults, including Army S&Es and K-12 teachers, volunteered with the eCM (3,144 adults) and JSHS (3,555 adults) STEM competitions as mentors, advisors, and judges. Youth participation increased in 7 programs (CII, eCM, GEMS, JSHS, JSS, Unite, and URAP) while youth participation in other programs remained steady (SEAP) or declined slightly (CQL and REAP).

Table 2. 2017 AEOP Participation by Youth and Adults

		Youth	Adults
CII	Camp Invention Initiative	1,425	112
CQL	College Qualified Leaders	229	206
eCM	eCYBERMISSION	21,277	3,253
GEMS	Gains in the Education of Mathematics & Science	2,845	510
HSAP	High School Apprenticeship Program	54	40
JSHS	Junior Science & Humanities Symposium	5,577	3,555
JSS	Junior Solar Sprint	892	327
REAP	Research & Engineering Apprenticeship Program	118	118
RESET	Research Experiences for STEM Educators and Teachers	NA	25
SEAP	Science & Engineering Apprentice Program	113	119
Unite	Unite	358	402
URAP	Undergraduate Research Apprenticeship Program	59	49
	Total 2016 AEOP Participants	**32,947**	**8,714**

In FY17, the AEOP continued to make progress toward its goal of serving groups underserved in STEM, as 38% of particpants were identified as underserved using data from program registrations (Table 3). Unite (65%), REAP (54%), and eCYBERMISSION (45%) included the largest percentages of participants from underserved groups. 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 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.

Table 3.2017 AEOP U2 Participation captured in CVENT			
		Youth	**% of U2 Participants**
CII	Camp Invention Initiative	1,425	100%*
CQL	College Qualified Leaders	229	6%
eCM	eCYBERMISSION	21,277	45%
GEMS	Gains in the Education of Mathematics & Science	2,845	29%
HSAP	High School Apprenticeship Program	54	19%
JSHS	Junior Science & Humanities Symposium	5,577	13%*
JSS	Junior Solar Sprint	892	29%
REAP	Research & Engineering Apprenticeship Program	118	54%
RESET	Research Experiences for STEM Educators and Teachers	NA	NA
SEAP	Science & Engineering Apprentice Program	113	6%
Unite	Unite	358	65%
URAP	Undergraduate Research Apprenticeship Program	59	8%
	Total 2017 AEOP Participants	**32,947**	**38%**

**Camp Invention Initiative U2 Data self-reported by AEOP partner in the National Inventors Hall of Fame*

***JSHS 13% of 2,435 student data from 34 regions were captured in CVENT; remaining student data were self-reported by 13 regional sites.*

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 (Table 4). 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. The 8,714 adults who served as mentors, judges, and presenters within AEOP apprenticeship, competitions, and STEM programs across the country represented DoD/Army laboratories, K-12 schools, and college/universities. In 2017, 2,248 adult participants were Army/DoD S&Es and 2,612 other S&Es (e.g., college or university S&Es). Of these, 532 served as mentors to student apprentices in CQL, HSAP, REAP, SEAP, and URAP. Another 1,204 Army/DoD S&Es participated in eCM as judges and in other roles (i.e. Cyberguides and ambassadors), 281 participated in GEMS, 246 served as judges and presenters in JSHS, 37 as judges and team advisors in JSS, and 38 as presenters in Unite. This is an increase in Army/DoD S&E participation as compared to FY16 when 1,282 Army and DoD S&Es participated in AEOPs. In FY17, 4 of the 12 AEOP initiatives (GEMS, SEAP, RESET and CQL) took place at Army laboratories. HSAP and URAP apprentices were placed in 75 Army-funded laboratories at colleges and universities around the country, with 89 college/university S&Es serving as mentors to HSAP and URAP apprentices.

The AEOP also actively engaged K-12 participants both nationally and internationally (from DoDEA schools) in FY17 programs. Youth and teachers from 3,476 K-12 schools (1,333 with Title I status) participated in AEOPs in 2017. K-12 teachers are frequently a source of information about AEOPs for their students and are especially critical to the success of the eCM, JSS, and JSHS competitions, often engaging

entire classrooms of students in the programs and serving as team advisors or mentors. In 2017, 1,019 K-12 teachers participated in eCM, 300 in JSS, and 998 in JSHS.

Colleges and universities are also key collaborators for AEOP programming. College and university S&Es, students, and other staff actively participated in AEOP initiatives such as HSAP, URAP, Unite, and GEMS in 2017. Colleges and universities across the U.S. acted as host sites for JSHS regional symposia (46), the Unite summer program (18), and the HSAP (36) and URAP (39) apprenticeship programs. The AEOP collaborated with 485 colleges and universities in 2017, including 88 HBCU/MSIs.

Table 4. Number of 2017 Collaborating Schools, Laboratories, Army/DoD S&Es, and Other Organizations

Program	K-12 Schools		Colleges/Universities (represented by participants or serving as host sites)		Army and DoD Research Labs/ Army Agencies	Army-Funded University Labs	Army and DoD Scientists & Engineers (S&Es)	Other Collaborating Organizations
	Total	Title I	Total	HBCU/ MIs				
Camp Invention (CII)*	19	17	NA	NA	11	NA	NA	NA
College Qualified Leaders (CQL)	NA	NA	102	4	12	NA	206	NA
eCYBERMISSION (eCM)	776	290	62	NA	46	NA	1,204	12
Gains in the Education of Mathematics and Science (GEMS)	924	315	74	3	15	NA	281	NA
High School Apprenticeship Program (HSAP)	54	15	36	20	NA	36	NA	NA
Junior Science and Humanities Symposium (JSHS)	1,024	378	112	11	37	NA	246	200
Junior Solar Sprint (JSS)	312	92	NA	NA	NA	NA	37	3
Research and Engineering Apprenticeship Program (REAP)	72	46	41	24	NA	NA	NA	NA
Research Experiences for STEM Educators (RESET)	19	10	1	NA	3	NA	6	7

Science and Engineering Apprentice Program (SEAP)	55	14	NA	NA	11	NA	119	NA
Unite	149	110	18	13	2	NA	38	20
University Research Apprenticeship Program (URAP)	NA	NA	39	17	NA	41	NA	NA
Total Sites	**3,404**	**1,287**	**485**	**92**	**NA**	**NA**	**2,137**	**242**

In FY17, AEOP engaged 2,248 scientists and engineers from across 97 DoD organizations to include the majority of the Army Science and Technology community, Navy and Air Force research organizations, as well as other Army organizations and commands with highly technical workforce.

The demographic backgrounds of particpants in FY17 AEOPs by individual program were recorded by programs at registration (Table 5).

Table 5. 2017 AEOP Youth Participant Demographics captured in CVENT

		Asian	Black or African American	Hispanic or Latino	Native American	Native Hawaiian or Other Pacific Islander	White or Caucasian	Choose not to report	Other
CII	Camp Invention Initiative*								
CQL	College Qualified Leaders	14%	8%	5%		1%	66%	2%	5%
eCM	eCYBERMISSION	10%	11%	19%	1%	1%	47%	7%	5%
GEMS	Gains in the Education of Mathematics & Science	18%	26%	7%	1%		38%	5%	5%
HSAP	High School Apprenticeship Program	26%	15%	13%			41%	4%	2%
JSHS	Junior Science & Humanities Symposium**	25%	6%	7%			54%	5%	3%
JSS	Junior Solar Sprint***								
REAP	Research & Engineering Apprenticeship Program	19%	38%	23%	1%		12%	1%	7%
SEAP	Science & Engineering Apprentice Program	33%	17%	3%			42%	3%	3%
Unite	Unite	6%	63%	15%	2%	1%	9%	1%	4%
URAP	Undergraduate Research Apprenticeship Program	14%	8%	15%		2%	53%	5%	3%
% Total of 2017 AEOP Youth Participants		**12%**	**12%**	**6%**	**1%**	**1%**	**47%**	**6%**	**4%**

**Camp Invention Initiative aggregate Youth Demographic Data self-reported by AEOP partner in the National Inventors Hall of Fame*

***JSHS 13% of 2,435 student data from 34 regions were captured in CVENT; remaining student data were self-reported by 13 regional sites.*

***JSS Youth Demographic Data will be captured in FY18

Costs associated with the implementation of the FY17 AEOP portfolio of programs are detailed in Table 6. The portfolio is broken into four categories of programming: competitions, STEM enrichment programs, apprenticeships, and STEM educator programs. The cost of AEOP competitions (eCM, JSS, and JSHS) in FY17 ranged from $140 per student (eCM) to $362 per student (JSHS). The cost of STEM enrichment programs (CII, GEMS, Unite) ranged from $459 per student for GEMS, typically a 1-week summer STEM experience in the Army labs, to $1,849 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 $3,313 per apprentice (REAP) to $8,186 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 its cost is $7,083 per participant.

Table 6. 2017 AEOP Costs				
	Program Type	**Program Cost**	**Cost Per Participant**	**Average Stipend Per Participant**
CII	STEM Enrichment Program (grades K-6)	$337,583	$237	NA
CQL	STEM Apprenticeship Program (undergraduate/graduate)	$1,874,600	$8,186	$7,620
eCM	STEM Competition (grades 6-9)	$2,980,003	$140	NA
GEMS	STEM Enrichment Program (grades 5-12)	$1,306,404	$459	$311
HSAP	STEM Apprenticeship Program (grades 9-12)	$230,961	$4,277	$3,044
JSHS	STEM Competition (grades 9-12)	$2,019,112	$362	NA
JSS	STEM Competition (grades 5-8)	$150,000	$168	NA
REAP	STEM Apprenticeship Program (grades 9-12)	$390,924	$3,313	$2,127
RESET	STEM Educator Program	$141,661	$7,083	Varies by level
SEAP	STEM Apprenticeship Program (grades 9-12)	$419,955	$3,717	$3,152
Unite	STEM Enrichment Program (grades 9-12)	$662,000	$1,849	NA
URAP	STEM Apprenticeship Program (undergraduate)	$246,405	$4,176	$2,924

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. Several programs, including CQL, e-CM, JSS, and Unite appeared to be more efficient in FY17 than in FY16 based upon their slightly lower cost per student participant in FY17. Other programs experienced slight increases in cost per student.

4 | Evaluation Strategy

The 2017 AEOP portfolio evaluation was conducted by Purdue University, the lead for AEOP evaluation, 2015-2025. 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 the eleven AEOP elements including: 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 FY17 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). Purdue University conducted all data analysis and prepared all AEOP FY17 evaluation reports with the exception of the Camp Invention Initiative (CII). Purdue University assessed and evaluated eleven of the AEOP elements in collaboration with AEOP CA consortium members,[1] 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 2017 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 FY17 was the second year of RESET program operation, 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 2017 evaluation was informed by AEOP priorities[2] (established in 2012) 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

[1] The 2015 AEOP CA consortium members included the Academy of Applied Science (AAS; JSHS, REAP), the American Society for Engineering Education (ASEE; GEMS, SEAP, CQL), the Technology Student Association (TSA; JSS, Unite), the National Science Teachers Association (NSTA: eCM), the University of New Hampshire (Science Teacher Program Initiative), and Virginia Tech (Lead Organization). HSAP and URAP are managed by the Army Research Office (ARO). The West Point Bridge Design Competition (WPBDC) was removed from the 2015 AEOP as the result of a mutual agreement between the PI of WPBDC and AEOP leadership. WPBDC has evolved in a way that its goals and objectives no longer aligned with those of the AEOP.

[2] The AEOP priorities and objectives have been updated for 2015 to include the addition of 1-f: Increase participants' awareness of AEOP's pipeline of opportunities; and 2-g: Increase educators' awareness of AEOP pipeline of opportunities.

assessments include appropriate measures of intended outputs and outcomes that align with the AEOP's priorities and objectives and federal requirements (Table 7).

Table 7. AEOP Priorities and Objectives (2017)
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 2017, 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 research facilities, 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 2017 AEOP evaluation plan is summarized by program in Table 8. In short, most evaluations utilized participant questionnaires, as well as focus groups or interviews with the youth population (herein called

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

Table 8. 2017 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 pilot	• 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	• To nurture interest and excitement in STEM for middle and high school participants.

	• Student focus groups • Mentor focus groups • Site observations	• To nurture interest and excitement in STEM for mentor participants. • 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 focus group • 21st Century Skills Assessment pilot	• 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 • Student focus groups • Mentor focus groups <u>National Symposium Evaluation:</u> • Student questionnaire	• 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.

	• Mentor questionnaire[3] • Student focus groups • Mentor focus group	• 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 • Mentor 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 • Mentor interviews • Apprentice interviews • 21st Century Skills Assessment pilot	• 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.

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

SEAP	<u>Program Evaluation:</u> • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews • Mentor interviews • 21st Century Skills Assessment pilot	• To acquaint qualified high school students with activities of DoD laboratories 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. • 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 • Student focus groups • Mentor focus groups • 21st Century Skills Assessment pilot	• 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 pilot	• 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 Purdue University's Institutional Review Board (IRB) for the protection of human research subjects. Additional details about Purdue University's measures and sampling, data collection and analyses, and reporting and dissemination are provided in Appendix A.

5 | Study Sample

The FY17 AEOP evaluation included an analysis of participation in questionnaires, the primary data collection method. Response rates and associated margins of error at the 95% confidence level for each sample were computed (see Table 9). As was the case in FY16, most of the margins of error for individual programs do not fall within the acceptable range (2-5%). This can be partially attributed to the fact that random sampling is not used for participation in the surveys. The large margin of error can indicate potential for response bias (that those who chose to respond to the questionnaire may not be representative of the entire population) and, consequently, results from questionnaire data should be viewed as preliminary indicators of program quality and impact and not as conclusive. Response rates for most programs improved in FY17.

Table 9. 2017 AEOP Program Participant Questionnaire Participation

Program	2017 Questionnaire	Sample	Population	Participation Rate	Margin of Error @ 95% Confidence[4]
CQL	Apprentice	107	229	46.7%	±6.93
	Mentor	46	206	22.3%	±12.77
eCM	Overall Participants	438	21,277	2.06%	±4.63%
	NJ&EE Participants	69	73	94.5%	±2.78%
	Team Advisor	72	792	9.1%	±11.02%
GEMS	Student	2,169	2,845	76%	±1.03%
	Mentor (incl. NPM, RT, S&Es)	54	510	11%	±12.62%
HSAP	Apprentice	31	54	57%	±11.6%
	Mentor	24	40	60%	±12.8%
JSHS	Regional Symposia Student	559	5,800	9.63%	±3.94%
	National Symposium Student	65	226	28.76%	±10.28%
	Mentor	262	3301	7.94%	±5.81%
JSS	Student	79	893	8.8%	±10.53%
	Mentor	23	255	9.0%	±19.53%
REAP	Apprentice	91	118	77%	±4.94%
	Mentor	70	118	59%	±7.50%
SEAP	Apprentice	61	113	54%	±8.55%
	Mentor	35	119	29%	±13.98%
Unite	Student	233	358	65.1%	±3.8%
	Mentor	69	402	17.2%	±10.75%
URAP	Apprentice	32	59	54%	±11.82%
	Mentor	34	49	69%	±9.4%
Alumni Study		312	2,415	13%	±5.18%

[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.

Total AEOP Questionnaire Participation	**4,935**	**40,252**	12.2%	

Focus groups or interviews were conducted with participants and mentors from each of the 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, 276 students, apprentices, and mentors participated in focus groups and interviews. Interviews were conducted with 35 individual AEOP participants, and focus groups were conducted with 241 students, apprentices, and mentors. Table 10 summarizes focus group and interview participation.

The FY16 AEOP evaluation included an alumni survey and an alumnus focus group session at JSHS. There were three participants in the JSHS alumni focus group.

Table 10. 2017 AEOP Program Participant Focus Group and Interview Participation

Program	2017 Focus Group and Interview	Focus Group Sample	Interview Sample
CQL	Apprentice	12	
	Mentor	16	
eCM	NJ&EE Student	21	
	NJ&EE Team Advisor	20	
GEMS	Student	31	
	Mentor	10	
HSAP	Apprentice		5
	Mentor		4
JSHS	Regional and National Symposium Participants	36	
	Competition Advisor/Mentor	14	
JSS	Student	32	
	Mentor	14	
REAP	Apprentice		8
	Mentor		5
SEAP	Apprentice	15	
	Mentor	10	
Unite	Student	2	
	Mentor	5	
URAP	Apprentice		8
	Mentor		5
Alumni Study		**3**	
Total AEOP Focus Group/Interview Participation		**241**	**35**

The FY16 evaluation also included a mid to long-term study of AEOP alumni. The alumni respondent profile is included in Table 11.

Table 11. Alumni Respondent Profile (Longitudinal 2016, 2017 participants)

Demographic Category	Questionnaire Respondents	
Gender (*n*=312)		
Female	197	57%
Male	127	41%
Choose not to report	6	2%
Race/Ethnicity (*n*=312)		
Asian	62	20%
Black or African American	66	18%
Hispanic or Latino	25	8%
Native American or Alaska Native	5	2%
Native Hawaiian or Other Pacific Islander	1	<.5%
White	148	47%
Other race or ethnicity (specify):[†]	13	4%
Choose not to report	2	<.5%
Program Year (*n*=312)		
2017	NA	NA
2016	107	34%
2015	113	36%
2014	58	19%
2013	20	7%
2012	14	4%
High School Graduation Year (*n*=312)		
Before 2012	38	12%
2012	10	3%
2013	16	5%
2014	23	7%
2015	12	4%
2016	30	10%
2017	43	14%
2018	40	13%
2019	79	25%
Choose not to report	21	7%

A new component of the FY17 evaluation in FY17 for was a pilot of the 21st Century Skills Assessment (Johnson & Sondergeld, 2016). This represents a move in the direction of beginning to objectively assess actual growth in skills in addition to self-reported impacts of the AEOPs on participants. A pre/post assessment was completed on most of the participating apprentices for HSAP, REAP, URAP, and participants in Unite for FY17. Pre-assessment was completed in the first days of the program. Post-assessment was completed at the end 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

On each of the six domains 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.

To be included in analysis, both a pre- and post-assessment needed to be completed for each participant. A majority of UNITE participants were observed at pre-observation (n=121), with approximately 40% (n=48) also being rated at post- and thus include in analysis. For apprenticeship programs, a total of 141 students had a pre-assessment conducted, and approximately 50% (n=71) also had a post-assessment to be included in analysis. HSAP, REAP, and URAP are represented in the apprenticeship analysis, however SEAP and CQL did not have any matched pre-post observations completed and are consequently not represented in the 21st Century Skills Observation findings. See Table 12 for sample information by program.

Table 12. Pre-Post Assessment Participation by Program

Program	Pre-Assessment	Post-Assessment	Included Matched Pre-Post Assessments
CQL	10	0	0
HSAP	38	29	19
REAP	42	46	32
SEAP	4	3	0
UNITE	121	70	48
URAP	47	28	20
Total	**262**	**176**	**119**

6 | Evaluation Findings

The FY17 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 13 and the mid to long-term (multiple years) research questions are detailed in Table 14.

Table 13. AEOP Priorities and Near-Term Research Questions (2017)
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? **(NEW for FY17)**
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 Scientists and Engineers (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 14. AEOP Priorities and Mid to Long Term Research Questions (2017)
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 FY17 AEOPs

Priority One: STEM Literate Citizenry

Findings from the FY17 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 32,000 participants. 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 FY17, the AEOP provided outreach to 32,947 youth participants, an increase of 6% over the 30,973 of youth participants served in FY16. This growth in enrollment begins to reverse a downward trend in participation from FY14 (41,802 youth participants) to FY16 (30,973 youth participants). These growing enrollment figures reflect the 22% increase in the number of applications in FY17 (48,419) as compared to FY16 (37,399). eCM experienced modest growth in participation in FY17 (3%) securing 21,277 FY17 participants compared to 20,607 in FY16. JSS turned around two years of decline in FY17, growing to 893 participants, a 34% improvement from FY16. There was also substantial increased interest in apprenticeship programs, with the number of applicants across the AEOP apprenticeship portfolio growing from 2,184 in FY16 to 3,384 in FY17, a 35% increase. It is important to note that in previous years, prior to the implementation of the use of the Cvent online registration system, most of AEOP program participation data were self-reported.

The overall placement rates across AEOPs decreased from 83% from FY16 to 68% in FY17. With the increasing number of applications, apprenticeship programs have experienced a downward trend in placement rates. CQL placed 41% of applicants in FY17, as compared with 51% in FY16; HSAP placed 9% of applicants in FY17 as compared to 18% in FY16; REAP placed 17% of applicants as compared to 25% in FY16; URAP placed 9% of applicants in FY17 as compared to 29% in FY16; and SEAP placed 13% of applicants as compared to 16% in FY16. However, placement rates grew slightly for STEM enrichment activities. GEMS placement increased from 55% in FY16 to 61% in FY17 and Unite enrollment grew from 41% in FY16 to 45% in FY17.

More than 2,500 K-12 teachers and over 2,000 Army and DoD S&Es engaged in AEOP programs, 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.

AEOP youth application numbers and placement rates for FY17 are detailed in Table 15. The various AEOPs received a total of 46,518 applications, an increase of 20% over the 37,399 applications received in FY16 and a 4% increase over the number of applications received in FY15 when 44,632 applications were received. These application rates indicate that there is strong student interest in AEOPs, although the current number of applications is 7% less than the 49,686 applications received in in FY14. There continues to be considerably higher demand for many programs than spaces available, however.

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 6^{th}-9^{th} grade students, continues to enroll the largest number of participants among AEOPs, enrolling 65% of the total

number of AEOP participants in FY17. JSS, another STEM competition, was similarly open to all those who met registration qualifications and increased actual participation by 32% from FY16 to FY17.

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 9% (HSAP) to 41% (CQL). A total of 3,384 applications to apprenticeship programs were received in FY17, an increase of 35% over the 2,184 applications received in FY16, and a 39% increase over FY15 (2,042 applicants). Of those applying for apprenticeships in FY17, 573 were selected for participation. Although nearly the same number of apprentices were placed in FY17 than in FY16 when 586 were selected for participation, the placement rate fell from 27% in FY16 to 17% in FY17. This also represents a decline in placement rate compared to FY15 when 684 or 33% of students were selected for apprenticeships, and FY14 when 31% of students were placed. The apprenticeships serving high school students (HSAP, REAP, and SEAP) were most competitive, and had a combined placement rate of only 13% (285 apprentices placed out of 2,190 applicants). This represents a substantial decrease from the 25% placement rate in FY16 and the 17% placement rate for these programs in FY15 and FY14. Likewise, placement in undergraduate apprenticeships (CQL and URAP) fell to 24% in FY17 (288 apprentices placed out of 1,194 applicants), from 45% in FY16. This is a substantial decrease from the 72% placement rate in FY15 and the 57% placement rate in FY14 for these programs.

Acceptance into AEOP STEM enrichment activities (Unite and GEMS) continued to be competitive in FY17, reflecting the limitations on enrollment imposed by the availability of resources such as funding, space, and staff. In spite of these limitations, acceptance rates increased in FY17, with 59% of applicants accepted to these programs compared with 53% in FY16. Acceptance rates for each program increased in FY17 (61% GEMS, 38% Unite) as compared to FY16 when 55% of GEMS applicants and 41% of Unite applicants were selected for these programs.

The JSHS competition is also restricted in the number of students that it can accept to participate in regional symposia. In FY17, 65% of JSHS regional applicants were accepted, an increase over FY16 when 60% were accepted (62% in FY15 and 55% in FY14). In spite of the increasing acceptance rates, it is important to note that 3,100 potential participants were turned away.

Table 15. 2017 AEOP Number of Youth Applications and Placement Rates

		Youth Applicants	Youth Participants	Placement Rate
CII	STEM Enrichment Activity	1,926	1,425	74%
CQL	STEM Apprenticeship Program (undergrad)	565	229	41%
eCM	STEM Competition	27,881	21,277	NA[†]
GEMS	STEM Enrichment Activity	4,653	2,845	61%
HSAP	STEM Apprenticeship Program (high school)	629	54	9%
JSHS	STEM Competition	8,900	5,577	65%
JSS	STEM Competition	893	892	NA[†]
REAP	STEM Apprenticeship Program (high school)	709	118	17%
SEAP	STEM Apprenticeship Program (high school)	852	113	13%

Unite	STEM Enrichment Activity	782	358	45%
URAP	STEM Apprenticeship Program (undergrad)	629	59	9%
	Total	**48,419**	**32,947**	**68%**

† *In 2017, all youth who met registration requirements for CII, eCM and JSS were able to participate.*

Table 16 summarizes participant demographics collected through evaluation questionnaires in 2016 and 2017. Data are provided for participation by females; participants identifying with racial and ethnic groups other than White or Asian; students who received free or reduced-price lunch, a commonly used indicator of socioeconomic status; and students who meet the AEOP definition of underserved[5]

Participation of females in the evaluation, a group historically underserved in some STEM fields, varied among programs (range of 42%-61%). Female participation increased over FY16 levels for 5 programs (CQL, GEMS, HSAP, and JSS), while female participation remained constant in 2 programs (JSHS and Unite) and decreased slightly in 3 (eCM, REAP, and SEAP).

The proportion of students identifying with racial and ethnic groups other than White or Asian remained relatively constant for most programs on the evaluation questionnaire (range of 17%-82%) with two notable exceptions where there was a substantial increase in the percentage of participants from these minority groups. JSS minority participation rose from 15% in FY16 to 29% in FY17, and in URAP from 11% in FY16 to 32% in FY17. Participation by students identifying with these minority groups decreased somewhat for HSAP (28% in FY17 compared to 36% in FY16) and REAP (53% in FY17 compared to 60% in FY16). The proportions of students who reported that they were eligible for free or reduced-price lunch also varied between programs (8%-64%).

Table 16. Evaluation Questionnaire Respondent Demographics

Program	Females		Racial & Ethnic Minorities		Free or Reduced-Price Lunch Eligible	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**
CQL	44%	49%	16%	17%	NA††	NA††
eCM	51%	50%	21%	21%	28%	20%
eCM-NJ&EE	44%	56%	16%	16%	10%	13%
GEMS	45%	48%	37%	37%	8%	19%
HSAP	47%	48%	36%	28%	---†	---†
JSHS-R	60%	60%	18%	18%	14%	14%
JSS	38%	46%	15%	29%	---†	---†
REAP	73%	61%	60%	53%	38%	49%

[5] 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 underserved 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.

SEAP	60%	58%	16%	18%	3%	8%
Unite	52%	52%	85%	82%	100%	64%
URAP	39%	42%	11%	32%	NA[††]	NA[††]

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

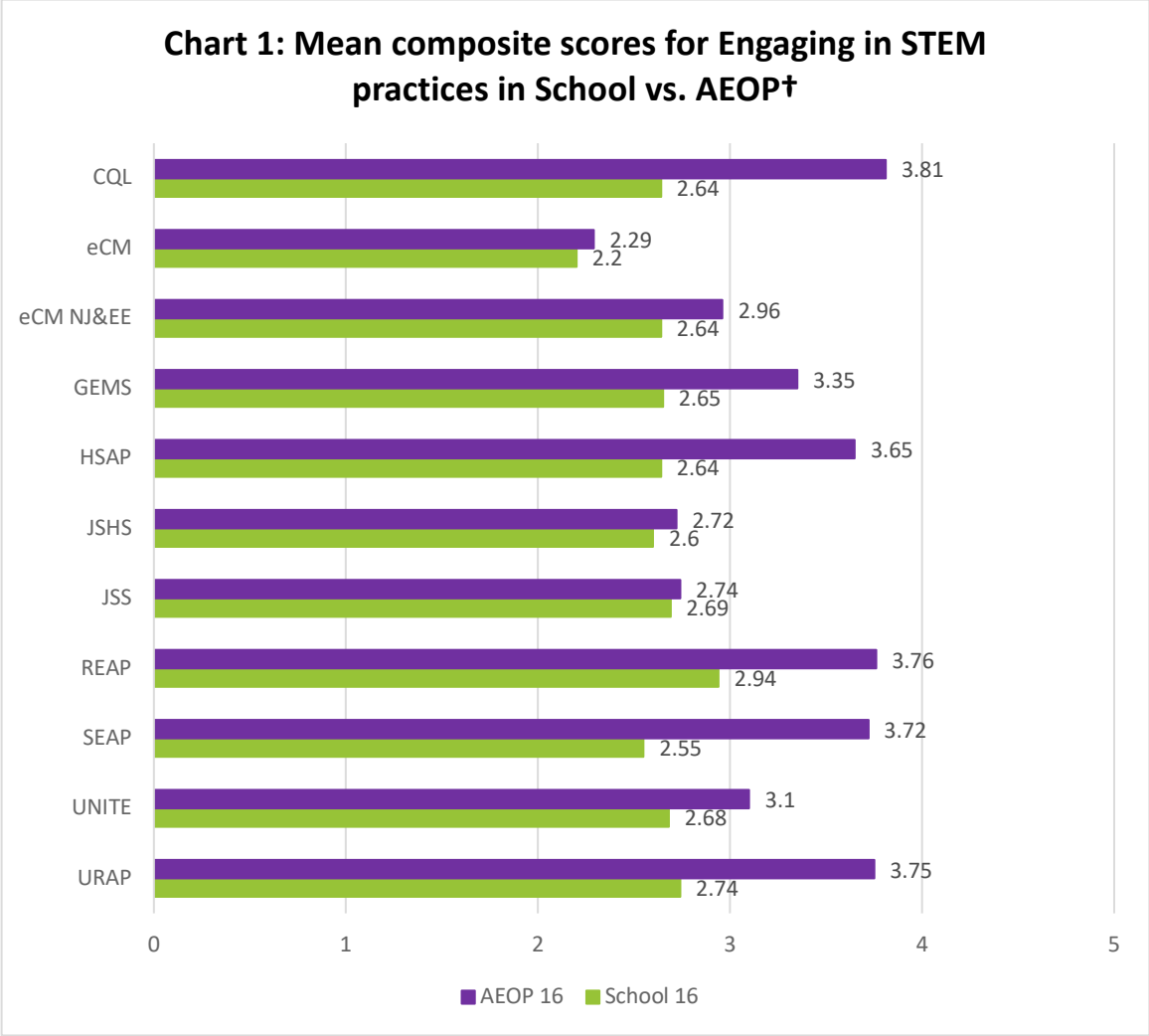
[††] *Not applicable – college program.*

Programs in the AEOP portfolio continued to provide participants with more frequent exposure to real world, hands-on, and collaborative STEM activities than they are exposed to in their typical in-school experiences. Participants were asked about how frequently they had opportunities to engage in STEM practices in their AEOP experiences as compared to in-school experiences. These items were combined into a composite variable; the items used to formulate the composite variables are shown in Table 17.

Table 17. 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 the mean composite scores for participant engagement in STEM practices for programs in FY17. Apprentices and students reported engaging in STEM practices significantly more in their AEOP programs as compared to in their typical school experiences for each program. Significant differences ranged from small to large in effect sizes.[6] Effect sizes were large in programs such as CQL, GEMS, HSAP, REAP, SEAP, Unite, and URAP, indicating that these programs offered participants STEM engagement experiences that were substantially more intense and interactive than their typical in-school experiences. It should be noted that teachers may use competition programs (eCM, JSS, and JSHS) as part of students' in-school learning experiences, and therefore these students may not distinguish between their engagement in STEM in AEOP and their engagement in STEM in school.

[6] Effect sizes: CQL, d = 2.61 standard deviations; R-ECM, d = 0.46 standard deviations; N-ECM = 1.21 standard deviations; GEMS, d = 1.79 standard deviations; HSAP, d = 2.07 standard deviations; REAP, d = 1.77 standard deviations; SEAP, d = 2.75 standard deviations; Unite, d = 0.96 standard deviations; and URAP, d = 0.75 standard deviations.



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

Evaluation findings 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 reflected in both participants' questionnaire responses and in comments made in focus groups and interviews. Participants' comments included the following

> *My mentor allowed me to define my project and design it in a way that I saw fit. On my second week, I was able to present my project proposal to the department head and work through issues and differences as a peer. This is one of the aspects I found most valuable, I was never treated as an intern. If I needed help it was always there for me but my capabilities were never questioned and my hand was never held. I was given the full experience of working as a research scientist.* (CQL Apprentice)

[A benefit of eCM was] having to face so many different problems, guidelines, challenges, and having to complete a very difficult project…I learned so many skills and gained so many experiences and have a whole new perspective on things. (eCM-NJ&EE Student)

GEMS has given me a chance to feel like a scientist. I have gotten the chance to use lab tools and [in] a great working environment. (GEMS Student)

We're able to learn a lot in such a short amount of time, and it's really thorough and comprehensive conversations that we have, which I think is different from school. (HSAP Apprentice)

JSHS was an amazing, eye-opening event. I was able to meet people from across the United States and be exposed to fields of science that are glanced over in the traditional high school setting. (N-JSHS Student)

JSS has given me the chance to work on real engineering tasks, and it also allowed me to research all of the different STEM possibilities that I can participate in. (JSS National Student)

I learned how to think like a scientist - look at a problem and try to solve it through different angles and if that doesn't work, just keep moving on, keep testing. I learned how to study and make data readable for people and try to communicate what I have learned. (REAP Apprentice)

It was incredible actually seeing the stuff I learned about in school come to life and how it's practiced. Some of the stuff that I teach, I saw it come to life, too. (RESET Participant)

The program has exposed me to science with real world applications. In high school science classes, we're rarely ever given a chance to use laboratory tools or materials. However, the program has given me the opportunity to use lab tools and learn basic rules of working in a lab. (SEAP Apprentice)

My Unite experiences have helped to increase my interest in pursuing a career in STEM disciplines, by allowing me to do further research in the college I want to go to and the job I want to be successful in. (Unite Student)

[URAP] enabled me to find work that genuinely interests me and gave me an opportunity to learn new skills in the lab. (URAP Apprentice)

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

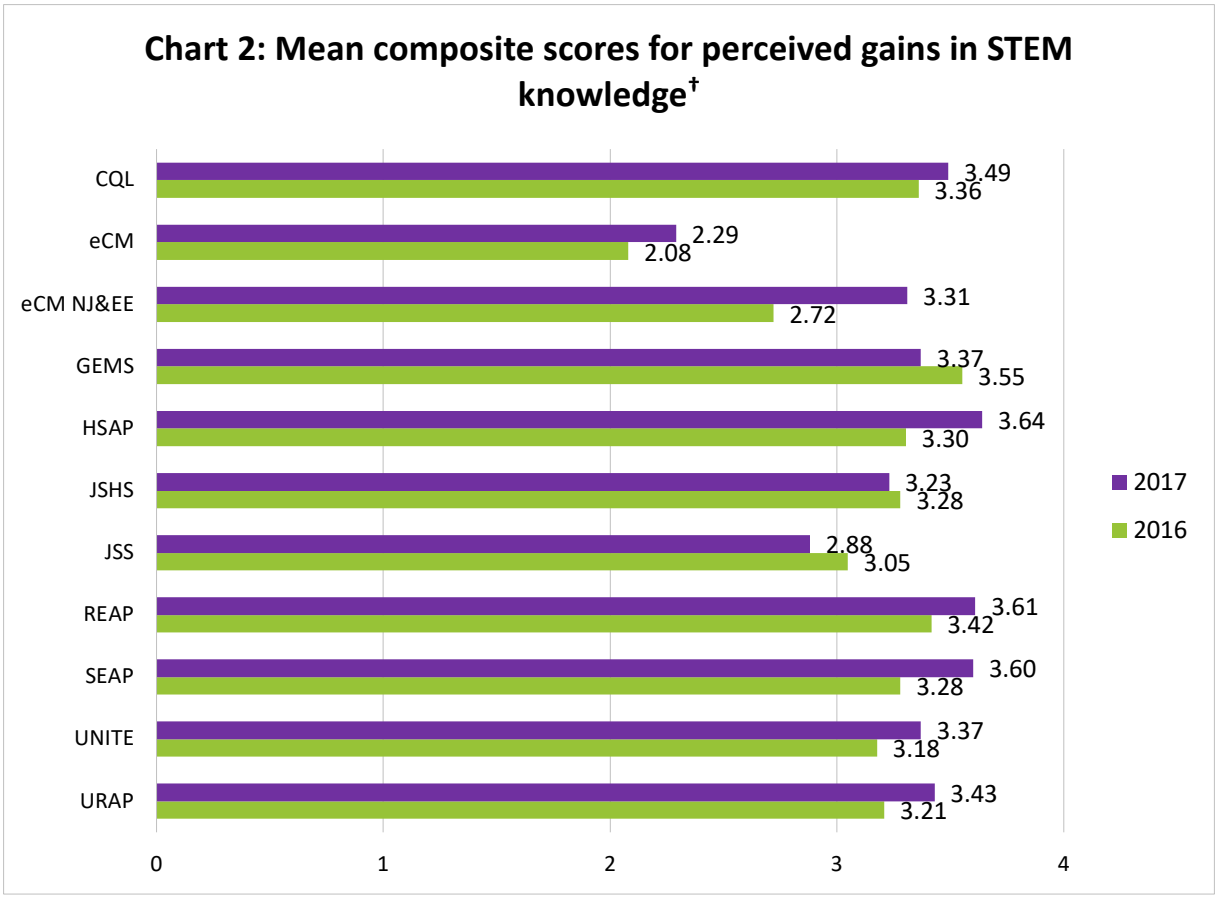
Participants reported that their AEOP experiences improved their STEM-specific and 21st Century STEM skills competencies. They also reported gains in their abilities to use the science and engineering practices described in the Next Generation Science Standards (NGSS), and reported gains in their STEM 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 FY17 evaluation examined students' and apprentices' perceptions of gains in their STEM-specific and 21st Century STEM 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.[7]

Table 18 displays the five questionnaire items that collectively form the composite for participants' perceptions of their gains in STEM knowledge. Participants rated their gains using a 4-point scale ranging from "no gain" to "large gain." Findings indicate that participants from all programs perceived some level of gain in their STEM knowledge after participating in AEOPs (Chart 2).

Table 18. 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

[7] 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.

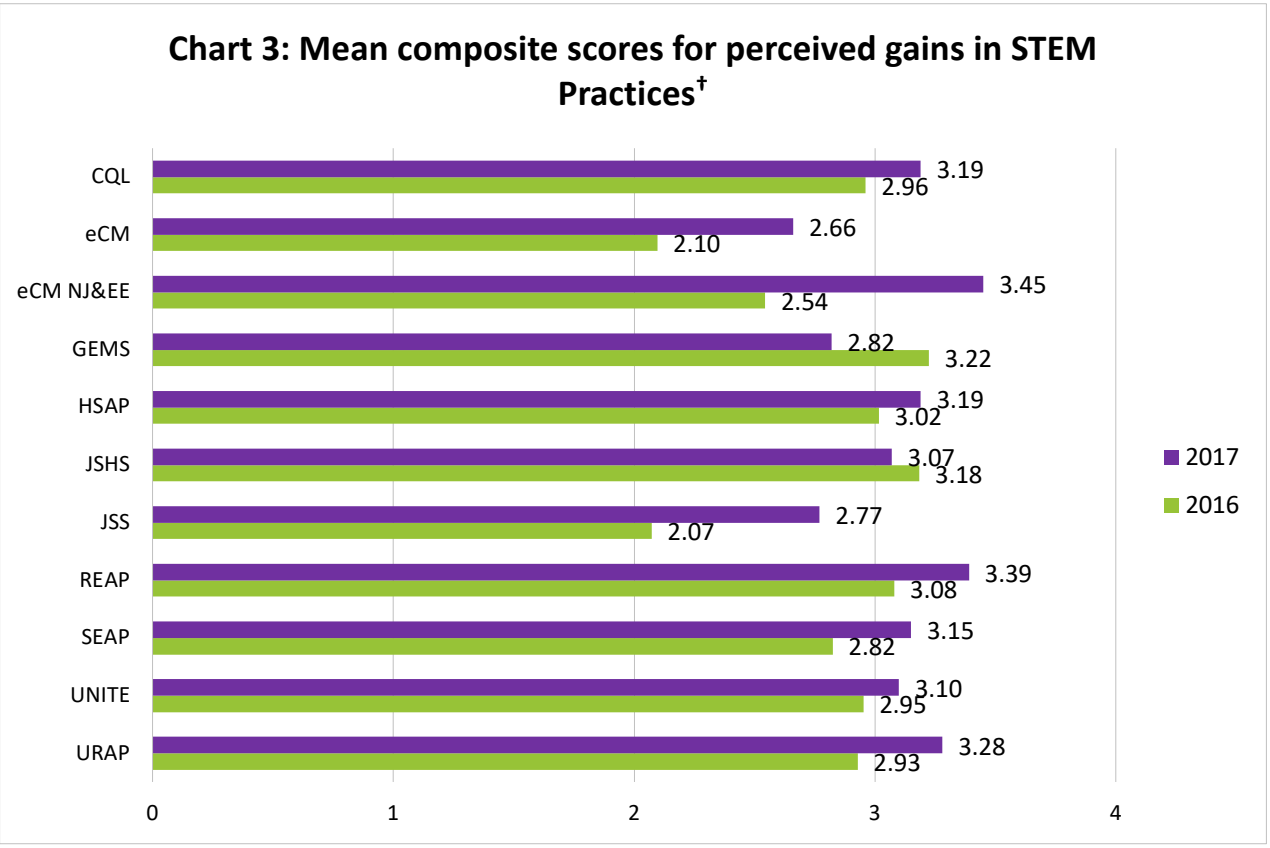


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

A goal of AEOP initiatives is to not only increase students' knowledge in STEM, but to give them opportunities to apply and improve their skills in STEM. The FY17 evaluation therefore investigated the impact of AEOPs on participants' abilities to use the STEM practices (i.e., their STEM competencies) described in the Next Generation Science Standards (NGSS)[8]. Table 19 provides an overview of the questionnaire items used to assess participants' gains in their STEM competencies. Chart 3 presents findings for 2016 and 2017. Students and apprentices in all programs reported gains in their STEM competencies, and gains were larger than those reported in FY16 for all programs except for GEMS and JSHS.

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

Table 19. Items that form the Perceived Gains in STEM Practices Composite	
1.	Asking a question that can be answered with one or more scientific experiments
2.	Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation
3.	Considering different interpretations of data when deciding how the data answer a question
4.	Supporting an explanation for an observation with data from experiments
5.	Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge
6.	Identifying the strengths and limitation of explanations in terms of how well they describe or predict observations
7.	Defending an argument that conveys how an explanation best decribes an observation
8.	Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts
9.	Integrating information from technical or scientific texts and other media to support your explanation of an observation
10.	Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics



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

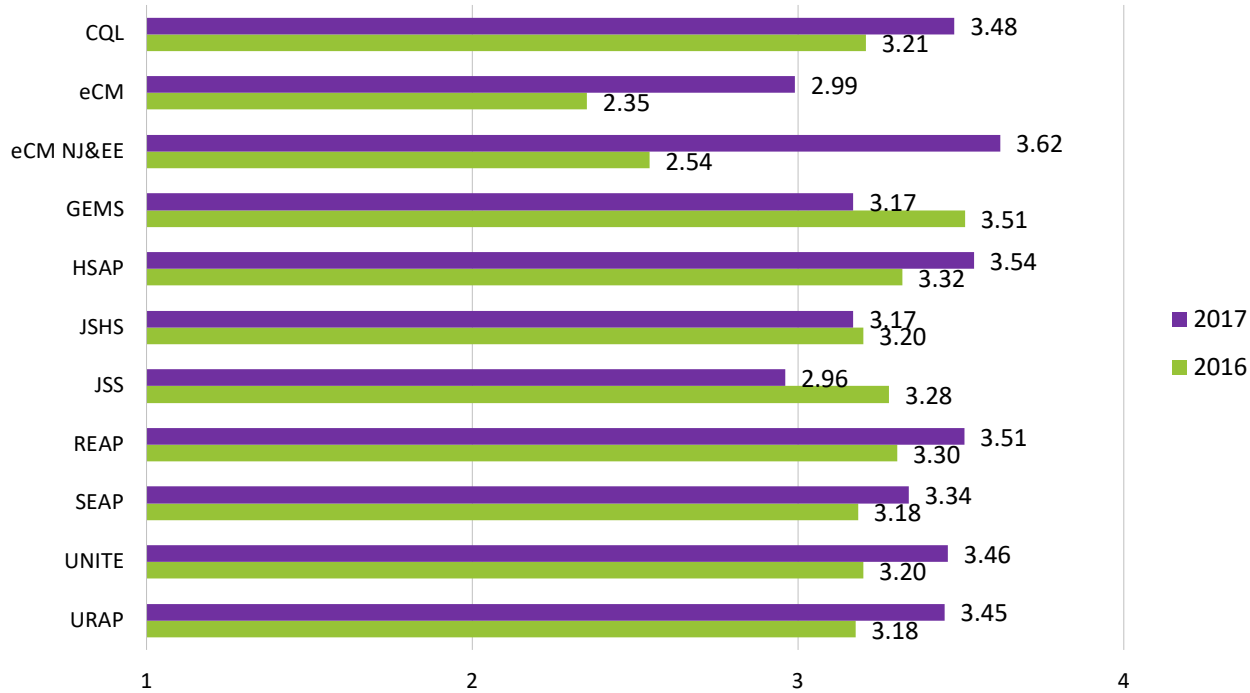
21st Century Skills are skills such as collaboration, communication, perseverance, and problem solving that are necessary across a wide variety of fields. Participants were asked about the impact of their AEOP

participation on these 21st Century Skills. The items comprising the Perceived Gains in 21st Century Skills Composite are outlined in Table 20. The findings displayed in Chart 4 include the mean composite scores for each program for both FY16 and FY17. Participants in each program reported gains in their 21st Century skills, with participants in eCM, HSAP, REAP, and CQL reporting the largest overall gains. Larger gains in these skills were reported in FY17 as compared to FY16 for each program with the exception of GEMS, JSHS, and JSS.

Table 20. Items that form the Perceived Gains in 21st Century STEM Skills Composite
1. Learning to work independently†
2. Setting goals and reflecting on performance†
3. Sticking with a task until it is finished
4. Making changes when things do not go as planned
5. Working well with students from all backgrounds
6. Including others' perspectives when making decisions
7. Communicating effectively with others
8. Viewing failure as an opportunity to learn

† *These two items were not included on the GEMS, JSS, and Unite versions of the survey.*

Chart 4: Mean composite scores for perceived gains in 21st century STEM skills†

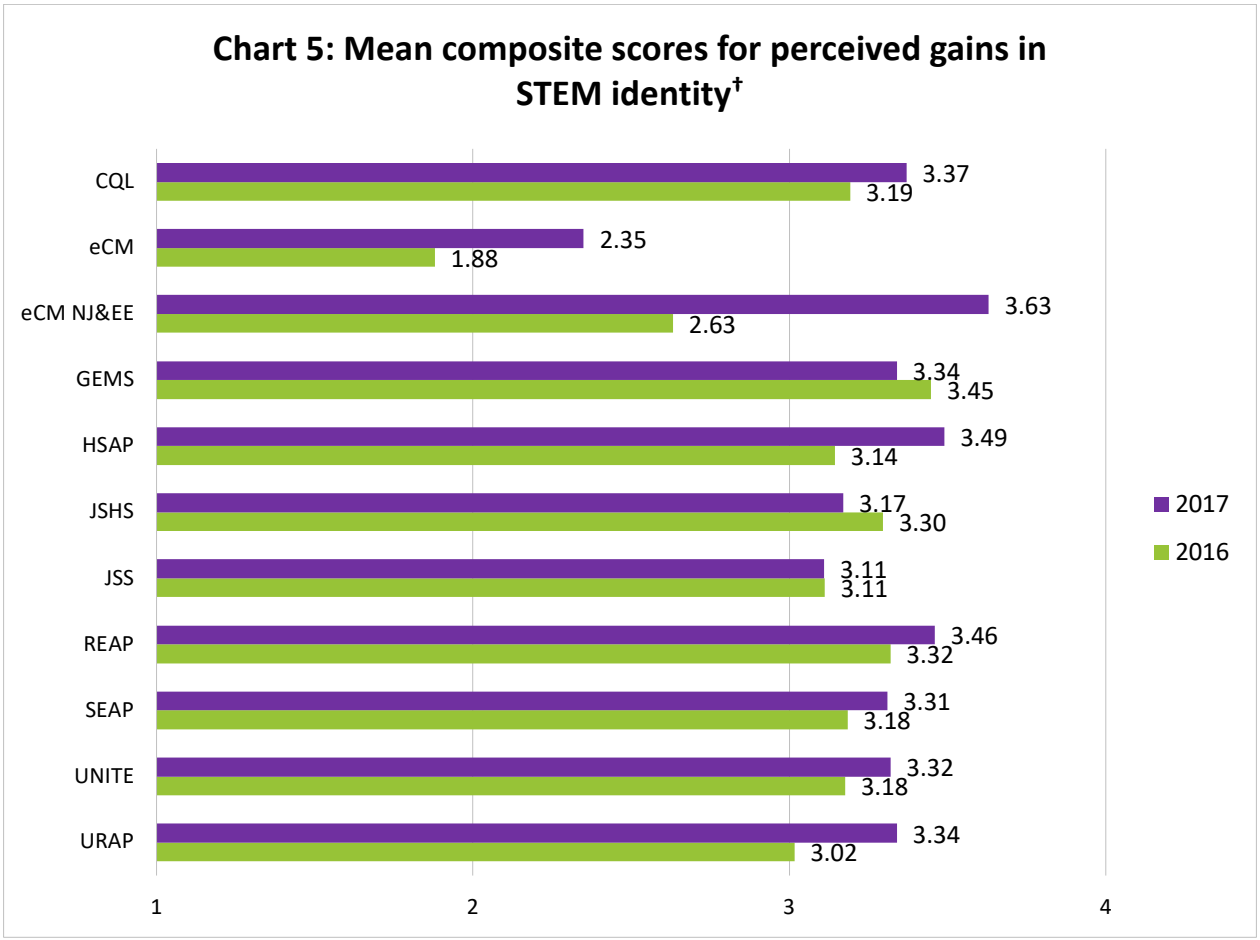


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain.*

Participants were also asked to consider the effect of their AEOP participation on their STEM identities. 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 about the extent to which their AEOP experiences impacted their STEM identities via a series of nine items that comprise the Perceived Gains in STEM Identity composite (Table 21). Findings for both FY16 and FY17 are displayed in Chart 5. Participants in all programs experienced some level of gains in their STEM identities, with the largest gains reported in eCM, HSAP, and REAP. Students reported larger gains in their STEM identities in FY17 as compared to FY16 in all programs with the exception of GEMS, JSHS, and JSS.

Table 21. 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. Patience for the slow pace of STEM research
7. Desire to build relationships with mentors who work in STEM
8. Connecting a STEM topic or field to my personal values

† *Not included on the CQL, JSHS, REAP, SEAP, URAP, HSAP 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.*

Students and apprentices were asked to rate the extent of their agreement with items describing program impacts related to their STEM confidence and interest in STEM. These items asked about interest in taking additional STEM classes in school, pursuing STEM activities outside of school, and participants' confidence in their STEM knowledge, skills, and abilities. Table 22 displays the results for these items for both FY16 and FY17. A majority of students in each program agreed that AEOP in which they participated contributed to the impact described. The area of the most consistently large impact was participants' confidence in their STEM knowledge, skills, and abilities (range of 74%-100% agreement). Most participants in all programs (range of 55%-90%) also agreed that participation in the AEOP contributed to their interest in participating in STEM activities outside of school requirements. In addition, most participants (range of 52%-81%) indicated that their AEOP participation increased their interest in taking STEM classes in school.

Table 22. Students Agreeing that the Program Contributed to their STEM Confidence and Interest

	Year	CQL	eCM	eCM NJ&EE	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
I am more confident in my STEM knowledge, skills, and abilities.	2016	98%	54%	83%	93%	97%	78%	79%	94%	94%	94%	90%
	2017	***90%***	***74%***	***91%***	***93%***	***100%***	***78%***	***76%***	***93%***	***93%***	***92%***	***88%***
I am more interested in participating in STEM activities outside of school requirements.	2016	86%	41%	76%	85%	75%	72%	73%	86%	89%	89%	85%
	2017	***79%***	***55%***	***90%***	***82%***	***90%***	***72%***	***76%***	***85%***	***77%***	***85%***	***84%***
I am more interested in taking STEM classes in school.	2016	76%	42%	68%	80%	69%	61%	71%	76%	71%	81%	60%
	2017	***66%***	***52%***	***81%***	***79%***	***74%***	***61%***	***78%***	***78%***	***67%***	***83%***	***69%***

Students and apprentices in all programs reported that, as a result of their AEOP participation, they had improved their STEM-specific skills and competencies and their 21st Century skills. Participants reported gains in their science and engineering practices as described in the NGSS and reported gains in participants' STEM identities and confidence in their STEM abilities. Again, these gains were apparent in participants' questionnaire responses as well as comments made by both youth participants and mentors during interviews and focus groups. For example:

> *I have had the opportunity of publishing scientific articles, giving talks at conferences, and performing cutting edge research. I recently was accepted into graduate school for Ph.D. studies and I believe a major part of my acceptance was the experience I gained from this program.* (CQL Apprentice)

The thing that this really helped me learn was how to be a part of a team because I'm not really a team person. I like to do things by myself. Doing this really helped me realize that when I'm on a team, I can take a step back and let us all contribute. (eCM-NJ&EE Student)

Not only did I learn a lot about STEM, I learned more about teamwork and persevering, especially when my design wasn't working. (GEMS Student)

I was scared going into the HSAP. I had no experience and no previous knowledge about an official work place going into the program. However, my mentor and those in my lab helped me to overcome the fear, become comfortable, and start to learn. (HSAP Student)

I was able to prepare for the presentations in a more professional way; it helped my public speaking. (R-JSHS Student)

It teaches me, as an adult, how to communicate, how to interact, how important it is to have teamwork, and understanding how to work through frustration and anger. This has been an eye-opening experience, not only for the students, but also for the adults. (JSS Mentor)

Thanks to REAP, I have gained an incredible amount of knowledge and skills, much of which will aid me as I pursue a future in STEM. However, the most important lessons I have taken away from REAP are learning to be independent and possessing confidence in my abilities, both skills that will help me greatly outside of the STEM field. (REAP Apprentice)

I am confident in the skills I learned from [my SEAP] experience and will be using them for the future. I learned a lot from my mentor and would love to pursue a career in this field. (SEAP Apprentice)

Students learned much more than STEM concepts. They learned social skills, networking, presentation and collaboration in groups. (Unite Mentor)

I feel like I've learned a lot about that and how to use specific technologies and techniques to accomplish what I'm trying to do. I also feel more confident in my research abilities. (URAP Apprentice)

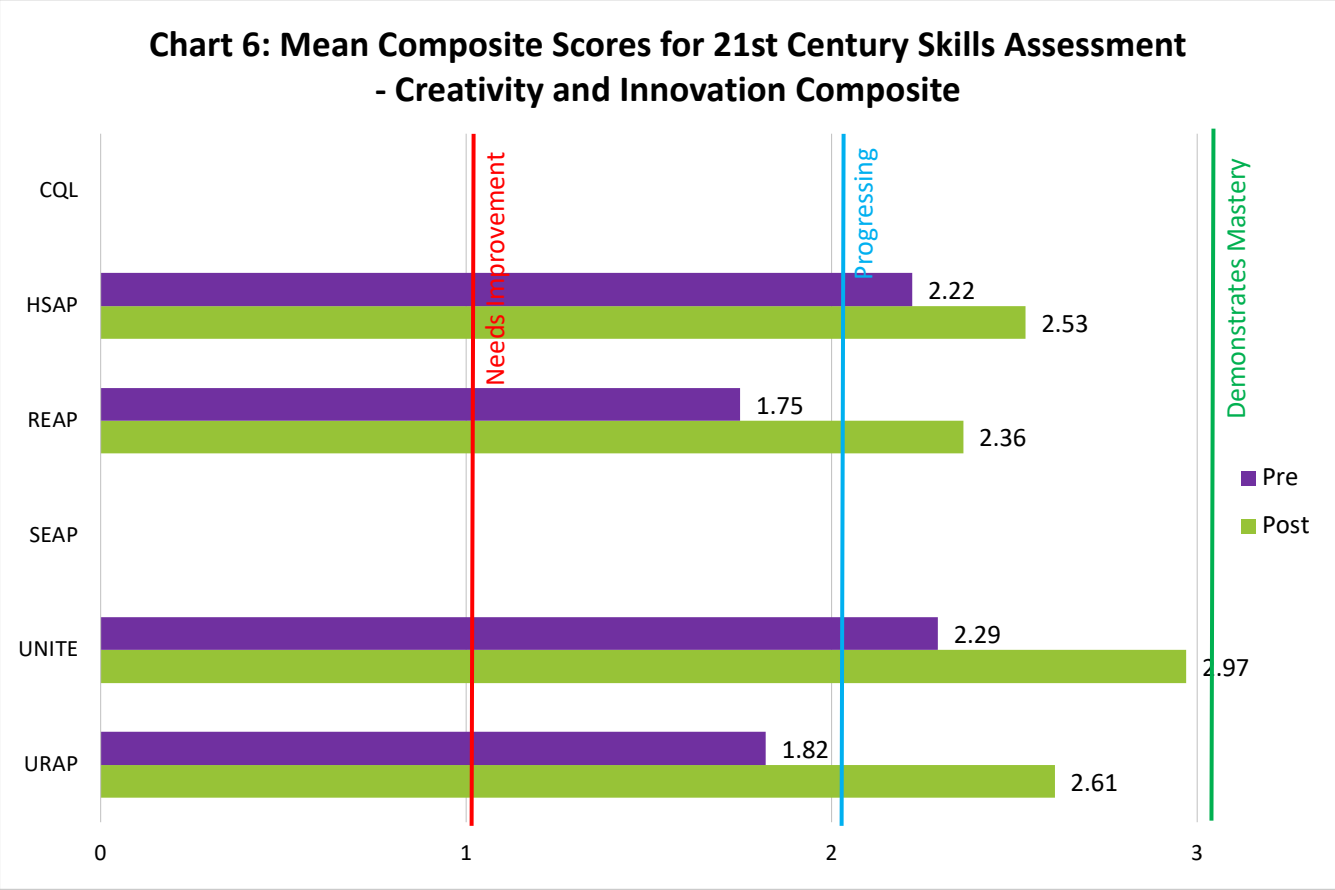
Research Question #2b – To what extent do participants demonstrate use of and growth in 21st Century skills? (NEW for FY17)

AEOP Apprentices and Unite participants demonstrated growth toward mastery of the 21st Century Skills as assessed by their mentor/teacher(s). Other AEOPs did not participate in the assessment during the FY17 pilot year.

Creativity & Innovation. Across all AEOPs, there was significant assessed participant growth in terms of creativity and innovation skills (p<.05). See Table 23 for items rated in this skill set. In general, participants began their program being rated near the Progressing level and grew to an approaching Demonstrates Mastery level by the end of their program. Chart 6 shows these results graphically. While all AEOPs

showed a significant increase in this area, URAP participants saw the greatest increase (+0.79). UNITE participants were rated at an average of Demonstrates Mastery (2.97) across the 48 students. While HSAP participants had the least growth (+0.31) across programs, their participants started at a relatively high level (Above Progressing – 2.22) and had less room to increase these skills compared to some of the other programs.

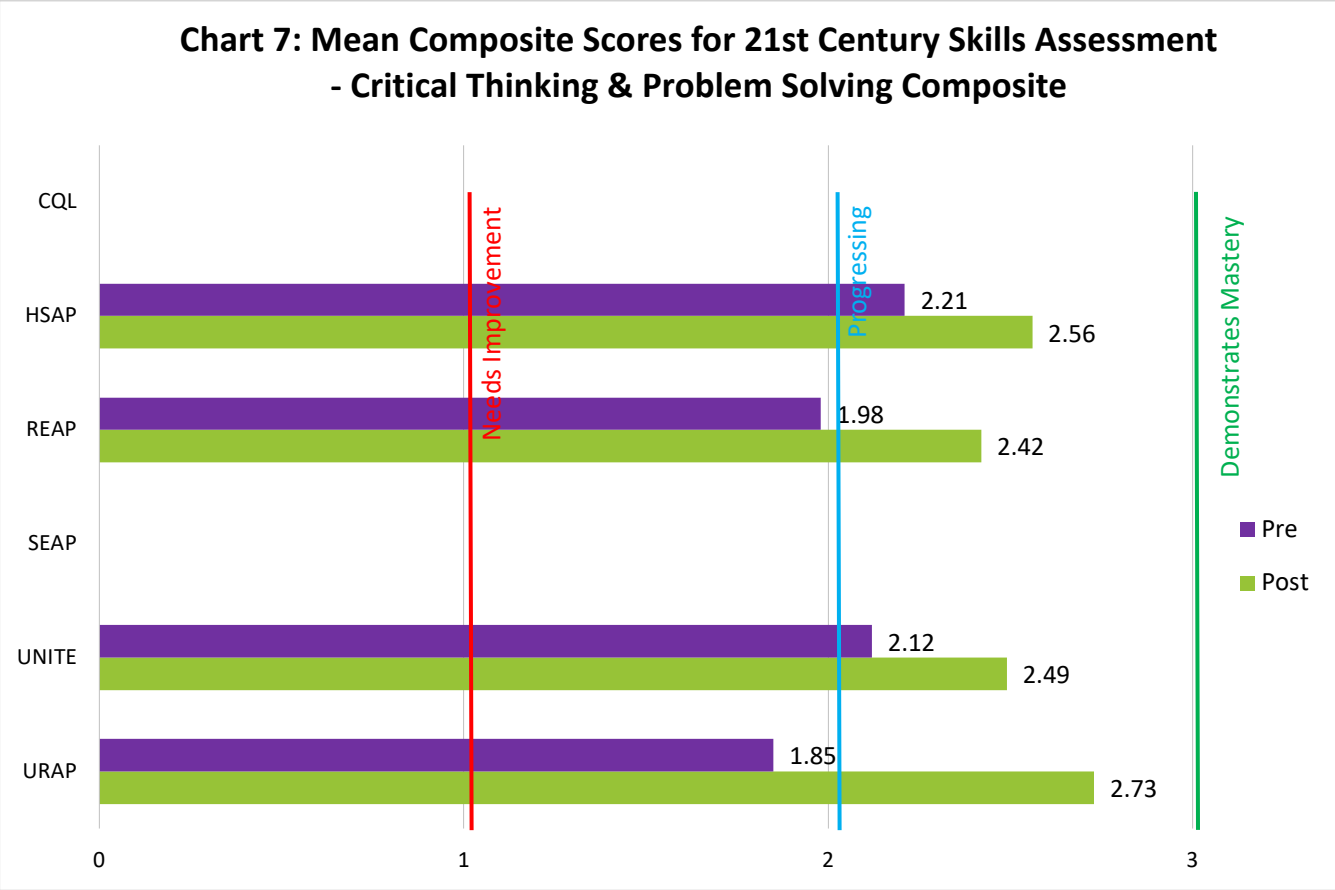
Table 23. Items that form the 21st Century Skills Assessment Subscale Composite of Creativity and Innovation
1. Think creatively
2. Work creatively with others
3. Implement innovations



Critical Thinking & Problem Solving. Significant growth in participant skills related to critical thinking and problem solving were observed by mentors (p<.01). See Table 24 for items rated in this skill set. Across AEOPs, participants began their program being rated at nearly Progressing or slightly above this level. By the post-assessment, participants grew to an approaching Demonstrates Mastery level. Chart 7 graphically displays these results by program. While all AEOPs showed a significant increase in this area, URAP participants saw the greatest increase (+0.88). All other programs averaged approximately +0.40

points growth. Comparing programs, URAP participants on average started lower and grew to a higher average.

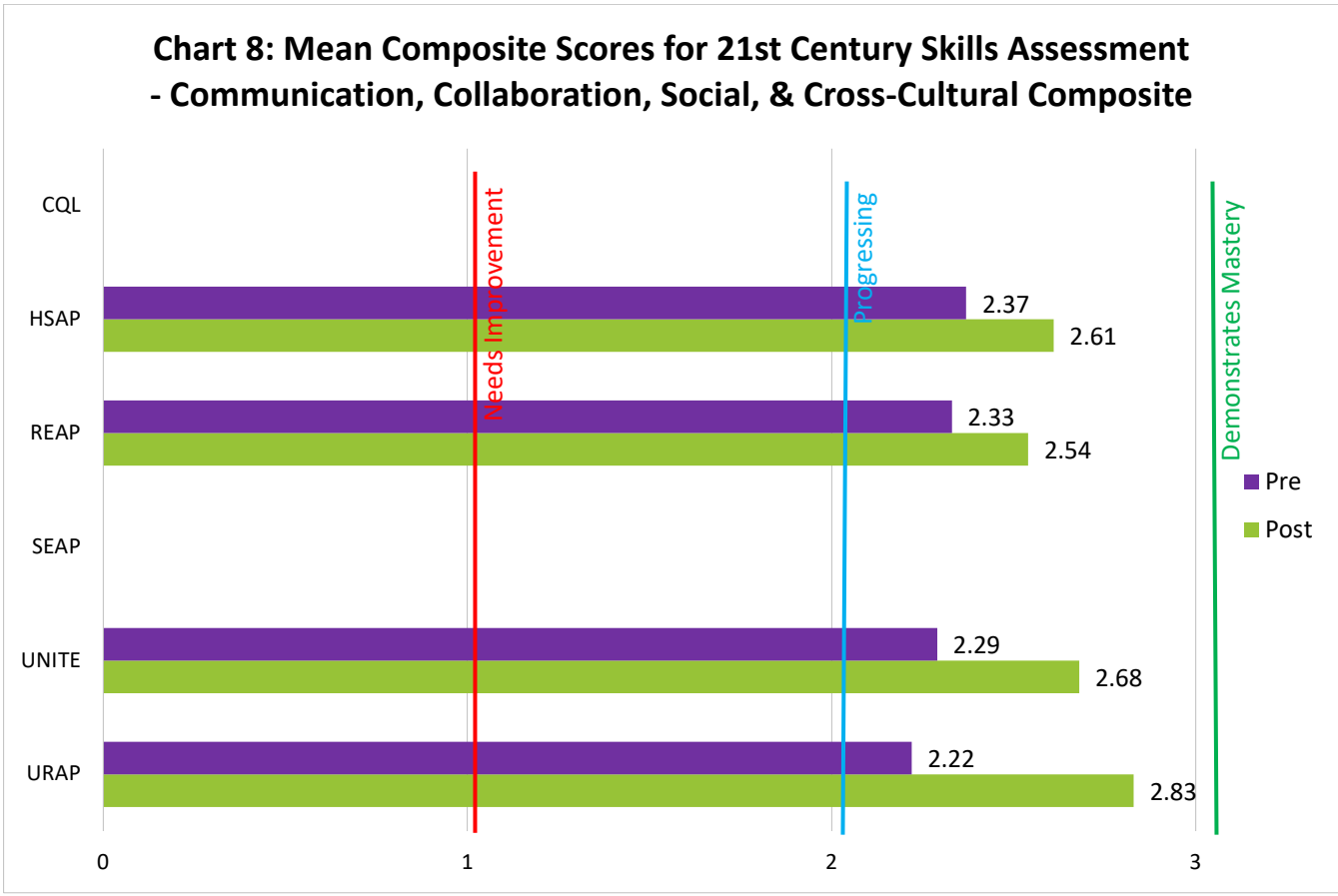
Table 24. Items that form the 21st Century Skills Assessment Subscale Composite of Critical Thinking & Problem Solving
1. Reason effectively
2. Use systems thinking
3. Make judgments and decisions
4. Solve problems



Communication, Collaboration, Social & Cross-Cultural. Across all AEOPs, positive participant growth in communication, collaboration, social, and cross-cultural skills was demonstrated from pre- to post-assessment. However, only REAP, UNITE, and URAP had statistically significant growth ($p<.05$). If HSAP had a larger observation sample size, we would have seen significant growth with them as well since they had greater average growth compared to other programs in this area. See Table 25 for items rated in this skill set. Regardless of program, participants were rated relatively high on these skills at the pre-assessment averaging over the Progressing level benchmark of 2.0. By the post-rating, participants grew to an approaching Demonstrates Mastery level (See Chart 8). Again, URAP students demonstrated the

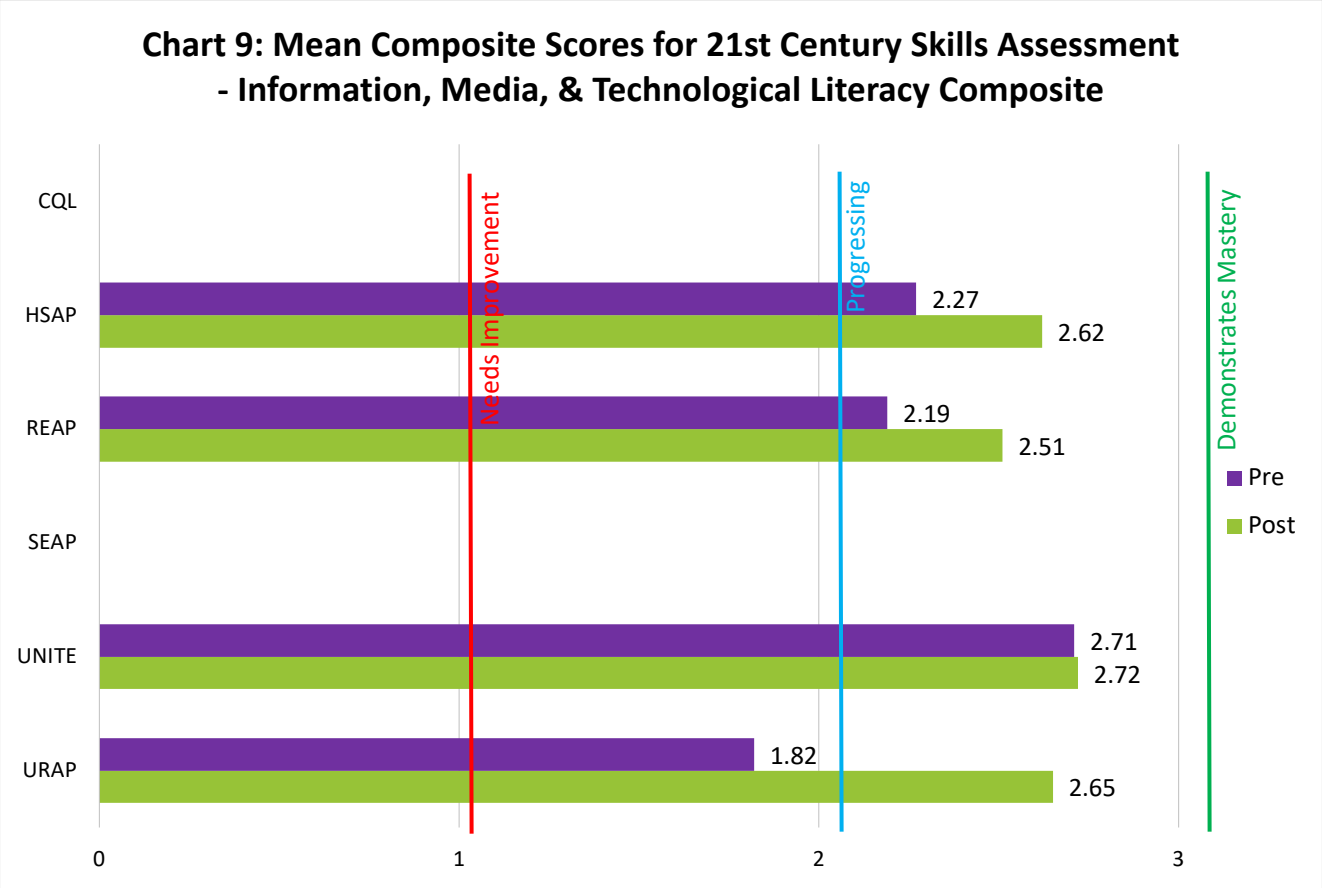
greatest average growth in this area (+0.61) with the other AEOPs averaging approximately +0.30 points of growth.

Table 25. 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. While participants across AEOPs averaged positive growth in their information, media, and technological literacy skills, only REAP and URAP participants had significant growth (p<.05). See Table 26 for items rated in this skill set. To further explain this phenomenon, HSAP and UNITE participants averaged higher pre-ratings in comparison to REAP and URAP (see Chart 9). Consequently, HSAP and UNITE were left with less "room to grow" in comparison to REAP and URAP participants. In the end, participants in all AEOPs averaged approaching Demonstrates Mastery with URAP participants demonstrating the greatest improvement from pre-post rating (+0.83).

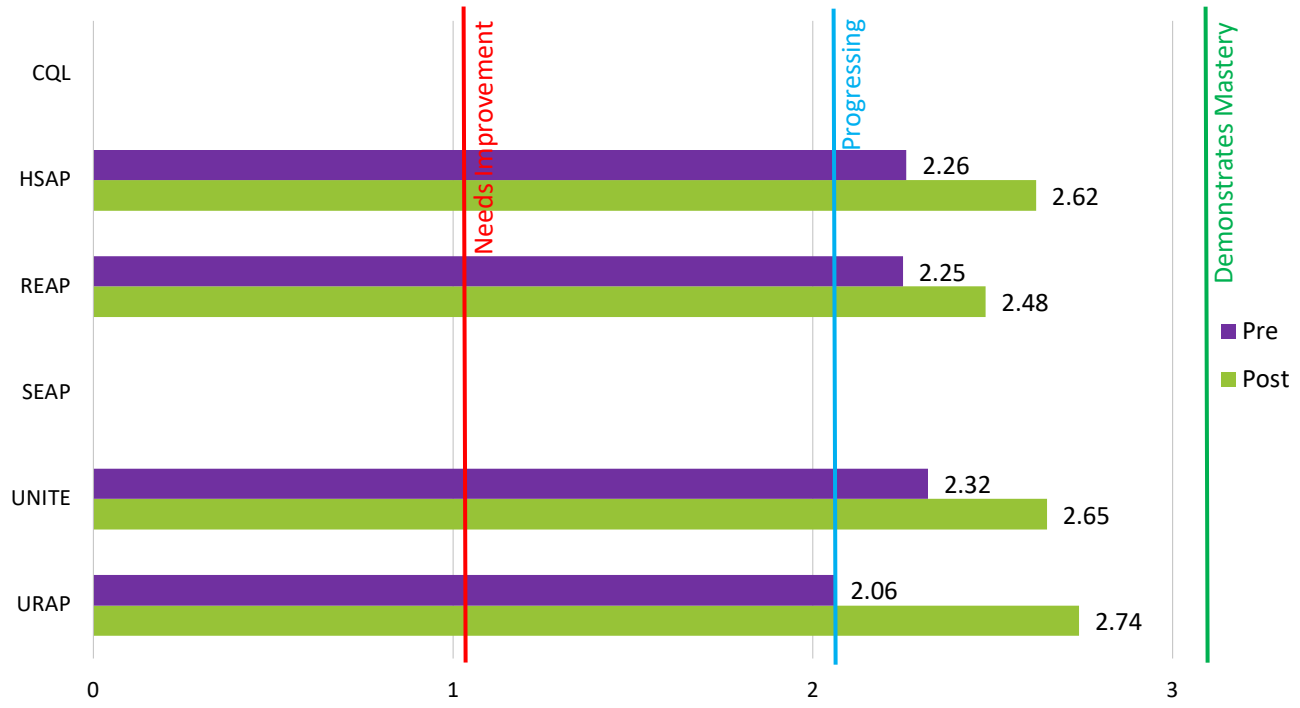
Table 26. Items that form the 21st Century Skills Assessment Subscale Composite of Information, Media, & Technological Literacy
1. Access and evaluate information
2. Use and manage information
3. Analyze media
4. Create media products
5. Apply technology effectively



Flexibility, Adaptability, Initiative, & Self-Direction. Statistically significant growth in flexibility, adaptability, initiative, and self-direction was found in all AEOPs from pre- to post-assessment ($p<.05$). See Table 27 for items rated in this skill set. Although URAP again showed the greatest growth in this subscale (+0.68), program findings appear quite similar. All programs began this domain slightly over the Progressing benchmark level (2.0) and significantly increased to approaching Demonstrates Mastery by post-rating (Chart 10).

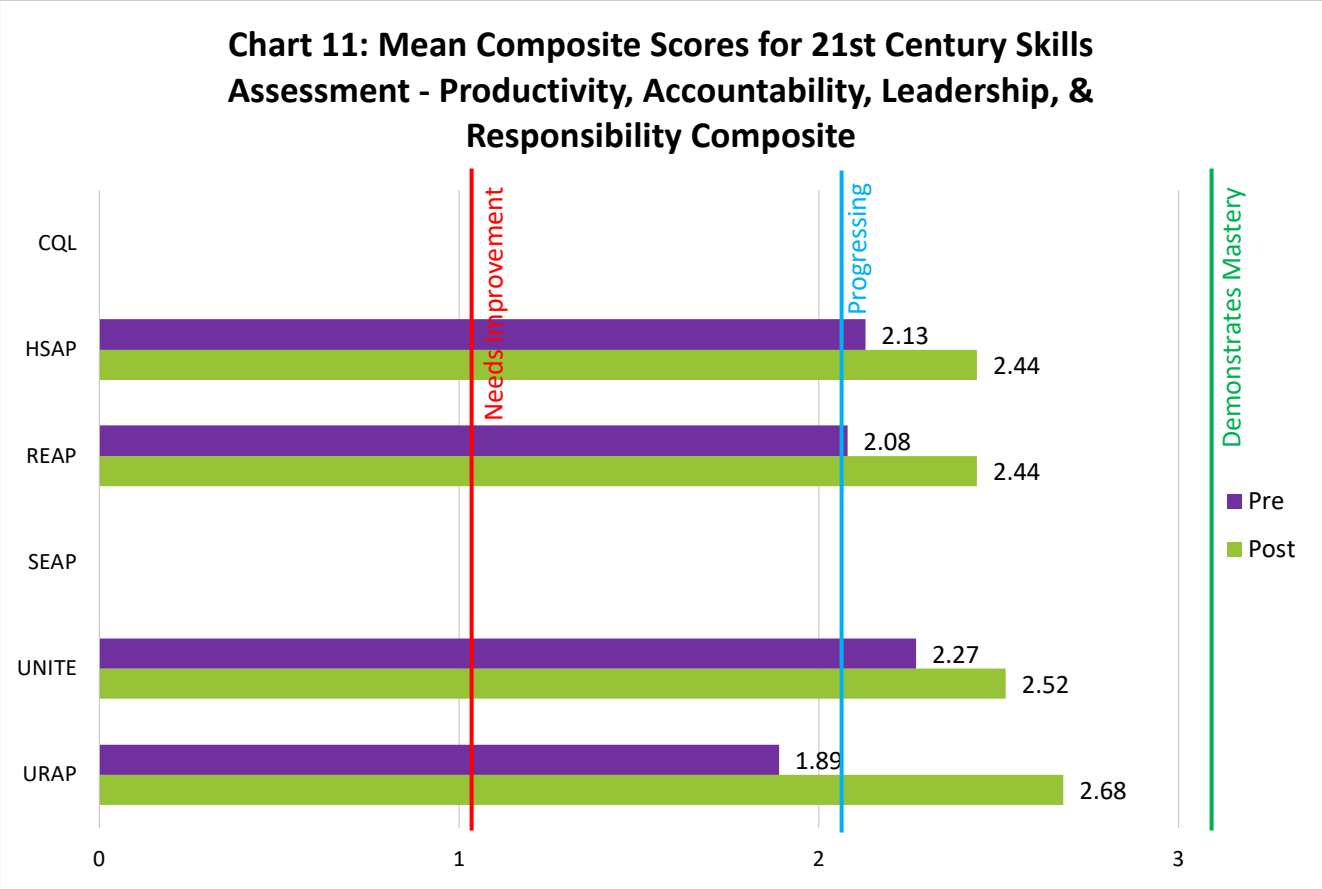
Table 27. Items that form the 21st Century Skills Assessment Subscale Composite of Flexibility, Adaptability, Initiative, & Self-Direction
1. Adapt to change
2. Be flexible
3. Manage goals and time
4. Work independently
5. Be a self-directed learner

Chart 10: Mean Composite Scores for 21st Century Skills Assessment - Flexibility, Adaptability, Initiative, & Self-Direction Composite



Productivity, Accountability, Leadership, & Responsibility. Regardless of program, significant growth in productivity, accountability, leadership, and responsibility skills were found from pre- to post-assessment (p<.05). See Table 28 for items rated in this skill set and Chart 11 for findings. With the exception of URAP whose students averaged slightly below Progressing at pre-assessment, all other programs' participants averaged slightly above Progressing. By post-assessment, URAP grew more than any other program (+0.79) in this skill set to average approaching Demonstrates Mastery making them similar to the other programs at post-assessment.

Table 28. 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



Although results slightly varied across programs, the skill sets of Creativity and Innovation as well as Critical Thinking and Problem Solving were areas where participants showed the greatest improvement over the duration of their program. In terms of programs, HSAP and UNITE participants on average entered their programs being rated above the Progressing level (2.0). This made it more challenging for these participants to demonstrate significant growth in some areas due to the ceiling effect (not enough room to grow). While URAP participants on average entered their program with lower observation ratings (most below Progressing level), and then "caught up" to the other programs at post-observation through highly significant growth (p<.001) in all skill sets to finish at the approaching Demonstrates Mastery level.

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 FY17 the AEOP continued to highlight DoD STEM research through program activities that engage participants in or provide meaningful exposure to DoD research. Table 29 summarizes some of these efforts.

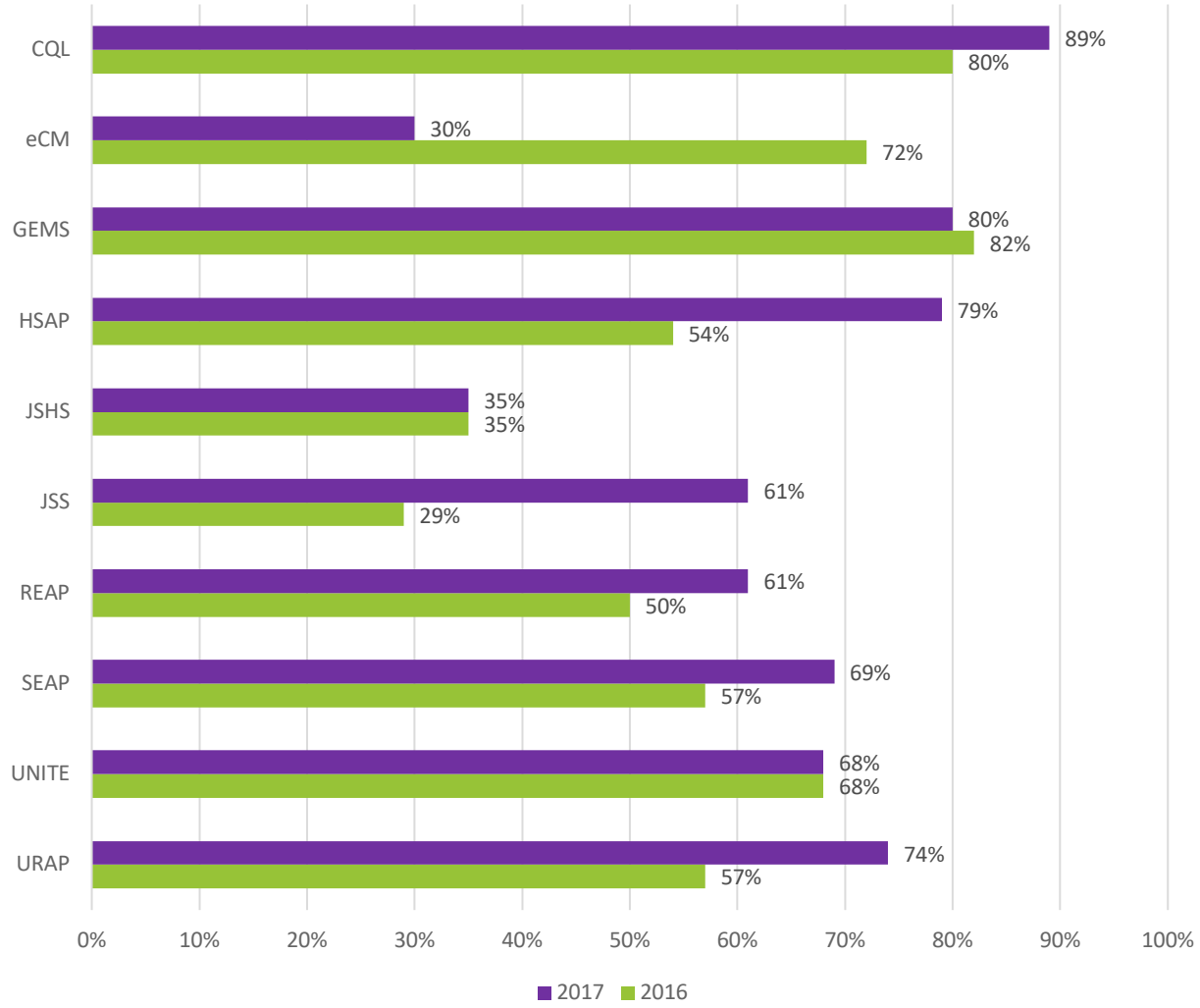
Table 29. 2017 Participant Engagement in and Exposure to DoD Research	
AEOP	**Engagement in DoD Research**
CQL, SEAP	**342** high school and undergraduate or graduate participants (**113 for SEAP, 229 for CQL**) serving as apprentices on DoD research projects at Army or DoD research laboratories.
HSAP, URAP	**113** (**54 for HSAP, 59 for URAP**) high school and undergraduate participants serving as apprentices on Army research projects at college/university research laboratories.
GEMS	**2,845** elementary, middle and high school participants, and **62** K-12 teachers were engaged in DoD research through GEMS activities hosted by Army research laboratories.
AEOP	**Exposure to DoD Research**
eCM	**69** participants and their **22** team advisors (in-service teachers) were exposed to DoD research through the National Judging & Educational Event activities. **149** students participated in CyberGuides live chats.
JSHS	**230** participants and their **34** 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. **5,800** students were exposed to DoD research through DoD S&Es who engage at regional JSHS symposia.
Unite	**358** high school participants and **402** program mentors participated in experiences including field trips and speakers about the work of DoD STEM personnel and/or DoD research facilities.
JSS	**893** participants in regional competitions and **245** participants in the national competition were exposed to DoD research through JSS activities facilitated by **37** Army S&Es.

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, SEAP, and URAP, actively engage participants in DoD research projects by providing apprentices opportunities to work alongside Army S&Es make meaningful contributions to research. STEM enrichment activities provide students with hands-on, interactive experiences that are relevant to nearby Army labs. 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.

Mentors provide students and apprentices with valuable information about the DoD and STEM research in the DoD. In recognition of this key mentor role, the mentor questionnaire asked mentors to report

whether they discussed STEM opportunities in the DoD and other government agencies with apprentices and students in order to support their STEM educational and career pathways. Results for this item for FY16 and FY17 are displayed in Chart 12. There continues to be substantial variation in mentor responses to this item across programs and across program years. While only 30% of eCM mentors and 35% of JSHS mentors discussed STEM opportunities in the DoD with students, a majority of mentors in all other programs (range of 61%-89%) discussed these opportunities with their students or apprentices. Mentors in six programs (CQL, HSAP, JSS, REAP, SEAP, and URAP) discussed these opportunities at greater rates than in FY16, while the percentage of mentors in JSHS and Unite discussing these opportunities remained at FY16 levels. Fewer mentors for eCM and GEMS discussed STEM opportunities in the DoD with students in FY17 as compared to FY16.

Chart 12: Percent of Mentors Who Report Discussing STEM Opportunities in the DoD with Apprentices



Students and apprentices were presented with several positive statements about DoD research and researchers and were asked to indicate their level of agreement. Participant responses indicate that attitudes toward Army/DoD research and researchers remain consistently positive. The proportion of respondents who agreed with the statements in FY16 and FY17 are provided in Table 30. A majority of participants in all programs agreed that Army/DoD research and researchers advance science and engineering fields (range of 51%-97%), develop new cutting-edge technologies (range of 56%-94%), that DoD researchers solve real-world problems (range of 61%-95%), and that DoD research is valuable to society (range of 56%-98%). These responses are similar to those from 2016.

The highest rates of agreement with these statements continues to be from participants at programs hosted at DoD research laboratories (CQL, GEMS, 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. These findings suggest that experiences at DoD research laboratories 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 research labs 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 30. AEOP Participants' Agreeing with Various Statements about DoD STEM Research

	Year	CQL	eCM	eCMNJ&E	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
DoD researchers advance science and engineering fields	2016	100%	45%	97%	84%	100%	68%	66%	79%	94%	84%	90%
	2017	***94%***	***51%***	***91%***	***80%***	***97%***	***68%***	***67%***	***87%***	***92%***	***74%***	***88%***
DoD researchers develop new, cutting edge technologies	2016	92%	46%	97%	83%	97%	67%	62%	79%	89%	83%	90%
	2017	***94%***	***56%***	***91%***	***81%***	***97%***	***67%***	***64%***	***87%***	***92%***	***75%***	***84%***
DoD researchers solve real-world problems	2016	98%	49%	96%	87%	92%	71%	70%	80%	96%	81%	85%
	2017	***94%***	***61%***	***94%***	***85%***	***94%***	***71%***	***69%***	***87%***	***95%***	***76%***	***88%***
DoD research is	2016	96%	48%	94%	85%	92%	68%	70%	80%	97%	81%	85%

valuable to society	***2017***	***95%***	***56%***	***94%***	***84%***	***94%***	***68%***	***69%***	***89%***	***98%***	***77%***	***91%***

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 FY17 AEOP programs. Evaluation findings indicated that the AEOP exposed students and apprentices to STEM careers generally and to Army and DoD STEM careers, and that participating in these programs increased their interest in pursuing STEM careers.

Students and apprentices were asked to report on the number of STEM careers generally, and the number of STEM careers in the Army/DoD, they learned about during their AEOP experiences. Chart 13 displays results for participants who reported learning about 3 or more general STEM careers (range of 32%-97%). A majority of participants (range of 53%-97%) in CQL, eCM National, GEMS, HSAP, JSHS, REAP, SEAP, and Unite reported learning about 3 or more STEM careers. Fewer students (range of 32%-44%) in eCM Regional, JSS, and URAP had learned about 3 or more STEM careers. A somewhat larger proportion of students had learned about 3 or more STEM careers in FY17 as compared to FY16 in eCM National, GEMS, and JSHS. The percentage of students learning about these careers in all other programs decreased in FY17 compared to FY16.

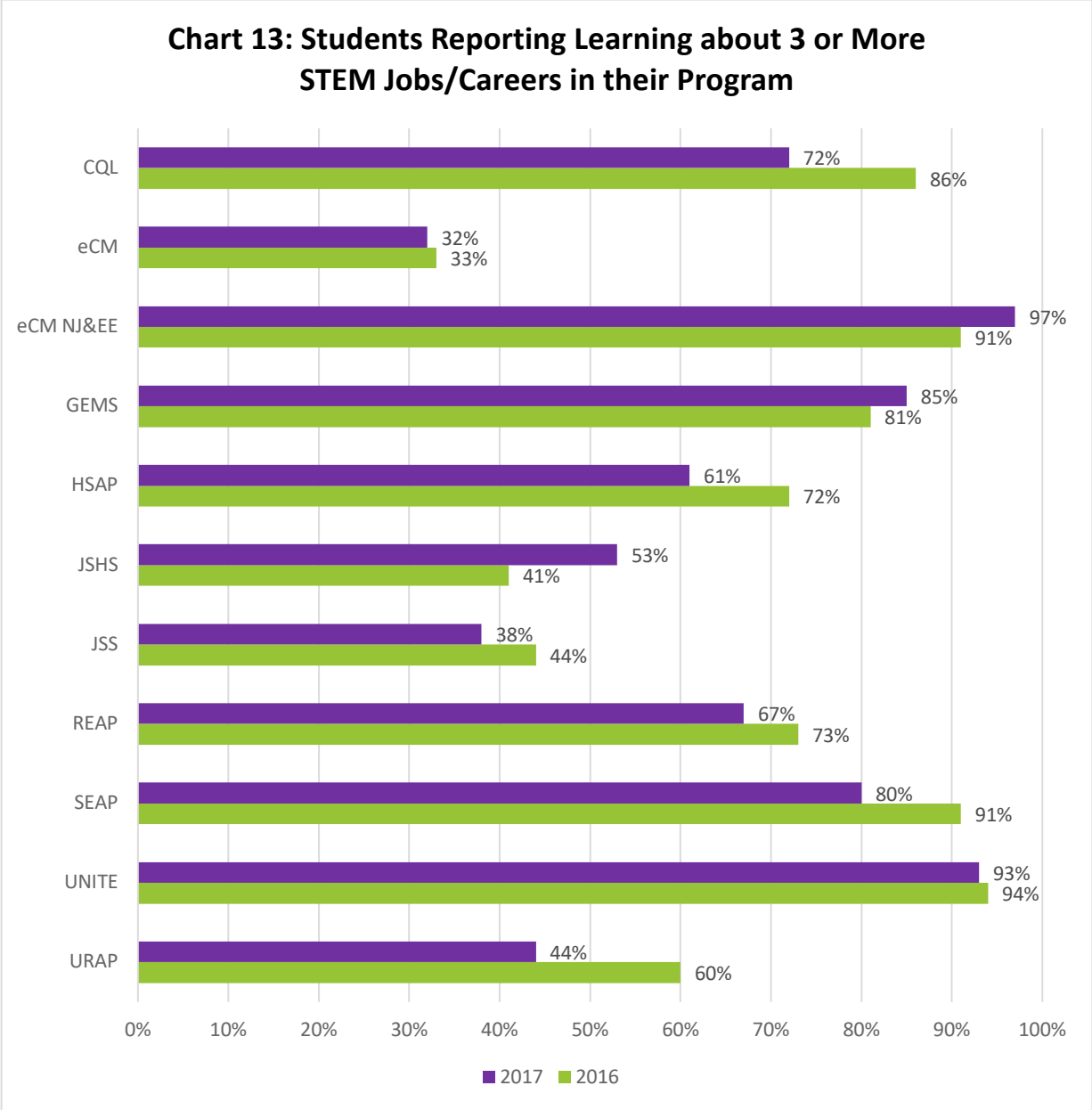
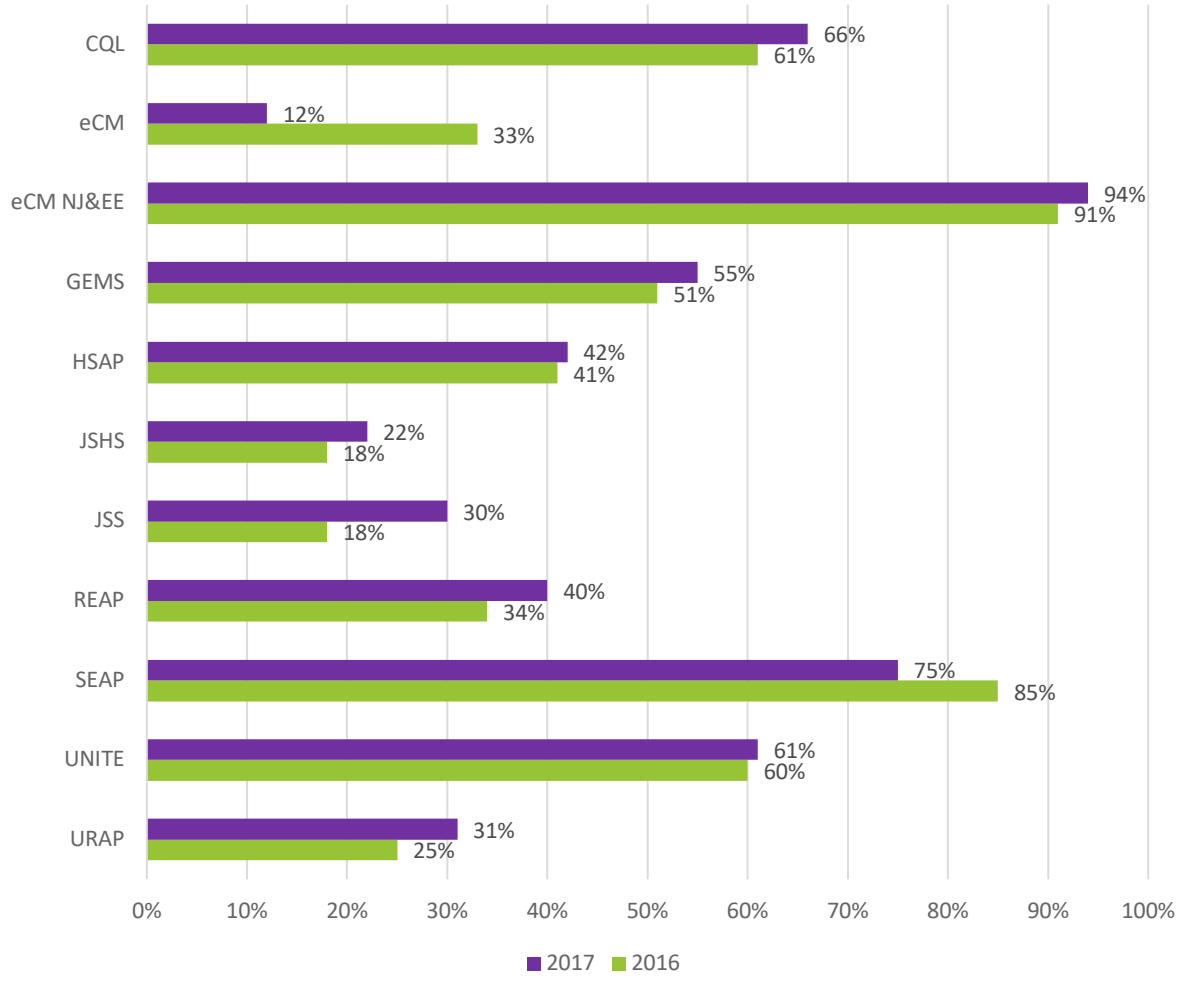


Chart 14 displays findings for students who learned about 3 or more STEM careers within the Army or DoD. A somewhat smaller percentage of students (range of 12%-94%) had learned about these careers as compared with STEM careers more generally (Chart 8). A majority of students (range of 55%-94%) in CQL, eCM National, GEMS, SEAP, and Unite had learned about 3 or more DoD STEM careers. Fewer students (range of 12%-42%) in other programs had learned about this number of DoD STEM careers. In FY17 a greater percentage of participants than in FY16 in all programs with the exception of eCM Regional and SEAP learned about these careers. As in previous years, comparisons of participants participating in AEOPs held at Army research laboratories (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)

reveal that, overall, these participants learned about more DoD STEM careers. It is noteworthy, however, that an overwhelming majority (94%) of eCM National students and more than half of Unite students reported learning about 3 or more DoD STEM careers although they participated in programs in non-Army affiliated settings. It may be useful, therefore, to examine the practices used by these programs to determine their suitability for implementation in other programs hosted in non-Army affiliated settings.

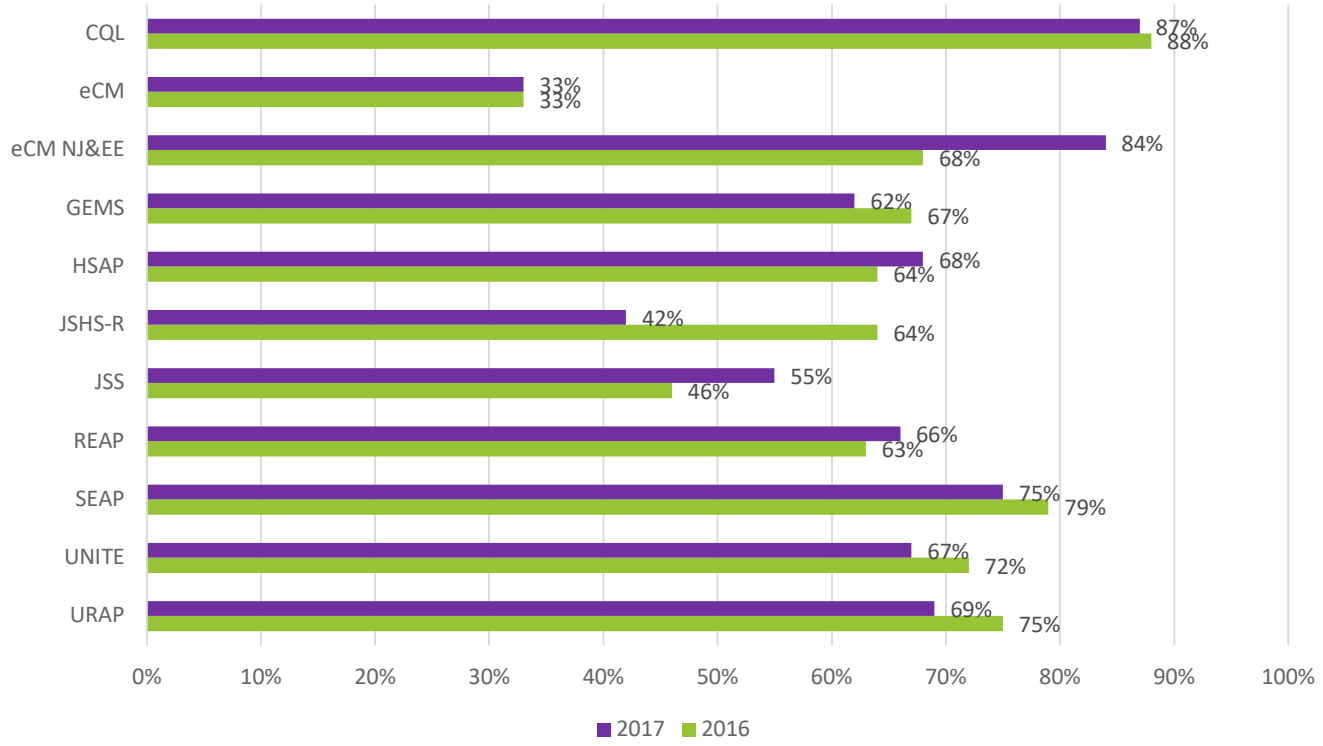
Chart 14: Students Reporting Learning about 3 or More DoD STEM Jobs/Careers in their Program



Participants were also 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 past years, participants in some programs reported that their AEOP experiences were more impactful in this area (e.g., CQL, SEAP, national eCM, and URAP) than did participants in programs such as regional e-CM and GEMS. Because the programs for which participants tend to report the greatest impact in this area are those in which participants have exposure to Army and DoD STEM researchers and/or facilities during program activities, this suggests that this type of direct engagement is especially useful for informing participants about specific jobs and

careers within the DoD. Mentors in many programs were unaware of AEOP electronic and print resources and therefore these had limited usefulness in exposing apprentices and students to STEM DoD careers, although findings suggest that these resources are used differently across programs.

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



Participants were also asked to rate their agreement with a number of statements about their interest and awareness of STEM careers, both generally and within the DoD (Table 31). A majority of students (range of 64%-84%) in all programs except for eCM Regional (39%) were more interested in pursuing STEM careers after their AEOP participation. Somewhat smaller percentages of participants in most programs (range of 29%-88%) indicated that their AEOP participation resulted in an increased interest in DoD STEM careers, although more CQL students indicated an increased interest in DoD STEM careers (88%) as compared to STEM careers more generally (69%). A majority of participants (53%-96%) in all programs with the exception of eCM Regional (39%) were more aware of DoD STEM research and careers after their AEOP experiences, and, likewise, a majority of participants (56%-100%) with the exception of eCM Regional (42%) had a greater appreciation of Army or DoD STEM research after their AEOP experiences. There was substantially greater agreement with these statements in FY17 as compared to FY16 for eCM National and HSAP, and many more GEMS students indicated an increased interest in STEM careers with the Army DoD in FY17 (62% in FY17; 29% in FY16).

Table 31. 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	2016	86%	39%	70%	77%	61%	64%	65%	73%	70%	81%	68%
	2017	***69%***	***42%***	***84%***	***75%***	***81%***	***64%***	***64%***	***78%***	***69%***	***80%***	***63%***
I am more aware of DoD STEM research and careers	2016	96%	39%	77%	83%	75%	53%	56%	77%	97%	82%	75%
	2017	***92%***	***47%***	***96%***	***80%***	***97%***	***53%***	***61%***	***77%***	***89%***	***85%***	***72%***
I have a greater appreciation of Army or DoD STEM research	2016	100%	42%	80%	85%	89%	56%	58%	83%	97%	81%	90%
	2017	***93%***	***51%***	***96%***	***84%***	***97%***	***56%***	***70%***	***78%***	***93%***	***77%***	***84%***
I am more interested in pursuing a STEM career with the DoD	2016	88%	33%	68%	29%	64%	42%	46%	63%	79%	72%	75%
	2017	***87%***	***33%***	***84%***	***62%***	***68%***	***42%***	***55%***	***66%***	***75%***	***67%***	***69%***

Findings for apprentice interest in pursuing DoD STEM careers is displayed in Table 32. More than half of responding apprentices reported interest in DoD STEM careers in FY17 (range of 66%-87%), findings similar to those for FY16 (a range of 63%-88%). Most programs showed an upward trend in interest in these careers from FY16 to FY17 with the exception of SEAP (79% in FY16, 75% in FY17) and URAP (75% in FY16, 69% in FY17).

Table 32. Apprentices' Interest in DoD STEM Careers 2016 - 2017		
Program	**2016**	**2017**
CQL	88%	87%
HSAP	64%	68%
REAP	63%	66%
SEAP	79%	75%
URAP	75%	69%

In all programs, youth and adult participants reported that AEOP participation afforded students 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:

> *Before my apprenticeship, I wasn't really sure if I wanted to continue my education after my bachelor's, but now I know that I definitely want to pursue a Ph.D. and do research for the rest of my life.* (CQL Apprentice)

I've always wanted to pursue STEM as a career, but when I came here I saw a lot of the opportunities that the Army has to offer. I think that a lot of the engineers here are really impressive people. Now I'm starting to realize that the Army is a really great place to pursue a STEM career. (eCM-NJ&EE student)

[GEMS] has greatly bolstered my interest in STEM, and shown me multiple careers and major paths to choose from. It has also given me a chance to interact with college students and ask them various questions, something I am not usually able to do. (GEMS Student)

I think the biggest benefit [of HSAP] would definitely be getting greater knowledge base in some areas that I was interested in. Just knowing what more careers and various subjects would be like, and getting to work with people who have such vast knowledge in the areas that I was interested in. (HSAP Apprentice)

JSHS has given me more knowledge about possibilities in the future in terms of education and work. (R-JSHS Student)

JSS has opened the door to STEM related career fields for all of my students. 90% of my former students that have graduated from high school are not in the military in STEM fields or enrolled in college in STEM related programs. All of them built and raced in the JSS. (JSS Mentor)

I got to work in a real-life lab with real-life scientists, I learned about many careers in STEM, I learned a whole lot about nanoparticles and quantum dots, I learned how to do self-sufficient research and develop procedures for experiments, I established networks with professionals in STEM in my area, I learned how to work with peers and superiors toward common goals, and I developed great friendships with my fellow apprentices. (REAP Apprentice)

One of the biggest questions I get asked in my class, especially being a math class is, "When am I ever going to use this?" I was doing stuff in an environmental lab but I was still using a lot of math… That's something that I'm going to incorporate [in my teaching] this year. (RESET Participant)

My overall experience has been wonderful and I know that my time at [the Army lab] has helped prepare me for my education moving forward. I also hope to continue into the CQL program with hopes of eventually becoming a DoD employee or Army civilian. (SEAP Apprentice)

The UNITE program has helped me learn more about the different STEM careers and what to expect if you choose to pursue one. (Unite Student)

This program is very beneficial for undergraduate students interesting in exploring STEM research. This also gives them a chance to think and work independently, as well as in collaboration with other researchers, thereby preparing them for a future career in STEM research. (URAP Mentor)

Because mentors play a key role in providing information to program participants, the AEOP has focused since 2014 on supporting mentors with resources to expose participants to DoD STEM careers. Mentors

were asked, as part of the FY17 evaluation, to rate the usefulness of various resources for this purpose. Table 33 presents findings for FY16 and FY17. Across all programs, simply participating in the program was chosen most frequently as useful for exposing participants to DoD STEM careers (a range of 69%-100%). Mentors' perceptions of the usefulness of various AEOP resources varied across programs. For example, while 83% of HSAP mentors found the AEOP website useful, only 10% of JSHS mentors reported that the website was a useful resource, and while 68% of Unite mentors found the AEOP brochure useful, only 6% of SEAP mentors and 9% of CQL mentors reported that the brochure helped them to expose apprentices to DoD STEM careers. A large majority of mentors in eCM (87%) and JSS (78%) found the program administrator websites (e.g., TSA website) to be useful. A large majority of Unite mentors (78%) and GEMS mentors (76%) indicated that invited speakers or career events were useful in exposing students to DoD STEM careers.

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.)	2016	NA	85%	NA	62%	15%	89%	31%	NA	36%	64%
	2017	***NA***	***87%***	***NA***	***63%***	***15%***	***78%***	***NA***	***NA***	***39%***	***56%***
AEOP website	2016	20%	24%	54%	77%	10%	35%	59%	0%	59%	64%
	2017	***22%***	***38%***	***48%***	***83%***	***10%***	***48%***	***54%***	***17%***	***67%***	***71%***
AEOP social media	2016	0%	9%	14%	31%	3%	5%	19%	0%	27%	0%
	2017	***2%***	***21%***	***17%***	***25%***	***3%***	***17%***	***19%***	***3%***	***33%***	***18%***
AEOP brochure	2016	0%	9%	50%	69%	13%	11%	47%	0%	56%	43%
	2017	***9%***	***25%***	***54%***	***58%***	***13%***	***22%***	***46%***	***6%***	***68%***	***47%***
Program administrator or site coordinator	2016	33%	40%	89%	77%	76%	11%	63%	43%	71%	71%
	2017	***48%***	***51%***	***89%***	***92%***	***76%***	***22%***	***69%***	***54%***	***80%***	***71%***
Invited speakers or "career" events	2016	27%	11%	89%	23%	49%	3%	25%	14%	70%	8%
	2017	***22%***	***28%***	***76%***	***38%***	***49%***	***9%***	***29%***	***17%***	***78%***	***44%***
Participation in program	2016	80%	86%	89%	92%	93%	70%	81%	50%	80%	79%
	2017	***78%***	***94%***	***93%***	***100%***	***93%***	***74%***	***80%***	***69%***	***93%***	***91%***

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?

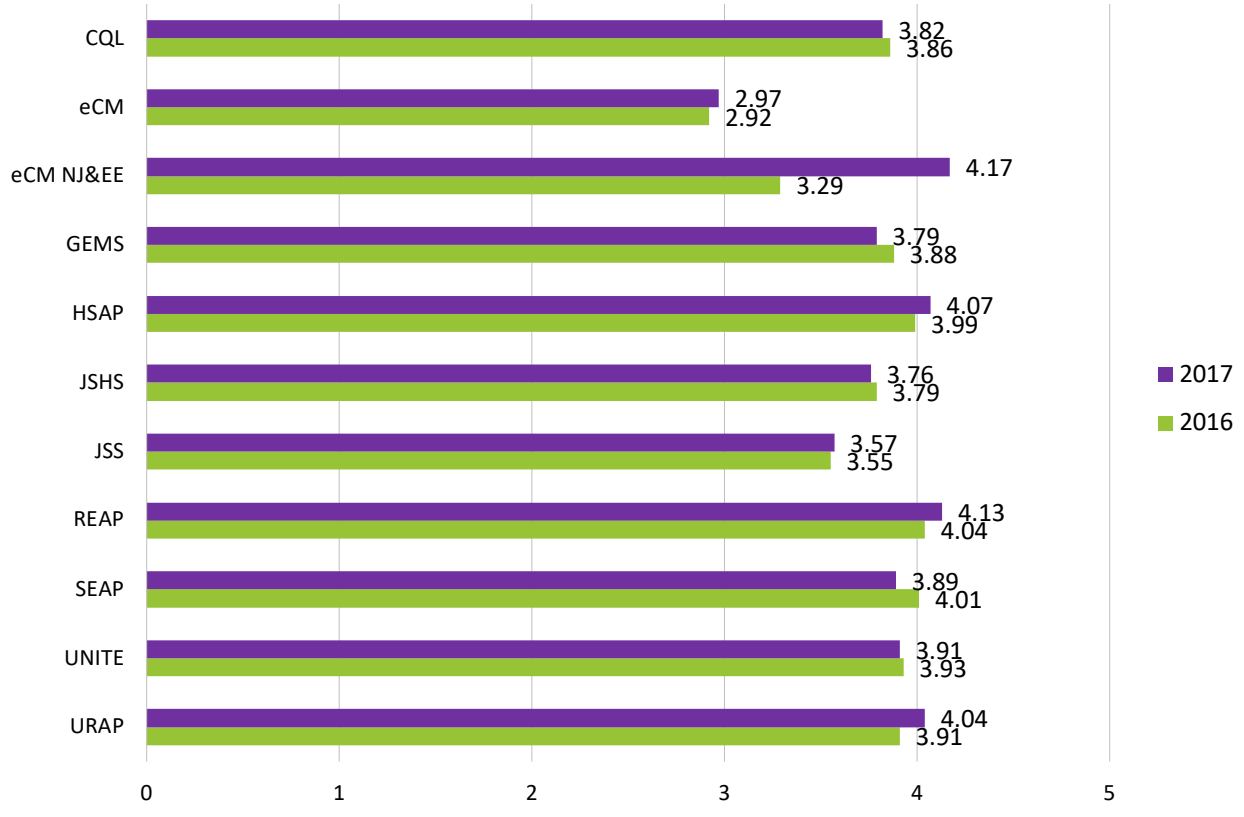
FY17 AEOP programs served to sustain existing STEM educational and career aspirations of participants and to inspire intentions to pursue post-baccalaureate education. In addition, participants reported gains in interest in pursuing DoD STEM careers as a result of their AEOP participation, although the 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, the evaluation asked AEOP participants to rate the likelihood that they would engage in STEM activities outside of AEOP or scheduled school classes. The Intentions to Engage in STEM Activities composite (Table 34) included items that asked about things participants may do at home, with family, in clubs, in the community, and in other settings. Findings suggest that participants in AEOP programs were somewhat more likely to engage in these types of activities after participating in the AEOP. Chart 16 displays the mean composite scores for the apprentices and students for FY16 and FY17. The largest impact on participants' intentions to engage in STEM in the future occurred in eCM National, REAP, and HSAP.

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†

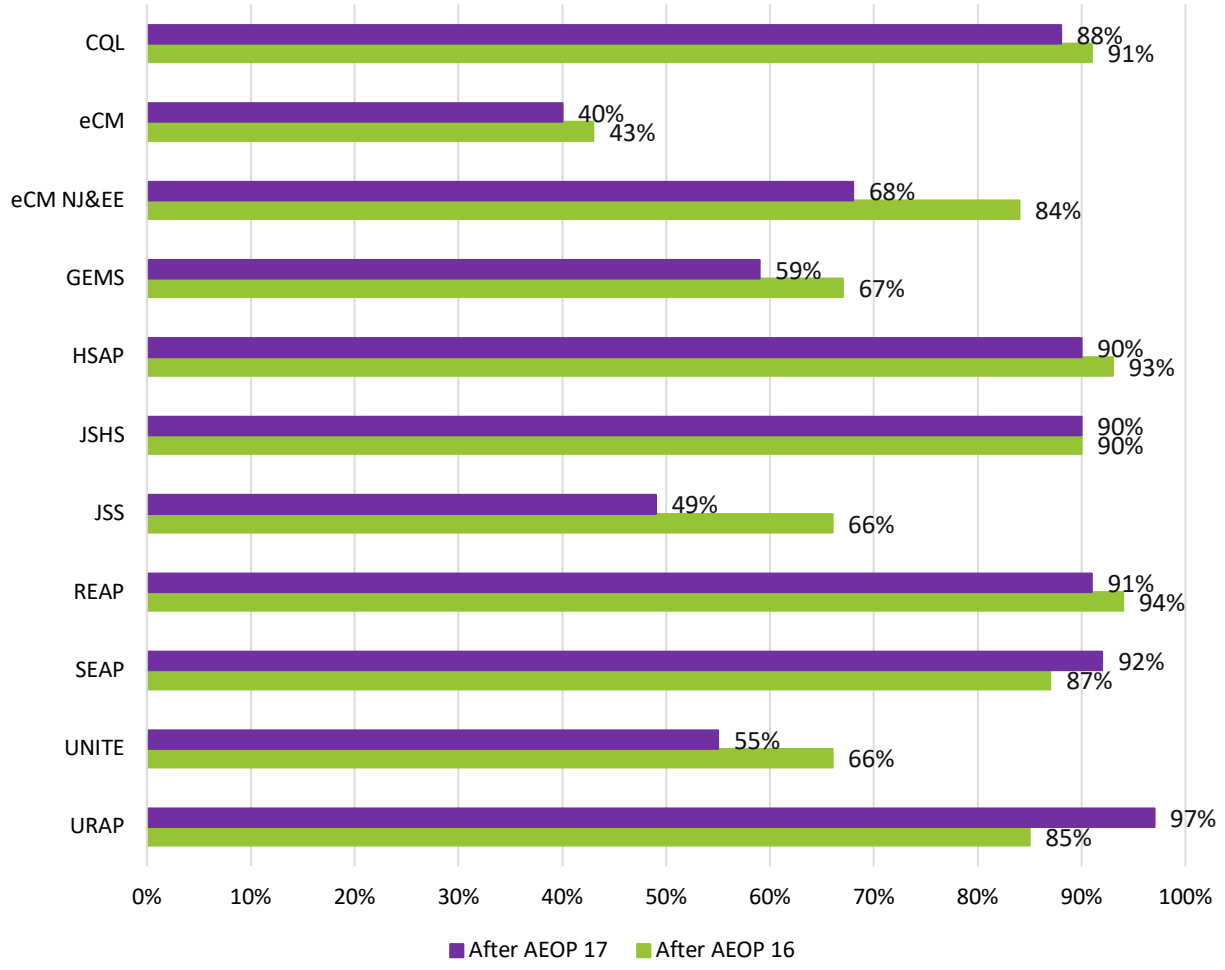


† *Response options for the items forming this composite were: 1 – Much less likely, 2 – Less likely, 3 – About the same before and after, 4 – More likely, 5 – Much more likely.*

Students and apprentices were asked to indicate their educational aspirations after their AEOP experiences. Data for participants planning to continue their education beyond a bachelor's degree for FY16 and FY17 are displayed in Chart 17. A large majority of participants in all programs indicated wanting to at least earn a bachelor's degree, and a majority of participants (55%-97%) in all programs with the exception of eCM regional (40%) and JSS (49%) indicated that they planned to continue their education

beyond a bachelor's degree. Comparing FY17 findings to FY16, there was a slight decrease in the percentage of participants with these educational aspirations for several programs (CQL, eCM, GEMS, HSAP, JSS, REAP, and Unite), although the percentage of apprentices with these post-bachelor's aspirations grew for URAP and SEAP.

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 2017 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 FY17, 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. Use of mentoring strategies varied across programs, although a majority of mentors in each program indicated using each of the mentoring strategies about which they were asked. As in FY16, mentors across programs were most likely to report using strategies to engage students in authentic STEM activities (range of 82%-94%) and least likely to report using strategies to support their students' STEM educational and career pathways (range of 47%-69%).

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 FY17 evaluation to report on their use mentoring strategies with participants. These strategies comprised five main areas of effective mentoring:[9]

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.

For each area of mentoring, items were combined into composite variables. The items that comprise the Establishing the Relevance of Learning Activities composite are shown in Table 33, and mean composite scores for this variable are shown in Chart 18. A majority of mentors across all programs (range of 71%-83%) reported using these strategies. Overall, the proportion of mentors using these strategies is similar to FY16 (range of 69%-88%). In FY17, slightly fewer mentors in eCM, GEMS, REAP, Unite, and URAP reported using these strategies as compared to FY16. There was no change in the use of these strategies

[9] 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.

in JSHS, and use of the strategies increased in CQL, HSAP, JSS, and SEAP. A comparison of composite scores from FY16 and FY17 is found in 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

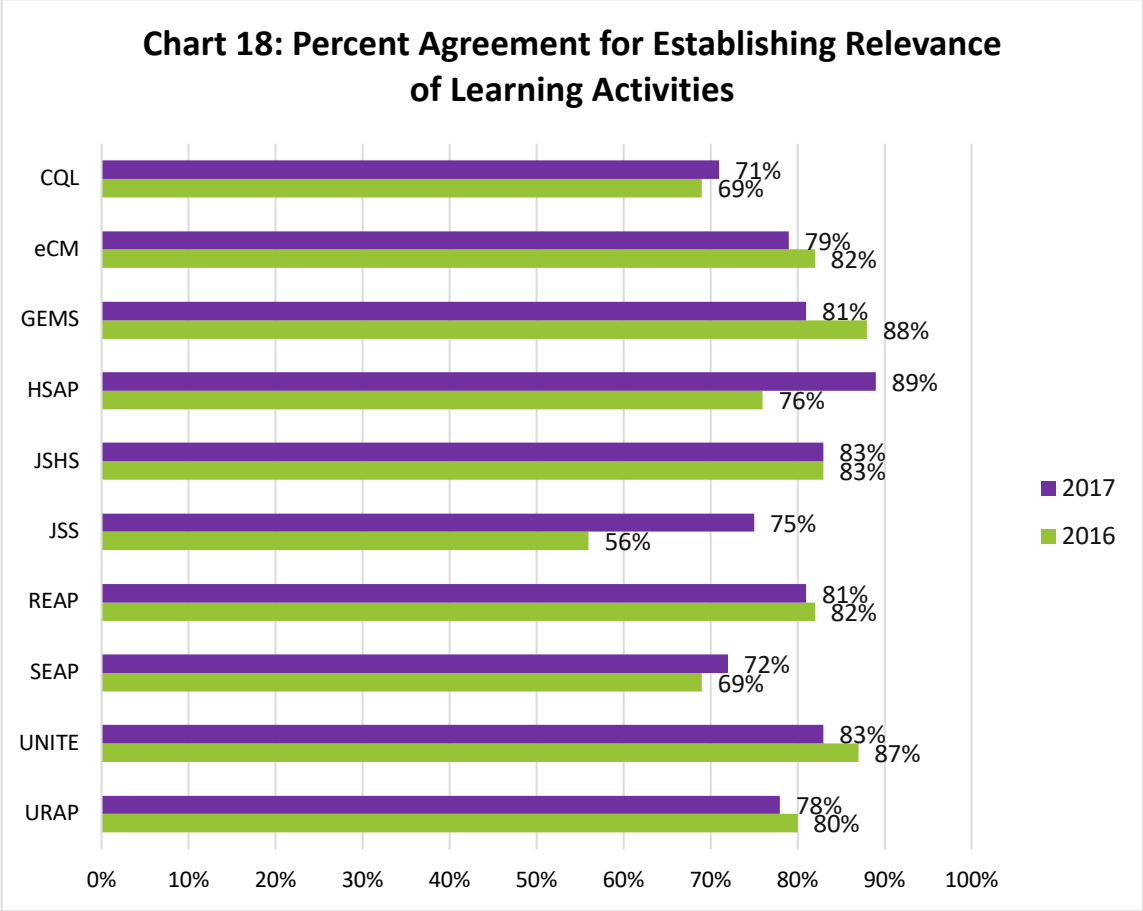


Table 36. Mentor Overall Percent Agreement for Establishing the Relevance of Learning Activities		
Program	**2016 Composite % Agreement**	**2017 Composite % Agreement**
CQL	69%	71%
eCM	82%	79%
GEMS	88%	81%
HSAP	76%	89%
JSHS	83%	83%
JSS	56%	75%
REAP	82%	81%
SEAP	69%	72%
Unite	87%	83%
URAP	80%	78%

Similarly, the items comprising the Supporting the Diverse Needs of Students as Learners composite are shown in Table 35, and mean composite scores are shown in Chart 19 and Table 37. A majority of all mentors (range of 63%-86%) reported using these mentoring strategies. There was a slight decline in the use of these strategies in FY17 for CQL and GEMS as compared with FY16, however the use of these strategies increased over FY16 rates for all other programs except for JSHS, where reported usage remained constant. A comparison of composite scores from FY16 and FY17 is found in Table 38.

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

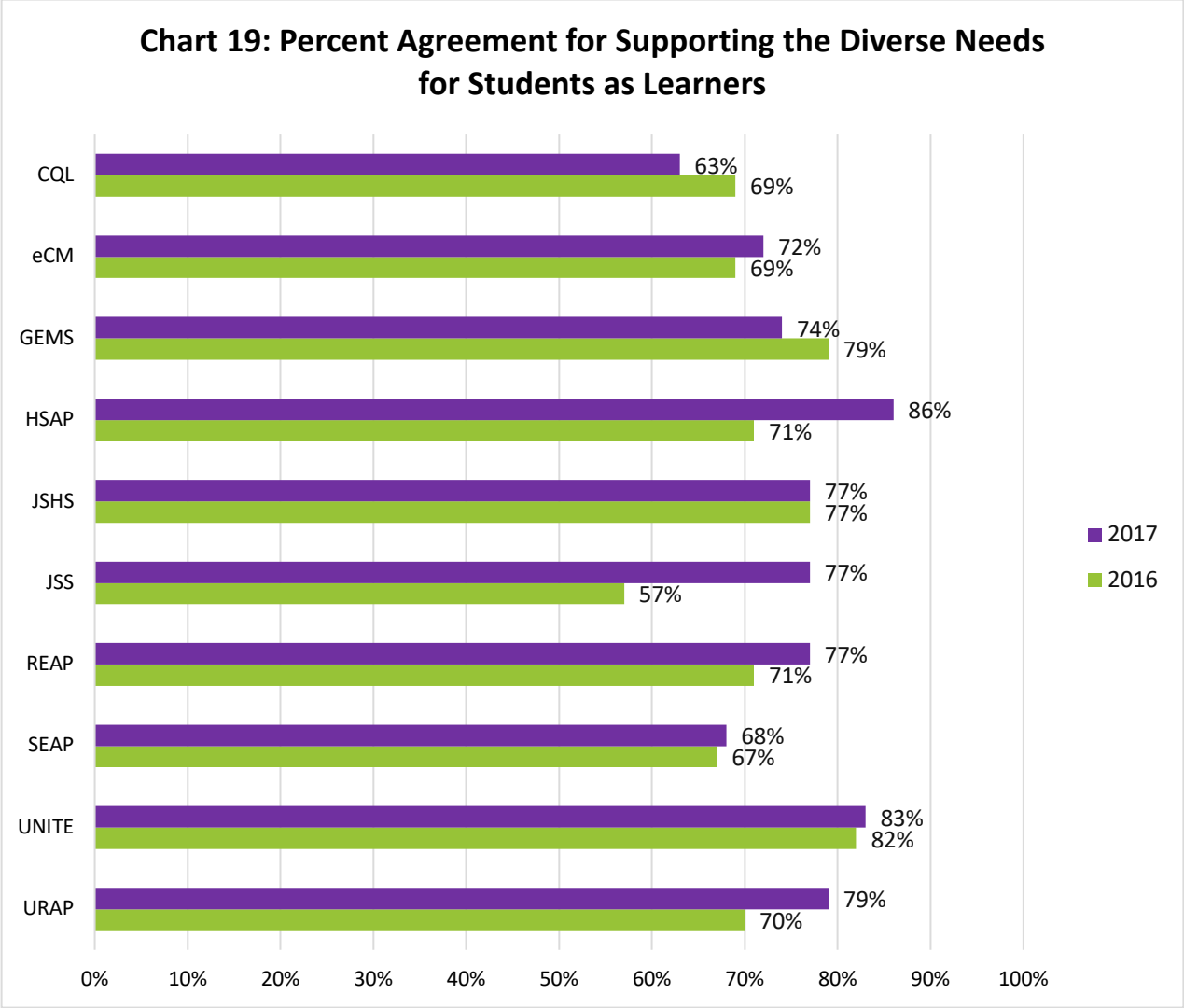


Table 38. Mentor Overall Percent Agreement for Supporting the Diverse Needs of Students as Learners		
Program	**2016 Composite % Agreement**	**2017 Composite % Agreement**
CQL	69%	63%
eCM	69%	72%
GEMS	79%	74%
HSAP	71%	86%
JSHS	77%	77%
JSS	57%	77%
REAP	71%	77%
SEAP	67%	68%
Unite	82%	83%
URAP	70%	79%

The third area of mentoring is comprised of strategies that together form the composite Supporting Student Development of Collaboration and Interpersonal Skills (Table 39 and Chart 20). Large majorities (77%-89%) of mentors across all programs reported using these strategies. The percentage of mentors using these strategies increased from FY16 levels for all programs with the exception of JSHS, SEAP, Unite, and URAP where they remained constant at FY16 levels. A comparison of composite scores from FY16 and FY17 is found in Table 40.

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

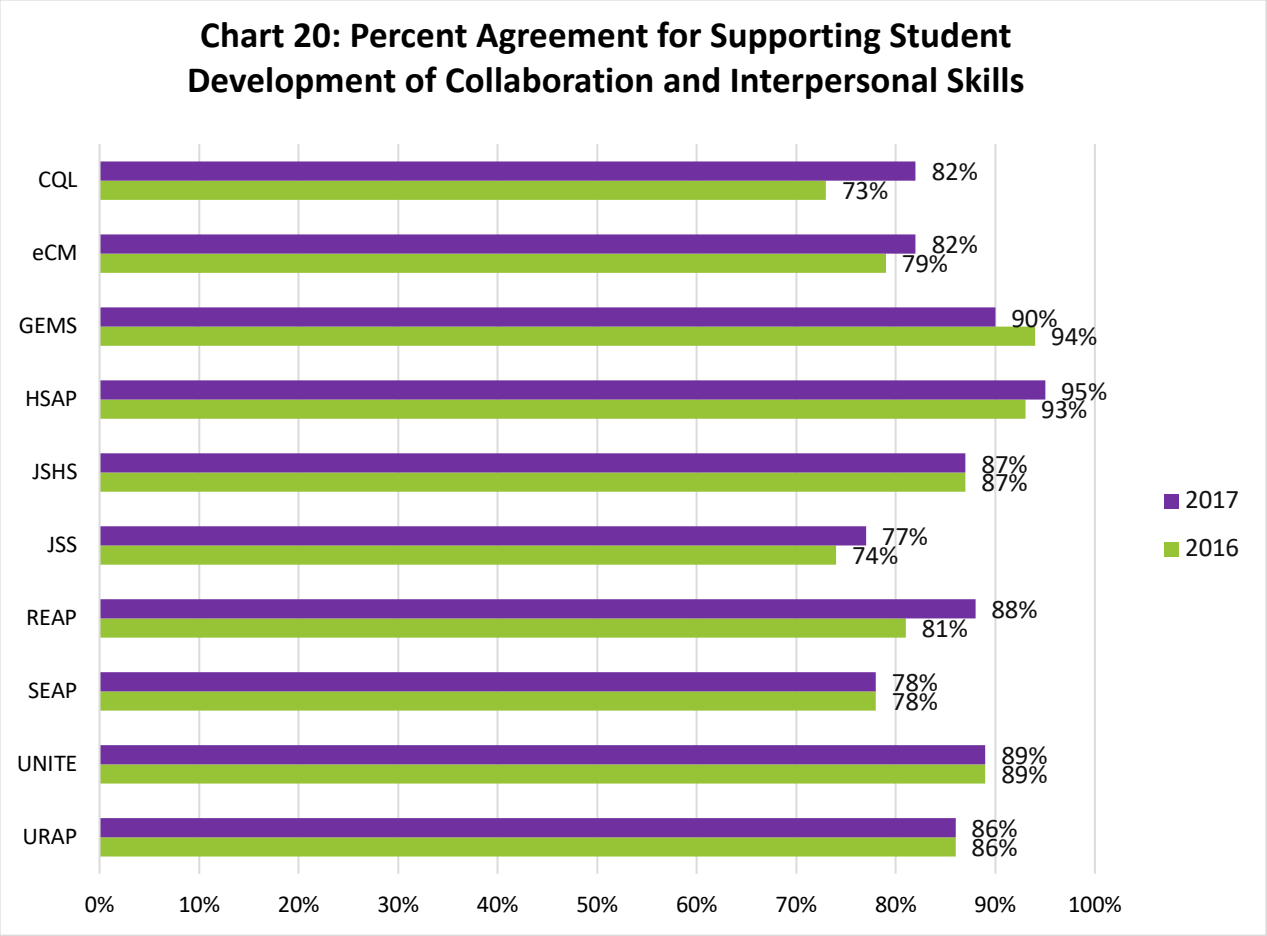


Table 40. Mentor Overall Percent Agreement for Supporting Student Development of Collaboration and Interpersonal Skills		
Program	**2016 Composite % Agreement**	**2017 Composite % Agreement**
CQL	73%	82%
eCM	79%	82%
GEMS	94%	90%
HSAP	93%	95%
JSHS	87%	87%
JSS	74%	77%
REAP	81%	88%
SEAP	78%	78%
Unite	89%	89%
URAP	86%	86%

The fourth set of mentoring strategies focused on supporting student engagement in "authentic" STEM activities; the items comprising the composite for these strategies are shown in Table 41 and the mean composites for each program are displayed in Chart 21. A large majority of mentors (82%-94%) across programs reported using these strategies. Use of these strategies declined slightly for GEMS, SEAP, Unite and URAP as compared to FY16 and increased slightly for CQL, JSHS, and REAP. A comparison of FY16 and FY17 composite scores for this composite is provided in Table 42.

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

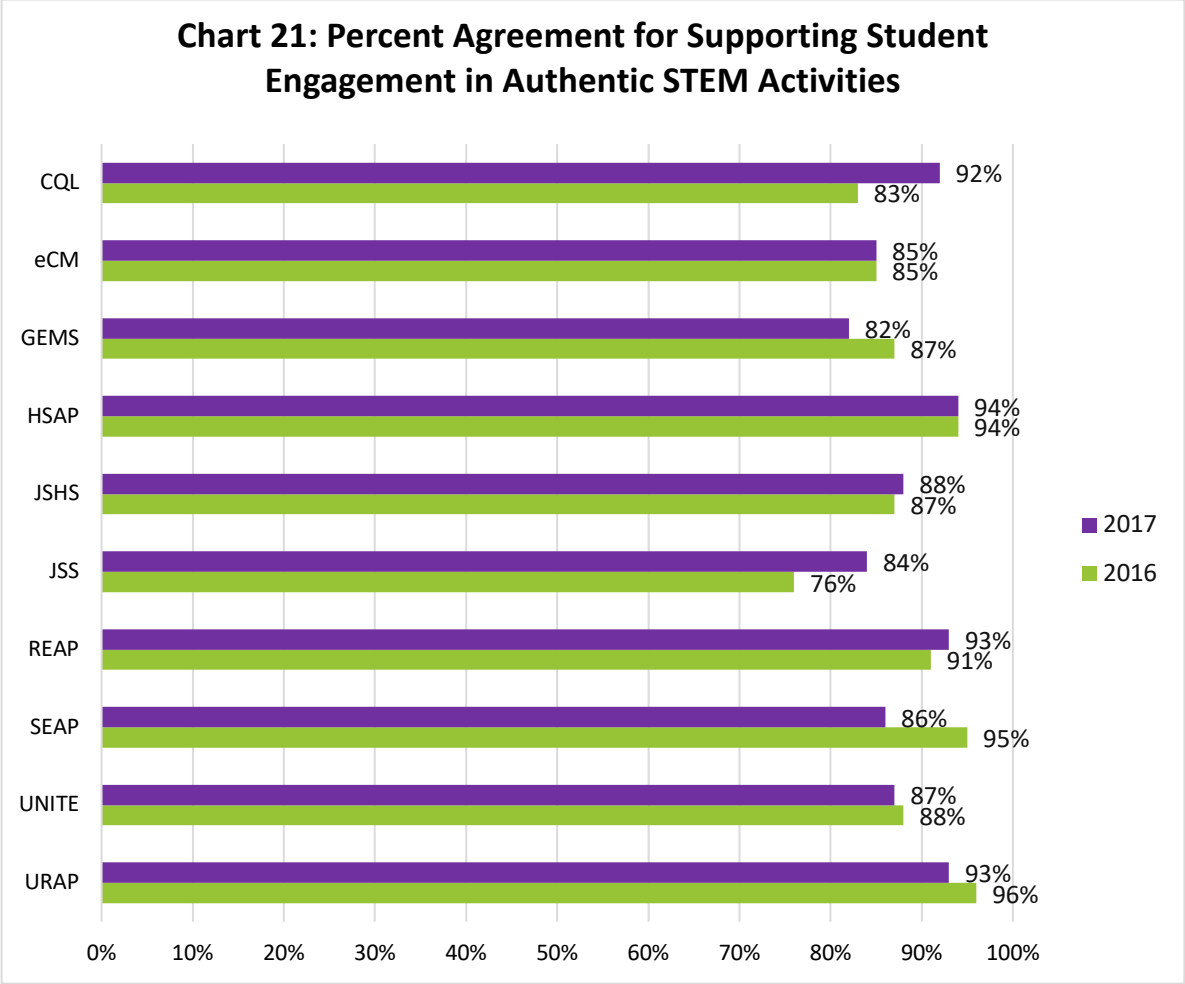


Table 42. Mentor Overall Percent Agreement for Supporting Student Engagement in Authentic STEM Activities		
Program	**2016 Composite % Agreement**	**2017 Composite % Agreement**
CQL	83%	92%
eCM	85%	85%
GEMS	87%	82%
HSAP	94%	94%
JSHS	87%	88%
JSS	76%	84%
REAP	91%	93%
SEAP	95%	86%
Unite	88%	87%
URAP	96%	93%

The final set of mentoring strategies focused on supporting students' STEM educational and career pathways. The items comprising this composite are shown in Table 43, and mean composite scores are shown in Chart 22. Somewhat fewer mentors reported using these strategies as compared to the other

mentoring strategies, although usage varied across programs (range of 47%-79%). A smaller percentage of GEMS mentors reported using these strategies as compared to FY16, however the use of these strategies increased for all other programs with the exception of JSHS where usage rates remained at FY16 levels. Table 44 provides a comparison of composite scores for FY16 and FY17 for mentor strategies to support students' STEM educational and career pathways.

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. Providing guidance about educational pathways that would prepare student(s) for a STEM career
4. Recommending Army Educational Outreach Programs that align with students' educational goals
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

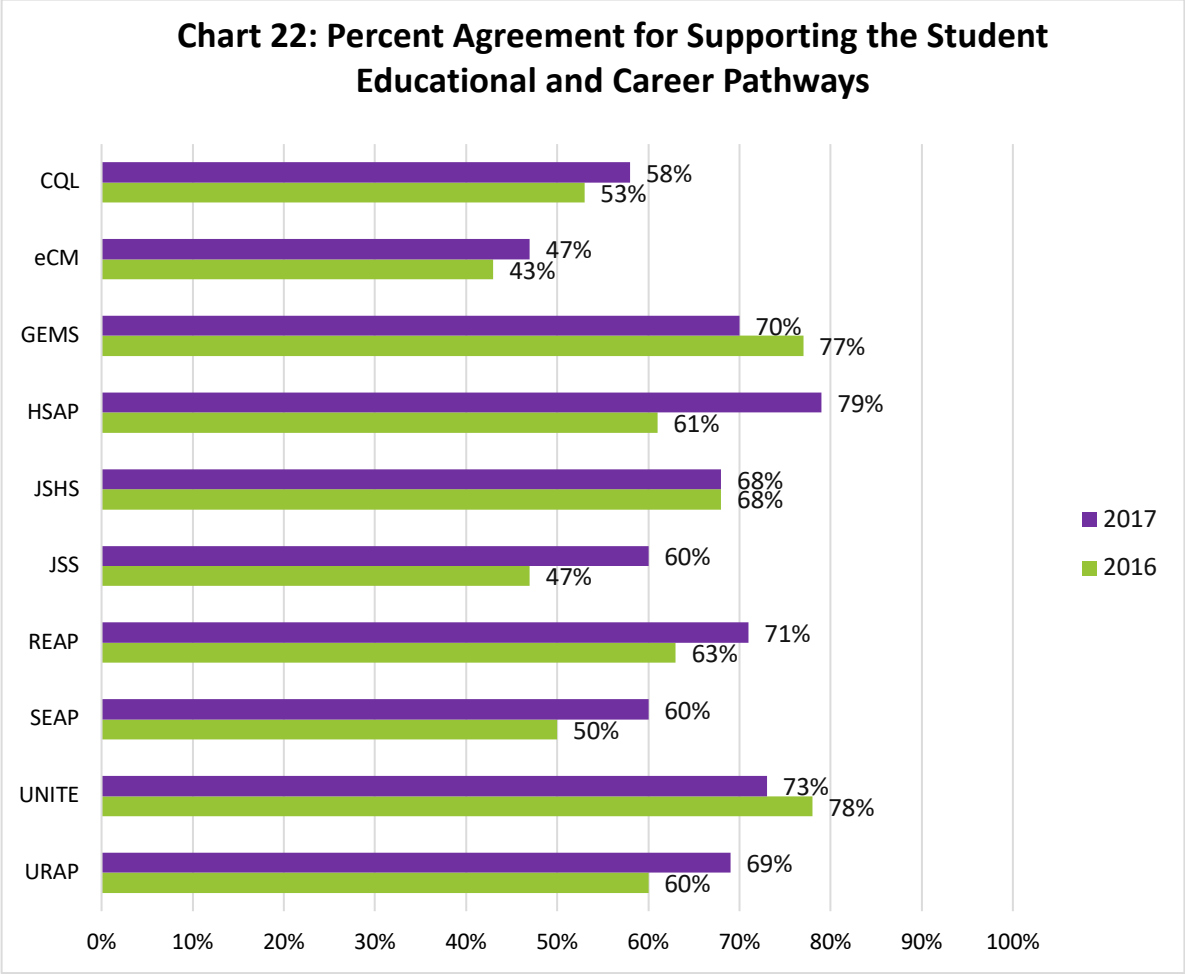


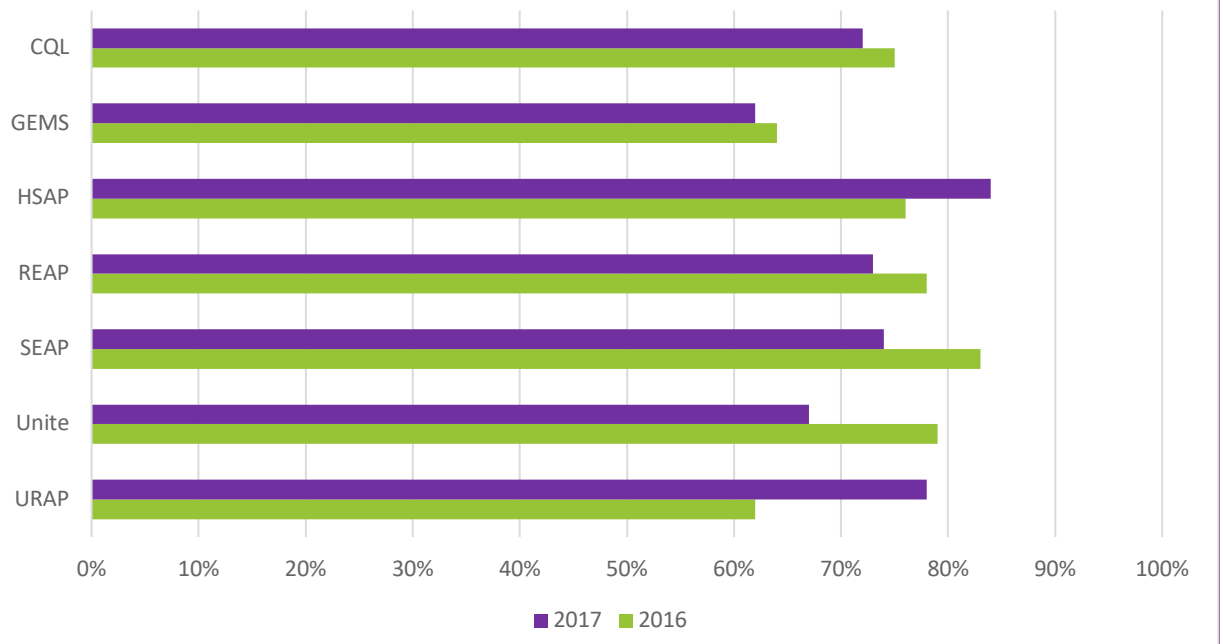
Table 44. Mentor Overall Percent Agreement for Supporting Student Student STEM Educational and Career Pathways		
Program	**2016 Composite % Agreement**	**2017 Composite % Agreement**
CQL	53%	58%
eCM	43%	47%
GEMS	77%	70%
HSAP	61%	79%
JSHS	68%	68%
JSS	47%	60%
REAP	63%	71%
SEAP	50%	60%
Unite	78%	73%
URAP	60%	69%

In sum, mentors were least likely to report using mentoring strategies related to supporting their students' educational and career pathways. 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.

The FY17 evaluation included an examination of participant satisfaction with mentorship during the AEOP program experience. Satisfaction with mentorship serves as a gauge of student perceptions of the quality of their mentoring experience, 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 displays data for apprentices and students who indicated that they were "very much" satisfied with the mentoring or instruction during their AEOP experiences, and Table 45 contains a comparison of these data for 2016 and 2017. Most apprentices and students in all programs reported high levels of satisfaction with their mentors and the quality of instruction they received (range of 62%-84%). The levels of satisfaction with mentorship for several programs, CQL, GEMS, REAP, SEAP, and Unite, were somewhat lower than those reported in FY16, however levels satisfaction with mentors in HSAP and URAP were higher than in FY16. Overall, the percentage of satisfaction with instruction or mentorship in FY17 was very similar to that reported in FY16 (range of 62%-83%).

Chart 23: Apprentices/Students "Very Much" Satisfied with Instruction or Mentorship During Program†



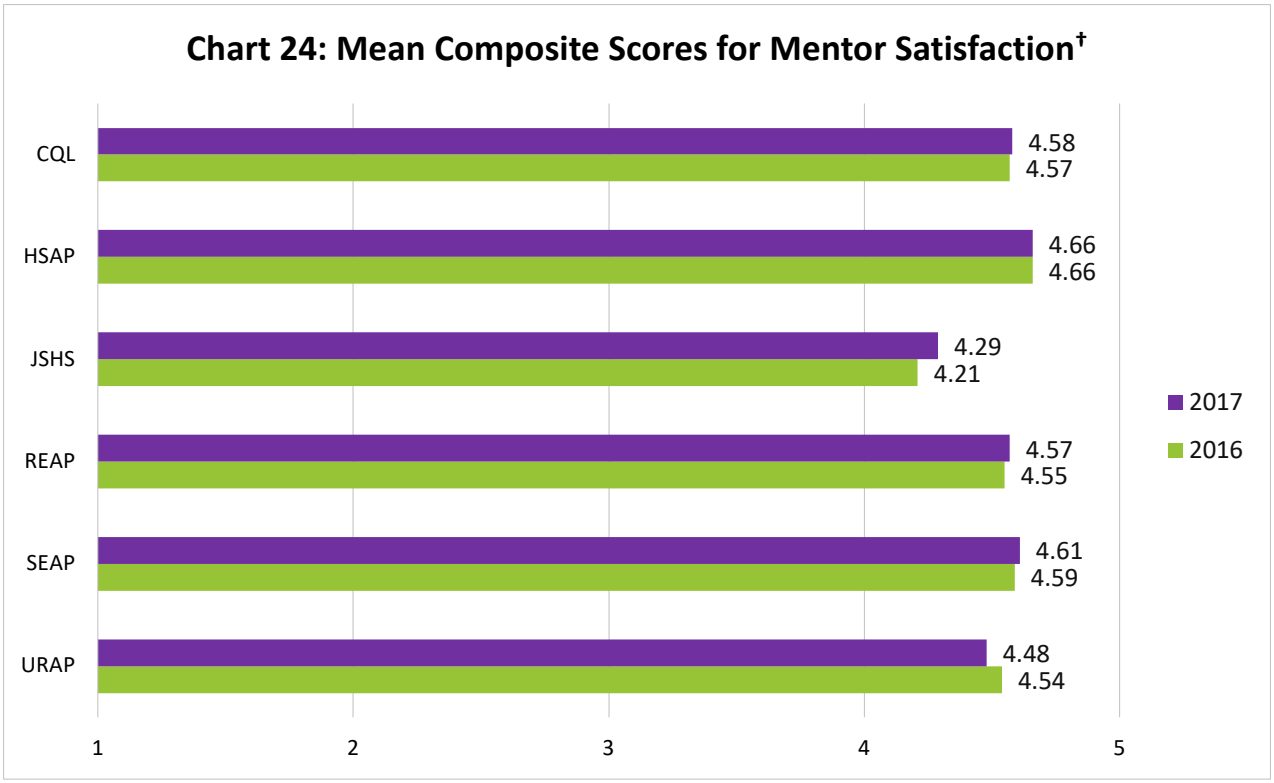
† *Only programs who work directly with a mentor (non-teacher) were asked this question.*

Table 45. Participants "Very Much" Satisfied with Teaching or Mentorship During Program		
Program	**2016**	**2017**
CQL	62%	78%
GEMS	79%	67%
HSAP	83%	74%
REAP	78%	73%
SEAP	76%	84%
Unite	64%	62%
URAP	75%	72%

The FY17 evaluation also asked participants in apprentice programs (CQL, REAP, SEAP, and URAP) and JSHS to rate their satisfaction with several aspects of their mentoring experiences and their research experiences overall. These items are shown in Table 46 and were used to create a Mentor Satisfaction Composite Variable. Chart 24 displays scores for this composite for FY16 and FY17. These scores remained uniformly high across programs in FY17, indicating that apprentices were very satisfied with the quality of the mentoring they received.

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?

FY17 was the second year of operation for the Research Experiences for STEM Educators and Teachers (RESET) program, 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 indicated that RESET supported the AEOP's objective of supporting and empowering educators with Army research and technology resources. Participants appreciated their experiences in Army labs and their exposure to Army/DoD research and considered ways that their RESET research experiences and their online learning experiences could be incorporated into their teaching practices. For example, interview participants commented:

> *[I will draw on my RESET research experience] when I talk to [students] about the importance of being accurate when you're doing measurement.* (RESET Participant)

> *[In the lab], we were doing a whole bunch of statistics, which is a big standard that I teach in Algebra 1 or the end of Algebra 1…I used Excel a lot when I was organizing data. That's a skill that they're going to need, being able to organize data in a spreadsheet, do formulas, manipulate that, and try and figure out some kind of information* out of that. *That's something that I'm going to incorporate this year.* (RESET Participant)

[My RESET research experience] opened my eyes to things that I personally have not done in my classroom to prepare my students for the workforce. (RESET Participant)

Priority Three: Sustainable Infrastructure

Findings from the FY16 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 FY16, 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 FY16, GEMS students and SEAP and CQL apprentices were most likely to have heard about the program through personal connections, including friends, family members, or past participants of the program. Over a third of GEMS students (38%) reported learning about the program through a past participant, suggesting that program alumnae often act as informal ambassadors of the GEMS program. About a third of CQL apprentices (33%) and SEAP apprentices (34%) learned about AEOP through someone who works with the DoD. Students in Unite and apprentices in HSAP, REAP, SEAP, and URAP were relatively likely to have heard about AEOP through a school or university newsletter or website. Nearly half of eCM participants and over half of URAP participants reported hearing about AEOP through a teacher or professor. Over a quarter of SEAP apprentices (27%) reported learning about AEOP through the AEOP website, however few participants in any other program (range of 0%-14%) reported the website as a source of information.

Table 47. How Students Learned About their AEOP Program

	Year	CQL	eCM	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
Friend	2016	7%	0%	21%	0%	10%	9%	6%	9%	8%	0%
	2017	***22%***	***5%***	***43%***	***17%***	***9%***	***11%***	***18%***	***30%***	***14%***	***17%***
Family member	2016	11%	0%	19%	12%	5%	8%	7%	21%	19%	0%
	2017	***20%***	***3%***	***41%***	***14%***	***5%***	***5%***	***11%***	***43%***	***25%***	***7%***
Past participant of program	2016	13%	0%	20%	0%	21%	16%	12%	12%	4%	0%
	2017	***17%***	***7%***	***38%***	***17%***	***18%***	***5%***	***22%***	***22%***	***7%***	***7%***
School or university newsletter, email, or website	2016	4%	0%	10%	12%	18%	13%	17%	13%	25%	29%
	2017	***9%***	***0%***	***13%***	***38%***	***18%***	***11%***	***35%***	***25%***	***22%***	***20%***
Someone who works with the Department of Defense	2016	23%	0%	6%	6%	1%	0%	2%	13%	1%	0%
	2017	***33%***	***0%***	***7%***	***7%***	***1%***	***5%***	***0%***	***34%***	***1%***	***3%***
Website: AEOP	2016	5%	25%	11%	15%	7%	0%	13%	11%	3%	0%
	2017	***6%***	***1%***	***12%***	***14%***	***8%***	***0%***	***11%***	***27%***	***4%***	***3%***
Someone who works with the program	2016	14%	0%	4%	15%	4%	2%	16%	8%	13%	13%
	2017	***28%***	***0%***	***3%***	***3%***	***4%***	***5%***	***28%***	***10%***	***22%***	***23%***
AEOP social media	2016	NA	0%	NA	NA	1%	0%	2%	1%	2%	4%

	2017	***0%***	***0%***	***3%***	***0%***	***2%***	***5%***	***4%***	***1%***	***0%***	***0%***
Teacher or someone who works at school/university I attend	2016	14%	25%	5%	36%	25%	30%	19%	11%	21%	46%
	2017	***25%***	***47%***	***8%***	***34%***	***25%***	***26%***	***43%***	***12%***	***22%***	***57%***
Community group or program	2016	0%	50%	3%	3%	4%	9%	5%	3%	3%	4%
	2017	***1%***	***3%***	***4%***	***7%***	***4%***	***5%***	***4%***	***9%***	***18%***	***0%***
Choose not to report	2016	9%	14%	.5%	0%	5%	14%	3%	0%	4%	4%
	2017	***3%***	***24%***	***1%***	***0%***	***5%***	***21%***	***1%***	***0%***	***5%***	***0%***

Mentors were also asked in a questionnaire item to indicate how they had learned about AEOP. Findings for FY16 and FY17 are presented in Table 48. The most frequently reported sources of information were a past participant of the program, someone who works with the DoD, and the AEOP website. These findings varied widely across programs, however. Past participants were a key source of information for JSHS mentors (67%), and about a third of HSAP (33%), JSS (28%), Unite, (33%), and URAP (32%) mentors cited past participants as a source of information. The majority of CQL mentors (52%) and HSAP mentors (53%) cited someone who works with the DoD as a source of AEOP information. About half of eCM mentors (50%) and HSAP mentors (53%) learned about AEOP through the AEOP website.

Table 48. How Mentors Learned about AEOP

	Year	**CQL**	**eCM**	**GEMS**	**HSAP**	**JSHS**	**JSS**	**REAP**	**SEAP**	**Unite**	**URAP**
Past participant	2016	15%	17%	16%	NA	39%	36%	17%	6%	%	%
	2017	***16%***	***NA***	***20%***	***33%***	***67%***	***28%***	***19%***	***19%***	***33%***	***32%***
School, university, or professional organization newsletter, email, or website	2016	0%	33%	18%	NA	12%	8%	10%	17%	18%	18%
	2017	***3%***	***0%***	***20%***	***0%***	***0%***	***6%***	***4%***	***0%***	***21%***	***5%***
Site host, director, or someone who works with program	2016	8%	0%	18%	NA	4%	6%	11%	0%	24%	24%
	2017	***16%***	***0%***	***41%***	***13%***	***NA***	***11%***	***23%***	***6%***	***26%***	***9%***
Social media	2016	0%	0%	0%	NA	0%	0%	1%	0%	6%	0%
	2017	***0%***	***0%***	***5%***	***0%***	***0%***	***0%***	***0%***	***0%***	***2%***	***0%***
Someone who works with the Department of Defense	2016	46%	0%	14%	NA	0%	3%	6%	50%	0%	12%
	2017	***52%***	***0%***	***39%***	***53%***	***0%***	***0%***	***1%***	***38%***	***0%***	***41%***
Friends	2016	0%	0%	7%	NA	4%	3%	4%	0%	0%	0%
	2017	***6%***	***0%***	***27%***	***0%***	***11%***	***0%***	***NA***	***6%***	***2%***	***0%***
Family member	2016	0%	0%	11%	NA	0%	3%	0%	0%	0%	0%
	2017	***0%***	***0%***	***32%***	***0%***	***0%***	***0%***	***NA***	***0%***	***0%***	***0%***
Community group or program	2016	0%	0%	NA	NA	4%	6%	0%	0%	0%	0%
	2017	***0%***	***0%***	***5%***	***0%***	***0%***	***22%***	***NA***	***0%***	***2%***	***0%***
Website: AEOP	2016	15%	50%	7%	NA	0%	22%	10%	0%	12%	24%
	2017	***16%***	***50%***	***15%***	***53%***	***0%***	***22%***	***19%***	***16%***	***14%***	***41%***

Choose Not to Report	2016	15%	0%	2%	NA	8%	8%	1%	17%	0%	0%
	2017	***10%***	***50%***	***0%***	***0%***	***11%***	***NA***	***NA***	***13%***	***5%***	***5%***

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. In order to understand the effectiveness of these efforts, the FY17 evaluation examined students' and apprentices' past participation in AEOPs and their interest in future participation in AEOPs. Table 49 displays data for past participation in AEOPs and shows that very few participants had ever participated in any AEOP other than the one in which they were currently enrolled. Two notable exceptions to this are that over a third of SEAP apprentices (36%) reported having participated in GEMS in the past, and nearly a quarter of REAP apprentices (23%) had participated in Unite in the past, suggesting that there is a relatively robust pipeline relationship between these 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	2016	0%	0%	1%	19%	0%	0%	1%	14%	0%	32%
	2017	***1%***	***0%***	***1%***	***9%***	***0%***	***0%***	***0%***	***13%***	***0%***	***15%***
eCM	2016	---	---	---	---	---	---	---	---	---	---
	2017	---	---	---	---	---	---	---	---	---	---
GEMS	2016	3%	<1%	<1%	38%	<1%	0%	0%	0%	0%	0%
	2017	***1%***	***0%***	***0%***	***49%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***
HSAP	2016	0%	0%	0%	3%	3%	0%	0%	0%	NA	NA
	2017	***0%***	***0%***	***3%***	***0%***	***0%***	***0%***	***0%***	***3%***	***0%***	***0%***
JSHS	2016	4%	<1%	35%	2%	0%	0%	0%	0%	0%	0%
	2017	***4%***	***1%***	***35%***	***2%***	***0%***	***0%***	***0%***	***1%***	---	---
JSS	**2016**	**3%**	**62%**	**0%**	**3%**	**0%**	**NA**	**NA**	**NA**	**NA**	**NA**
	2017	***5%***	***42%***	***0%***	***5%***	***0%***	***NA***	***NA***	***NA***	***NA***	***NA***
REAP	2016	1%	0%	0%	2%	10%	0%	4%	1%	0%	0%
	2017	***0%***	***1%***	***1%***	***5%***	***23%***	***3%***	***16%***	***1%***	***1%***	***0%***
SEAP	2016	2%	2%	0%	35%	0%	0%	0%	0%	0%	0%
	2017	***3%***	***1%***	***0%***	***36%***	***0%***	***0%***	***0%***	***13%***	***0%***	***0%***
Unite	2016	0%	0%	0%	1%	7%	1%	1%	2%	0%	0%
	2017	***1%***	***0%***	***0%***	***1%***	***19%***	***0%***	***0%***	***0%***	***0%***	***0%***
URAP	2016	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	2017	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***	***0%***

Participants were also asked to indicate their level of interest in participating in each of the AEOPs for which they currently are or will be eligible in the future. Table 50 displays the percentage of current AEOP participants who indicated they were "interested" or "very interested" in other programs in the AEOP portfolio. Participants from each program expressed interest in participating in other AEOPs in the future although participants in apprenticeship programs were most likely to express interest in future AEOPs.

For example, 60% of CQL apprentices expressed interest in SMART, 74% of HSAP students expressed interest in URAP, and 53% of SEAP apprentices expressed interest in CQL. Students enrolled in the eCM and JSS competition programs were likely to express interest in future participation in the program in which they were currently enrolled, but only small percentages of students expressed interest in other programs. JSHS students, however, while overwhelmingly interested in participating again in JSHS (90%), also expressed interest in many other AEOPs such as SEAP (31%), HSAP (30%), REAP (30%), and GEMS NPM (26%). Many participants in STEM enrichment programs were also interested in other AEOPs. For example, 61% of Unite students expressed interest in SMART and 61% in REAP, and 28% of GEMS students were interested in participating in SEAP and in SMART.

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	2016	NA	NA	NA‡	20%	NA	NA	NA	NA	16%	54%	43%	35%	---
	2017	***NA***	***NA***	***NA***	***---***	***NA***	***NA***	***NA***	***NA***	***45%***	***74%***	***60%***	***48%***	***28%***
eCM	2016	38%	11%	11%	13%	10%	13%	12%	13%	11%	13%	17%	14%	---
	2017	***46%***	***8%***	***10%***	***12%***	***8%***	***11%***	***11%***	***12%***	***10%***	***11%***	***17%***	***12%***	***9%***
GEMS	2016	16%	16%	16%	73%	12%	24%	24%	28%	19%	18%	28%	18%	43%
	2017	***8%***	***14%***	***11%***	***73%***	***9%***	***21%***	***20%***	***22%***	***15%***	***14%***	***24%***	***16%***	***42%***
HSAP	2016	NA	NA	19%	NA	7%	NA	46%	36%	43%	11%	32%	21%	---
	2017	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***74%***	***19%***	***52%***	***26%***	***29%***
JSHS	2016	NA	NA	89%	30%	24%	29%	30%	31%	29%	27%	33%	29%	25%
	2017	***NA***	**NA**	***90%***	***29%***	***23%***	***30%***	***30%***	***31%***	***28%***	***26%***	***32%***	***28%***	***26%***
JSS	2016	15%	86%	11%	19%	8%	16%	16%	18%	14%	15%	22%	16%	14%
	2017	***5%***	***71%***	***11%***	***13%***	***13%***	***16%***	***13%***	***20%***	***10%***	***11%***	***---***	***18%***	***8%***
REAP	2016	NA	NA	37%	40%	41%	59%	81%	63%	63%	53%	62%	46%	36%
	2017	***31%***	***NA***	***41%***	***---***	***---***	***---***	***---***	***---***	***62%***	***41%***	***63%***	***42%***	***46%***
SEAP	2016	NA	NA	15%	NA	8%	15%	39%	71%	42%	42%	55%	35%	33%
	2017	***NA***	***NA***	***---***	***NA***	***---***	***51%***	***---***	***---***	***46%***	***53%***	***57%***	***36%***	***---***
Unite	2016	NA	NA	42%	50%	85%	56%	56%	54%	52%	51%	61%	49%	50%
	2017	***NA***	***NA***	***37%***	***43%***	***83%***	***49%***	***60%***	***51%***	***38%***	***42%***	***61%***	***43%***	***36%***
URAP	2016	---	---	---	---	---	---	---	---	---	---	---	---	---
	2017	***---***	***---***	***---***	***---***	***---***	***---***	***---***	***---***	***63%***	***28%***	***41%***	***41%***	***19%***

As in previous evaluations, the FY17 evaluation findings suggests that youth participants and mentors across the AEOP have limited awareness of AEOP programs other than those in which they are currently participating. Students and apprentices continue to express 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

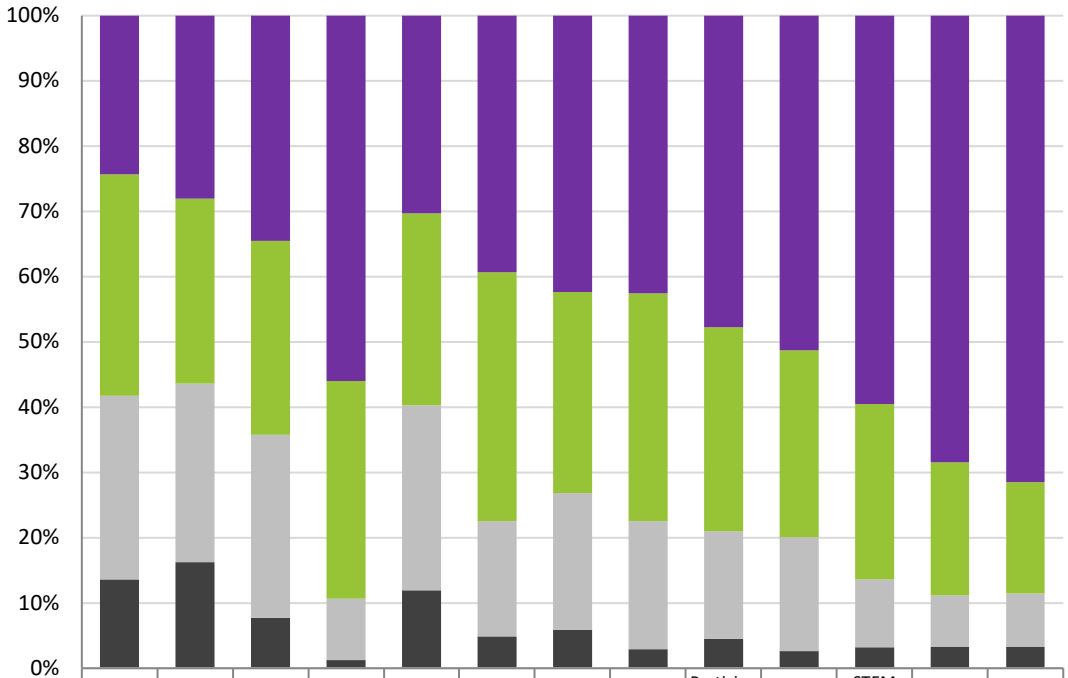
The FY17 AEOP evaluation included an alumni survey and focus group interview with a sample of alumni from JSHS. This portion of the evaluation is intended to capture near-term and mid-to long-term outcomes of AEOP participation.

PRIORITY ONE: STEM Literate Citizenry

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

Participating alumni were asked to report their current interest in STEM activities. Findings show that alumni have strong current interest in STEM (Chart 25). Specifically, a majority of alumni participating in the survey indicated they were both interested in earning a STEM degree (88%) and pursuing a STEM career (88%). More than three-quarters or alumni reported interest in taking elective STEM courses (80%), learning about new things in STEM (83%), and potential STEM projects/experiments in a university or professional setting (87%).

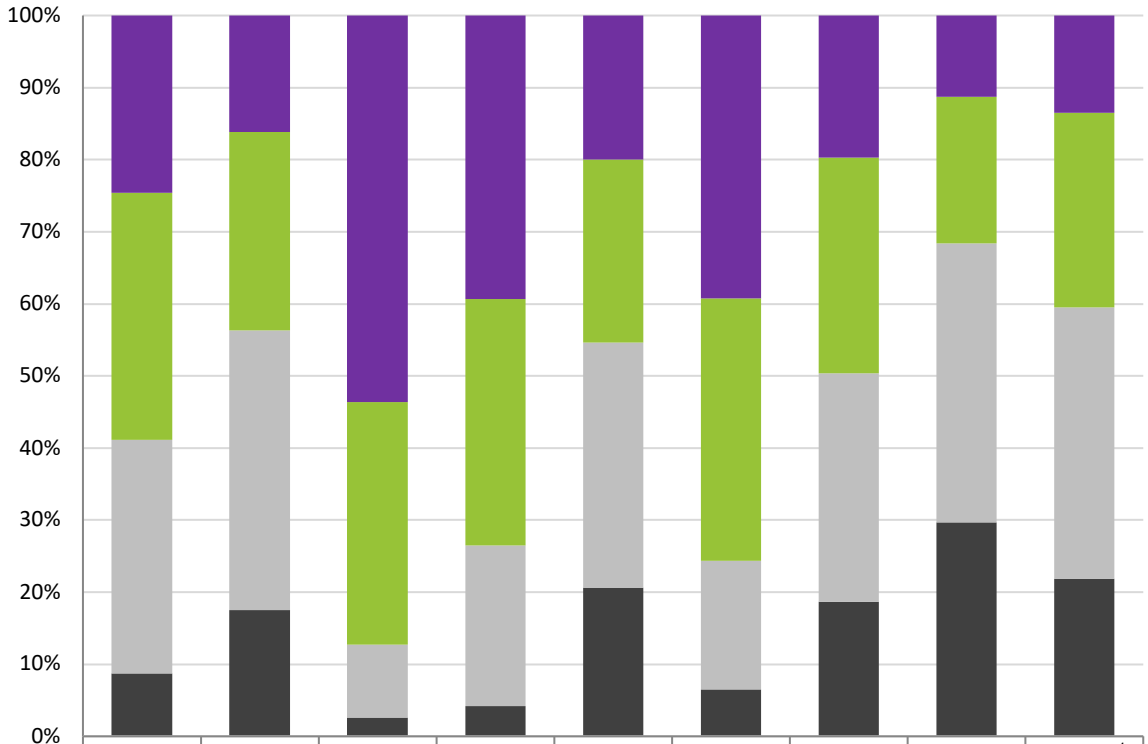
Chart 25: Alumni Interest in STEM Activities (*n* = 304-310)



	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	24%	28%	35%	56%	30%	39%	42%	43%	48%	51%	60%	68%	71%
Interested	34%	28%	30%	33%	29%	38%	31%	35%	31%	29%	27%	20%	17%
Somewhat Interested	28%	27%	28%	9%	28%	18%	21%	20%	16%	18%	10%	8%	8%
Not Interested	14%	16%	8%	1%	12%	5%	6%	3%	5%	3%	3%	3%	3%

Alumni were asked to report on their current engagement in STEM activities. In general, approximately half or more of alumni reported being at least sometimes engaged with most STEM activities from the survey (see Chart 26). Nearly three-quarters or more of alumni reported sometimes or frequently engaging in activities such as: learning about new things in STEM (88%), talking with family and friends about STEM (75%), and solving math/science puzzles (73%). Further, 50% or more of alumni reported engaging in STEM sometimes or frequently by reading/watching STEM non-fiction (59%) and mentoring/teaching others about STEM (50%).

Chart 26: Alumni Engagement in STEM Activities (*n* = 306-311)



	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	25%	16%	54%	39%	20%	39%	20%	11%	14%
Sometimes	34%	28%	34%	34%	25%	36%	30%	20%	27%
Not Often	32%	39%	10%	22%	34%	18%	32%	39%	38%
Never	9%	17%	3%	4%	21%	6%	19%	30%	22%

Many AEOP alumni reported to be currently talking a STEM elective course (43%). A third of alumni indicated they are currently pursuing a STEM degree (32%), and 13% are already working in a STEM career (See Table 51).

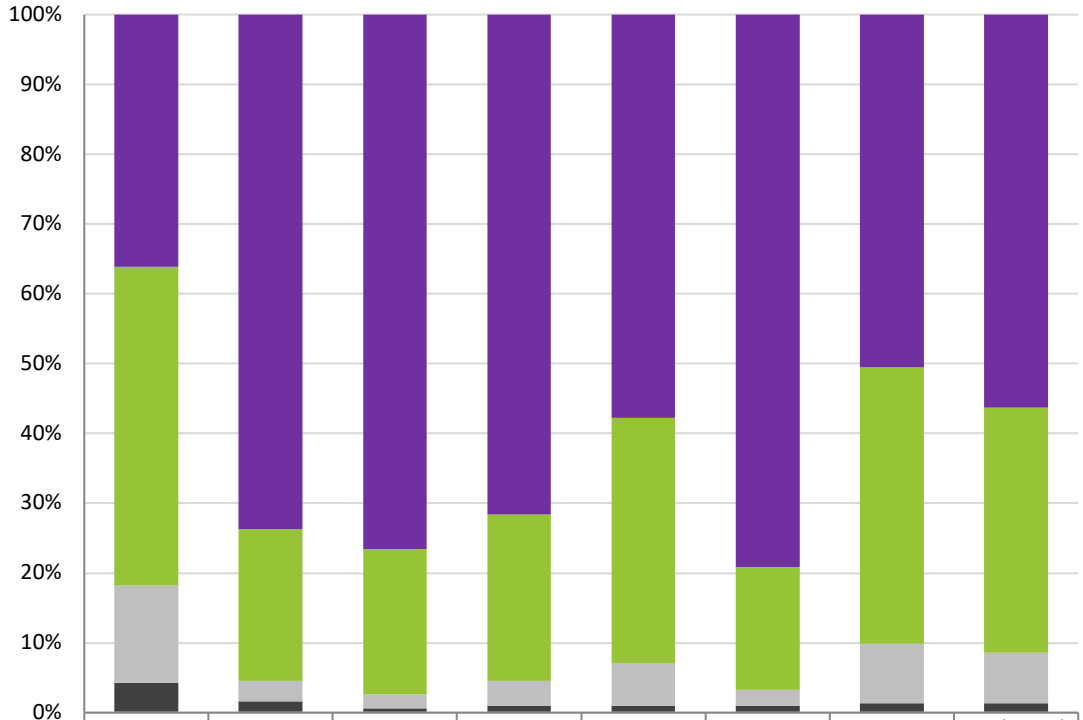
Table 51. Alumni Current STEM Activities (*n* = 184)	
Item	**Percentage**
Taking a STEM elective	43%

Working on STEM project/experiment in university/professional setting	28%
Pursuing a STEM degree	32%
Working in a STEM career	13%

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 one AEOP priority. Developing positive attitudes in youth toward STEM is an important step in this work. As such, alumni were asked through the questionnaire to share their thoughts regarding their attitudes toward STEM in general and specifically related to Army/DoD STEM. Chart 27 shows that AEOP alumni have extremely positive perceptions toward STEM in general. Over 80% believe that all people can be successful in STEM. More than 90% agree with all of the remaining items. STEM beliefs with nearly all alumni agreeing were include: I enjoy solving real-world problems (97%), STEM careers are a good fit with my interests (97%), I feel successful in STEM classes (95%), and I can use STEM to help improve my community (95%).

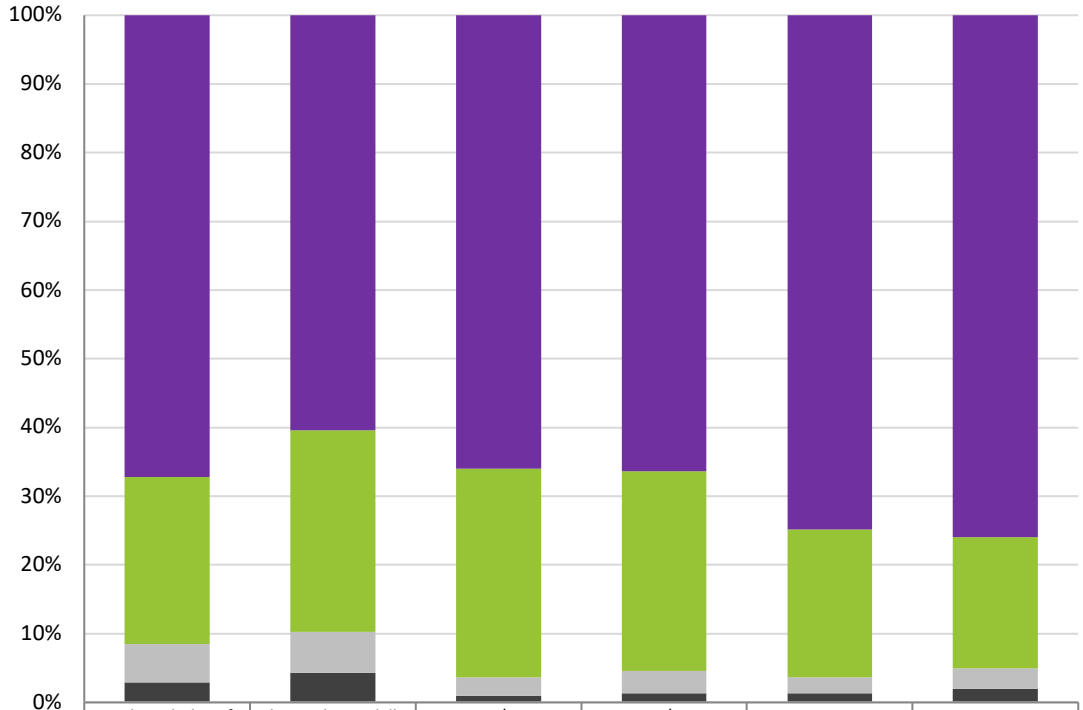
Chart 27: Alumni Attitudes Regarding STEM (*n* = 302-308)



	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	36%	74%	77%	72%	58%	79%	50%	56%
Somewhat Agree	46%	22%	21%	24%	35%	18%	40%	35%
Somewhat Disagree	14%	3%	2%	4%	6%	2%	9%	7%
Disagree	4%	2%	1%	1%	1%	1%	1%	1%

Concerning alumni beliefs that are specifically related to the AEOP and Army/DoD STEM, alumni also shared highly positive views (Chart 28). Nearly all alumni (91%) reported increased STEM knowledge as a result of participating in AEOP. Alumni reported highly positive perceptions related to the work of the Army/DoD in STEM. Ninety-five percent or more of alumni indicated feeling Army/DoD research is valuable to society (95%), the Army/DoD solves real-world problems (97%), as well as develops new, cutting edge technologies (97%).

Chart 28: Alumni Attitudes Regarding AEOP and Army/DoD STEM (*n* = 302-305)



	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	67%	60%	66%	66%	75%	76%
Somewhat Agree	24%	29%	30%	29%	22%	19%
Somewhat Disagree	6%	6%	3%	3%	2%	3%
Disagree	3%	4%	1%	1%	1%	2%

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?

AEOP alumni reported a high degree of STEM coursework completed in high school (Table 52). Many alumni indicated they had completed higher level STEM classes such as: AP Math (40%), Calculus (41%), AP Science (47%), Chemistry (70%), and Physics (59%).

Table 52. Alumni Reported STEM High School Coursework Completed (*n* = 237)

HS STEM Course	Percentage
Algebra I	86%
Algebra II	75%
AP Math	40%
AP Science	47%
Biology	84%

Calculus	41%
Chemistry	70%
Computer Science	28%
Earth Science	23%
Engineering	21%
Environmental Science	23%
Geometry	80%
Human Anatomy	18%
Intro Chemistry and Physics	28%
Physics	59%
Pre-Calculus	52%

AEOP alumni in post-secondary study reported on their enrollment in STEM degree programs (Table 53). Among the 48% of AEOP alumni self-reporting to be enrolled in post-secondary education, 41% indicated being in pursuit of some form of STEM degree or certificate. Most alumni in higher education STEM programs were pursuing a bachelor's degree (27%).

Table 53. STEM Degree at College or University

Degree Level	Percentage
Associate (*n*=308)	
Yes	4%
No	44%
Still in High School	52%
Bachelor's (*n*=309)	
Yes	27%
No	21%
Still in High School	52%
Graduate (*n*=306)	
Yes	7%
No	41%
Still in High School	52%
STEM Certificate/Training (*n*=308)	
Yes	3%
No	45%
Still in High School	52%

Table 54 shows that when indicating the specific post-secondary degree program enrolled in, engineering (11%) was the reported area of focus by most. This was followed by medicine (7%), life science (6%), physical science (5%), mathematics or statistics (2%), technology or computer science (2%), earth science (1%), environmental science (1%), and business (1%). No alumni reported pursuing a teaching degree. Most alumni reported having completed credits toward their degree (Table 55).

Table 54. STEM Degree Program Enrolled In (*n* = 292)	
STEM Degree Program	**Percentage**
Business	1%
Earth science	1%
Engineering	11%
Environmental science	1%
Life science	6%
Mathematics or statistics	2%
Medicine	7%
Physical science	5%
Teaching	0%
Technology/Computer science	2%
Other	4%
Not enrolled	61%

Table 55. AEOP Alumni College Credit Hours Completed in STEM Degree Program (*n* = 296)	
STEM Credits	**Percentage**
0-30 Credits	7%
31-60 Credits	4%
61-90 Credits	6%
91-120 Credits	5%
121+ Credits	5%
Not enrolled in classes	28%
Not enrolled in STEM	4%
Still in High School	40%

AEOP alumni currently enrolled college reported on their current GPAs (Table 56). A third of college enrolled students (34%) indicated they held a 4.0 or better. More than 80% indicated they held a GPA of 3.0 or better.

Table 56. AEOP Alumni College Student Current GPA (*n*=307)	
GPA	**Percentage**
4.0 or better	34%
3.75 - 3.9	19%
3.50 - 3.74	16%
3.0 - 3.49	14%
2.5 - 2.9	2%
2.0 - 2.49	1%
Lower than 2.0	0%
Not enrolled	15%

A smaller subset of AEOP alumni indicated they had already completed a post-secondary STEM degree program (Table 57). Approximately half (54%) had completed bachelor's degrees, 21% master's degrees, 8% associate degrees, and 13% had completed a STEM technical certificate program.

Table 57. STEM Degree Program Completed (*n*=52)	
STEM Degree Program	**Percentage**
Associates	8%
Bachelors	54%
Masters	21%
Doctoral	4%
Certificate	13%
More	8%

Of the 11 questionnaire respondents who provided a title for their degree programs, 8 listed degree programs in STEM fields. Of those who did not explicitly identify degree programs in STEM fields, one simply listed "BS," 1 was pursuing an MBA in business analytics, and 1 was pursuing a degree in educational leadership. The STEM degree programs listed by other respondents were:

- Biomedical engineering
- Coding
- Mechanical engineering
- Biophysics
- Mathematics
- Biomedical technology
- Animal sciences
- Computer science/engineering

Of the 17 questionnaire respondents who included a description of their employment in STEM-focused jobs, 13 were current or retired K-12 teachers, 2 were current or retired university faculty, and 2 held STEM-related positions within the DoD.

The 3 JSHS alumni who participated in the alumni focus group were all actively engaged in or pursuing STEM careers. Two participants were graduate students, each working toward a Ph.D. (1 in mathematics, 1 in astrophysics) and 1 was a DoD employee who worked in the field of aeronautical engineering. All credited their early JSHS experiences with providing focus to their educational and career pathways. This focusing occurred both in terms of their disciplinary focus and their selection of undergraduate institutions. For example,

> *One of the neat things about JSHS was it was the first time that I met working engineers and leaders in the field. One of the people I met there was…a Dean of Engineering at [a southeastern public university] at the time. He came as a judge at our state JSHS and then he showed up again at the national. He took me aside and asked me whether I was going to go to college. I said, "Yes." He said, "What are you going to major in?" At that point, I was thinking about either electrical engineering or aeronautical engineering. He said... "You should go into aeronautical engineering." He saw that I had a passion for it. He'd seen my presentation…He asked me where I was going to go to school, where I was thinking about. "I was thinking about [a Midwestern public university]." He said, "That's a good school."* (JSHS Alumnus)

> *[JSHS] was a phenomenal program that opened my eyes to what career possibilities were out there…I was growing up in a town where I would not have had any kind of opportunity like that to meet working engineers had it not been for [JSHS].* (JSHS Alumnus)

All 3 alumni emphasized the value of the presentation experience they gained as JSHS students. All felt strongly that JSHS uniquely prepared them for presenting their research as career professionals. For example,

> *I think the part of JSHS that really stuck out to me…. is giving a presentation. I was scared of the idea of public speaking; I think [JSHS] made me a lot more confident when I got into college…Now I love giving talks…I want to be a professor and really enjoy teaching classes.* (JSHS Alumnus)

> *The idea of standing up in front of a room and presenting your research in 20 minutes to an audience who are not experts, this is what other conferences are like when you become a professional.* (JSHS Alumnus)

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?

The alumni questionnaire included questions about STEM research generally that respondents had learned about through AEOP and STEM research within the DoD that alumni had learned about through AEOP. In addition, alumni were asked to list up to 3 Army/DoD STEM careers they had learned about in their programs.

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

- Biology
- Biomedical
- Agricultural science
- Cement engineering
- Bridge engineering
- Robotics
- Bioscience
- Software programming and development
- Computer science
- Soldier and pilot safety
- Technology
- Types of engineering
- Sustainable science
- 3D printing
- Molecular and translational sciences (health and infectious diseases)
- Nanotechnologies in the food industry
- Surface chemistry
- Food science

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

- Chemistry and physics
- Agriculture/food production and packaging for the military
- Paint science
- Robotics
- Solar technologies
- Helmet safety/gear research
- Bradley vehicle design
- Marksman training via interactive laser technology
- Engineering
- Laser scanning
- Lab animal husbandry and care
- Nanotechnologies in protective clothing for soldiers
- Environmental research
- Energy research
- Biomedical research
- Computer science

- Compensatory reserve index for battlefield triage
- Health/MRSA resistance

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

- Biomedical engineer
- Biologist
- Chemical engineer
- Computer scientist
- Architect
- Paint researcher
- Military engineer
- Software developer
- Mechanical engineer
- Equipment design and testing engineers
- SED programmer
- Environmental science engineering
- Robotics engineering
- Electrical engineering
- Physician
- Environmental engineering
- Green engineering
- Mathematician
- Instrumentation technician
- Biochemist
- Laboratory safety manager
- Veterinary pathologist
- Careers in aviation development
- Marine biologist
- Behavioral scientist
- Soils scientists
- Bioengineer
- Psychologist
- Computer programmer
- Medical research scientist
- Lab assistant
- Chemical engineering
- Surgeon
- Microbiologist

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?

AEOP alumni were asked to report on their awareness and interest in participating in STEM careers (Table 58). Nearly all alumni reported being interested in pursuing a STEM career (93%) in general. Three-quarters indicated they were aware of Army/DoD STEM careers (75%), and 82% of alumni indicated they would be interested in learning more about Army/DoD STEM careers. Approximately two-thirds (64%) of alumni were interested in pursuing an Army/DoD STEM career at the present moment.

Table 58. Alumni Awareness and Interests (*n* = 301-306)	
Item	**Somewhat Agree/Agree**
I am aware of Army or DoD STEM careers	75%
I am interested in pursuing a career in STEM	93%
I am interested in pursuing a DoD/Army STEM career	64%
I am interested in learning more about Army/DoD careers focused on STEM research	82%

Alumni were asked to report on their STEM career plans (Table 59). Most alumni indicated that they plan to seek a STEM-focused career in the future (87%). Some alumni have already applied for STEM-focused jobs (31%) or currently have a STEM-focused career (22%). Further, 44% of AEOP alumni indicated they plan to seek an Army/DoD STEM-focused career in the future, and 5% already have such a position.

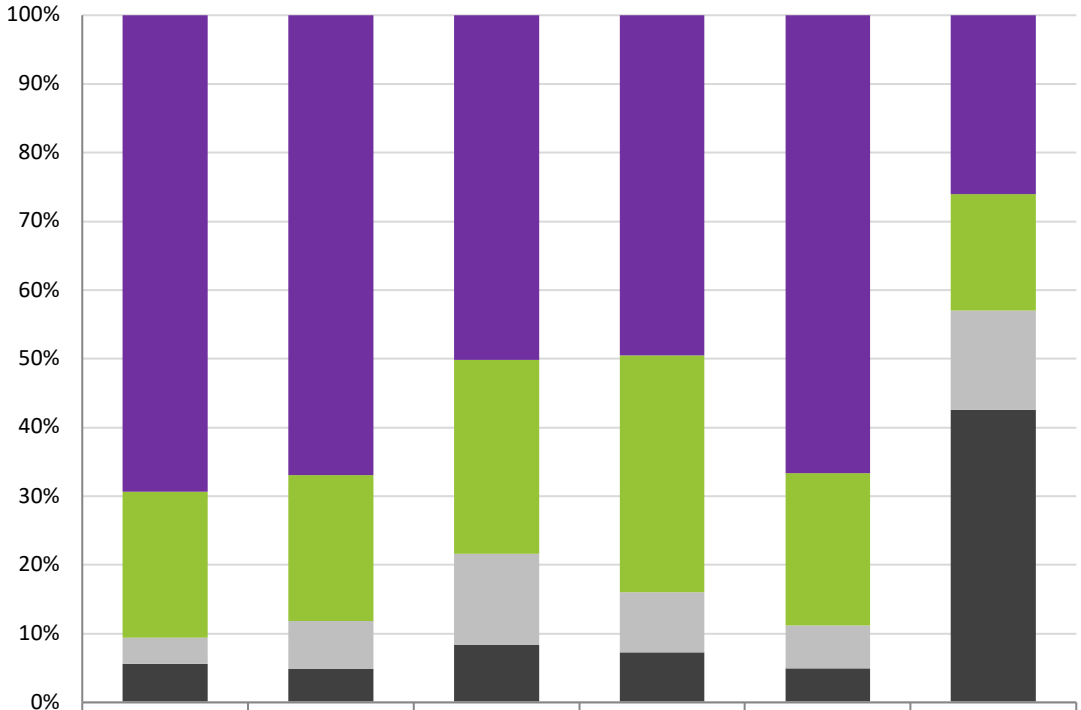
Table 59. Alumni STEM Career Focus (*n*=292-298)	
Item	**Yes**
I have applied for STEM-focused job positions	31%
My current job is in a STEM-focused career	22%
I plan to seek a STEM-focused career position in the future	87%
My current position is an Army/DoD STEM focused position	5%
I plan to seek an Army/DoD STEM-focused career position in the future	44%

PRIORITY TWO: STEM Savvy Educators

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

Alumni reported on their perceptions of the mentoring they received while in their AEOP (Chart 29). Most alumni felt their mentoring experience was very positive (90%), enhanced their learning (88%), and was a valuable aspect of their AEOP (88%). Many alumni also believed their AEOP mentor helped influence their future academic career decisions (83%), and helped them learn about Army/DoD careers (78%). While the reported mentoring relationships appeared to be strong, nearly half indicated they have stayed in touch with their AEOP mentor after the program (43%).

Chart 29: Alumni Perceptions of AEOP Mentoring Received (*n* = 284-287)



	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	69%	67%	50%	49%	67%	26%
Somewhat Agree	21%	21%	28%	34%	22%	17%
Somewhat Disagree	4%	7%	13%	9%	6%	14%
Disagree	6%	5%	8%	7%	5%	43%

The JSHS alumni who participated in the focus group placed a high value on the mentoring they experienced during JSHS. These alumni had a combined experience of 11 years as JSHS students (2 had participated for 4 years, 1 for 3 years), and during this time as JSHS participants they found, as one alumna noted, that "mentors come in a variety of flavors and different durations." These alumni spoke of mentors as being both the teachers or parents who had worked with them on their JSHS projects and the judges and other professionals they met while participating in JSHS.

One focus group participant credited a high school biology teacher with his motivation to participate in JSHS, saying that the teacher's reputation as a JSHS mentor inspired him as early as the fifth grade to plan on participating in JSHS when he entered high school. This alumna spoke of "the criticality of having a mentor that makes students aware of [JSHS]" and noted that after this teacher retired from his school that the school's participation in JSHS ended.

Another participant spoke of an engineer who had served as a judge at two JSHS competitions the alumnus had attended as a high school students. Although limited in duration, the encounters had a long-term

impact, ultimately influencing his choice of undergraduate institution and his major. In the alumnus's words,

> *I saw him twice. I didn't keep in touch with him, but he was a mentor in the sense that he saw something in me that I didn't see in myself. He saw a passion and he gave me some good advice, which I followed.* (JSHS Alumnus)

All focus group participants emphasized that the opportunity to meet and interact with STEM professionals impacted their interest and motivation to pursue STEM career paths. As one alumnus said,

> *A lot of times you're meeting professional scientists in your field for the first time…They're listening to [your presentation], and they're asking you questions about your project afterwards, and it really helps make your enthusiasm blossom. It certainly had that impact on me going into college.* (JSHS Alumnus)

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 FY16 as the RESET program was still in the first two years of the program. This question will be explored in the FY18 AEOP Summative Evaluation Report.

PRIORITY THREE: Sustainable Infrastructure

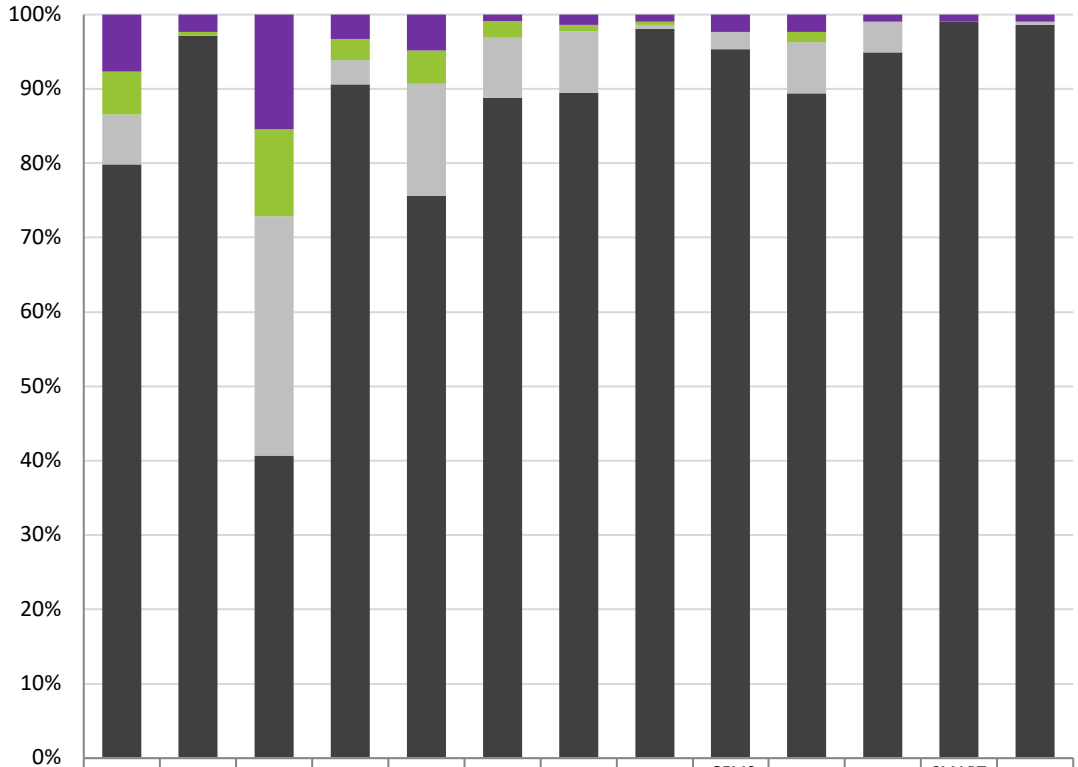
Research Question #8 - To what extent do alumni report increased awareness of and/or interest in AEOP opportunities?

AEOP alumni (n=312) were asked to report on their awareness of and interest in other AEOPs. More than half of alumni (59%) indicated that they were familiar with other AEOP programs, and 80% 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?

AEOP Alumni were asked to report past participation in AEOPs (Chart 30). The program with the most participation by alumni was GEMS with 59% of respondents reporting to have participated at least once. Alumni participants represented all programs. Further, alumni survey participants reported receiving each of the AEOP scholarships: SMART (1%) and NDSEG (1%).

Chart 30: Alumni Participation in AEOP Programs (n = 212-273)



	eCybermission	JSS	GEMS	UNITE	JSHS	SEAP	REAP	HSAP	GEMS Near Peer Mentors	CQL	URAP	SMART College Scholarship	NDSEG
Three or more times	8%	2%	15%	3%	5%	1%	1%	1%	2%	2%	1%	1%	1%
Twice	6%	0%	12%	3%	4%	2%	1%	0%	0%	1%	0%	0%	0%
Once	7%	0%	32%	3%	15%	8%	8%	0%	2%	7%	4%	0%	0%
Never	80%	97%	41%	91%	76%	89%	89%	98%	95%	89%	95%	99%	99%

7 | Summary of Findings

The 2017 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. 2017 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	**Growth in Overall Participation and Some Program Participation.** In FY17, the AEOPs increased participation overall 6%, from 30,972 in FY16 to a total of 32,947 participants in STEM programs, STEM competitions, and STEM apprenticeship programs. This increase reflects outcomes of increased investments in marketing and promoting AEOPs through a variety of methods at local, state, and national levels and reverses a three-year downward trend from enrollments of 41,802 in FY14, 38,039 in FY15, and 30,972 in FY16 respectively. Programs that experienced participation increases in FY17 include: CII 17% growth (1,425 compared to 1,185 in FY16); eCM 3% growth (21,277 compared to 20,607 in FY16); GEMS 15% growth (2,845 compared to 2,427 in FY16); JSHS 5% growth (5,577 compared to 5,300 in FY16); JSS 34% growth (892 compared to 585 in FY16); Unite 21% growth (358 compared to 282 in FY16); URAP 12% growth (59 compared to 52 in FY16). JSHS and JSS reversed a downward trend in enrollment in FY17. It is important to note that in previous years, prior to the implementation of the use of the Cvent online registration system, most of AEOP program participation data were self-reported.
Finding #2	**Decline in Participation for Most Apprenticeship Programs.** Despite overall growth in participation and some growth for programs mentioned in Finding #1, the remaining four apprenticeship programs stayed the same or experienced a decline in participation for FY17. CQL 3% decrease (229 compared to 236 in FY16); HSAP 17% decrease (54 compared to 65 in FY16); REAP 2% decrease (118 compared to 120 in FY16); and SEAP stayed the same at 113 for FY17 and FY16.
Finding #3	**Three-Year High Number of Applications to Participate in AEOPs – However, Placement Rates Declined in FY17 for some AEOPs.** The overall placement rates across AEOPs decreased from 83% from FY16 to 68% in FY17, despite a three-year high number of applications submitted to participate in AEOPs. For FY17, there were 46,518 applications, an increase of 20% over the 37,399 applications received in FY16 and a 4% increase over the number of applications received in FY15 when 44,632 applications were received. As a result of the increasing number of applications, apprenticeship programs have experienced a downward trend in placement rates due to limitations in funding and availability of placements/mentors. CQL placed 41% of applicants in FY17, as compared to 51% in FY16; HSAP placed 9% of applicants in FY17 as compared to 18% in FY16; REAP placed 17% of applicants as compared to 25% in FY16; URAP placed 9% of applicants in

	FY17 as compared to 29% in FY16; and SEAP placed 13% of applicants as compared to 16% in FY16. However, placement rates grew slightly for STEM enrichment activities. GEMS placement increased from 55% in FY16 to 61% in FY17 and Unite enrollment grew from 41% in FY16 to 45% in FY17. Acceptance rates for STEM enrichment programs increased in FY17 (61% GEMS, 38% Unite) as compared to FY16 when 55% of GEMS applicants and 41% of Unite applicants were selected for these programs. eCM continued to accept all applicants in FY17 to participate in the program, as in previous years. The JSHS competition does have restricted participation due to regional capacities. However, JSHS increased placements to 65% in FY17 compared to 60% in FY16.
Finding #4	**AEOPs Continued to Serve Underserved Populations.** The AEOPs continued to prioritize the participation of students from traditionally underserved groups, per the AEOP definition: *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 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.* As reported by AEOPs, apprenticeship programs included 38% of underserved students in their total population. CII achieved 100%, while Unite registered 65% and REAP 54% respectively. The next highest enrollment of underserved students was eCM with 45%. GEMS and JSS both had 29% participation of underserved students. All remaining programs had 19% or less underserved participation – with CQL and SEAP having the lowest percentages at 6%. Others included: HSAP (19%); JSHS (19%); and URAP (8%).
Finding #5	**Participants reported engaging in STEM practices significantly more in their AEOP programs as compared to in their typical school experiences for each program.** Evaluation findings indicated that AEOPs consistently provided opportunities for participants to engage in authentic STEM activities that are significantly more intensive than those they experience in their typical school settings.
Finding #6	**Participants reported increased STEM competencies, STEM skills, STEM knowledge, STEM practices, and confidence in STEM after participating in AEOPs.** The programs with the highest level of agreement (some gain to large gain) with growth in 21st Century STEM Skills; STEM Knowledge; and STEM practices after participation included: CQL, eCM, GEMS, HSAP, JSHS, REAP, SEAP, Unite, and URAP. Participants from all programs indicated some to a large gain in their STEM identity after participation. Participants from CQL, eCM NJ&EE, GEMS, HSAP, REAP, SEAP, Unite, and URAP reported 90% or higher agreement with the statement "I am more confident in my STEM knowledge, skills, and abilities" after participating in the AEOPs.
Finding #7	**Participants demonstrated increased attainment toward mastery of the 21st Century Skills across their participation in the AEOPs in the FY17 pilot of the assessment.** Participants from apprenticeship programs (REAP, URAP, HSAP) and STEM enrichment program Unite demonstrated growth in all areas of the 21st Century Skills Assessment from baseline (first days of program) to end of program. Participants exhibited growth in Creativity & Innovation; Critical Thinking & Problem Solving; Communication, Collaboration, and Social and Cross-Cultural Skills; Information, Media, & Technological Literacy; Flexibility, Adaptability, Initiative, & Self-Direction; Productivity, Accountability, Leadership, & Responsibility.

Finding #8	**Participants reported positive attitudes toward Army/DoD STEM Research.** AEOP participants in CQL, eCM NJ&EE, GEMS, HSAP, REAP, SEAP, Unite, and URAP reported 75% or more agreement with the statements: "DoD researchers advance science and engineering fields", "DoD researchers develop new cutting-edge technologies", "DoD researchers solve real-world problems", and "DoD research is valuable to society". Programs that reported less than 75% agreement with the statements included JSHS, JSS, and eCM (regional).
Finding #9	**Evaluation findings indicated that the AEOP exposed participants to STEM careers generally and to Army and DoD STEM careers, and participating in AEOPs increased their interest in pursuing STEM careers.** A majority of participants (range of 53%-97%) in CQL, eCM National, GEMS, HSAP, JSHS, REAP, SEAP, and Unite reported learning about 3 or more STEM careers. Fewer students (range of 32%-44%) in eCM Regional, JSS, and URAP had learned about 3 or more STEM careers. In regards to specific DoD STEM Careers, participants reported less exposure in FY17 AEOPs than to STEM careers overall. However, a majority of students (range of 64%-84%) in all programs except for eCM Regional (39%) were more interested in pursuing STEM careers after their AEOP participation and more than half of responding apprentices reported interest in DoD STEM careers in FY17 (range of 66%-87%).
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 FY17.** Strategies to engage students in authentic STEM activities (range of 82%-94%) were used most frequently, while strategies to support participants STEM educational and career pathways (range of 47%-69%) were used the least. A majority of all adults (range of 63%-86%) reported using strategies to support the needs of diverse students as learners. Further, a large majority of adults (82%-94%) reported the use of authentic STEM activities.
Finding #2	**In FY17, participants continued to be satisfied with the support received from their mentor/S&E/Team Advisor/teacher.** Most apprentices and students in all programs reported high levels of satisfaction with the mentorship they received and the quality of instruction they received (range of 62%-84%). The levels of satisfaction for several programs, CQL, GEMS, REAP, SEAP, and Unite, were somewhat lower than those reported in FY16, however levels satisfaction in HSAP and URAP were higher than in FY16. Overall, the percentage of satisfaction with instruction or mentorship in FY17 was very similar to that reported in FY16 (range of 62%-83%).
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 in FY17 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. Overwhelmingly, participants and mentors reported that AEOP social media, AEOP website, and other materials were much less frequently used as a means for introducing them to the program.

Finding #2	**Despite limited awareness of participants and mentors of the full AEOP and DoD/Army portfolio of opportunities, FY17 participants reported interest in continuing on to participate in another AEOP in the future.** Some individual programs made progress in FY17 in increasing awareness of AEOP programs overall. However, participants in some programs were not aware of other opportunities within AEOP.
Finding #3	**Participation in the AEOP evaluation in FY17 improved for apprentices/students in most programs. Mentor/adult questionnaire completion is still less than desired.** Programs including CQL, eCM NJ&EE, GEMS, HSAP, REAP, SEAP, URAP, Unite all improved apprentice/student participation in FY17 – reaching 46% to 94% response rate. Mentors from HSAP, REAP, and URAP also achieved acceptable return rates.

Table 61. 2017 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 indicated interest in pursuing a STEM degree and career.** A majority of alumni participating in the survey indicated they were both interested in earning a STEM degree (88%) and pursuing a STEM career (88%).
Finding #2	**Alumni are interested in completing additional elective STEM courses and other STEM opportunities.** More than three-quarters of alumni reported interest in taking elective STEM courses (80%), learning about new things in STEM (83%), and potential STEM projects/experiments in a university or professional setting (87%).
Finding #3	**AEOP Alumni continue to be engaged in STEM.** Nearly three-quarters or more of alumni reported sometimes or frequently engaging in activities such as: learning about new things in STEM (88%), talking with family and friends about STEM (75%), and solving math/science puzzles (73%).
Finding #4	**Alumni hold positive views toward STEM generally and Army/DoD STEM specifically.** Over 80% of AEOP alumni believe that all people can be successful in STEM. Alumni report agreement with the following statements: *I enjoy solving real-world problems* (97%); *STEM careers are a good fit with my interests* (97%), *I feel successful in STEM classes* (95%), *and I can use STEM to help improve my community* (95%). In regards to Army/DoD STEM attitudes specifically, 95% percent or more of alumni indicated feeling Army/DoD research is valuable to society, 97% agree that the Army/DoD solves real-world problems, as well as develops new, cutting edge technologies.
Finding #5	**Alumni report interest in STEM careers generally, as well as with the Army/DoD specifically.** Nearly all alumni reported being interested in pursuing a STEM career (93%) in general. Three-quarters indicated they were aware of Army/DoD STEM careers (75%), and 82% of alumni indicated they would be interested in learning more about Army/DoD STEM careers. Approximately two-thirds (64%) of alumni were interested in pursuing an Army/DoD STEM career at the present time.

Finding #6	**35% of AEOP Alumni reported enrollment in a STEM degree program.** Engineering was the highest enrolled field (11%), followed by medicine (7%), life science (6%), physical science (5%), mathematics or statistics and technology or computer science (2% each respectively), followed by Earth science and business (1% each respectively) and other 4%.
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	
Finding #1	**Participants reported very positive impacts of their mentors and agreed mentoring is a valuable aspect of AEOPs.** Many alumni also believed their AEOP mentor helped influence their future academic career decisions (83%), and helped them learn about Army/DoD careers (78%). While the reported mentoring relationships appeared to be strong, nearly half indicated they have stayed in touch with their AEOP mentor after the program (43%).
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, though less than 60% indicated they were familiar with other AEOPs.** In fact, 80% of alumni who responded to the mid to long term evaluation questionnaire indicated interest in future participation.

What AEOP Participants are saying…..

*"I have had a fantastic experience [in **CQL**]. I owe a lot to my mentors who guided me every step of the way. Thanks to them, I have had the opportunity of publishing scientific articles, giving talks at conferences, and performing cutting edge research. I recently was accepted into graduate school for Ph.D. studies and I believe a major part of my acceptance was the experience I gained from this program."* --CQL Apprentice

*"[**CQL**] provides full immersion of students into nonacademic labs to gain further experience in STEM programs to understand other available professional paths. It is an excellent summer program and I wish I had participated when I was in college."* --CQL Mentor

*"I never really thought of pursuing STEM because it seemed like a job where you had to sit behind a desk and type on a computer…After doing **eCM** and talking to the Army officers and everyone, it makes it seem like there are so many more opportunities*." --eCM-NJ&EE Student

*"I think the [**eCM**] program is so well organized and it's got so many resources that I can get a group of sixth grader to stick with a topic and work on a project for almost an entire year… it's very open-ended and they get to pick a topic. It's part of their community. They feel that direct connection. They take ownership for what they're doing. They become experts in what they're doing. They develop patience. They're collaborating. They're managing time. Their developing all of these skills, I think, is invaluable."* --eCM Adult Participant

*"[In **GEMS**], you get to meet people who do the jobs and hear their side of the story about what the [jobs are like] that you may be considering going in to."* --GEMS Student

*"[**GEMS**] kids are able to learn principles and apply them immediately, as opposed to the typical classroom setting where they would learn something but not get the direct application. They're able to conceptualize how it would happen in the real world as well as what skill sets they could use in a career"* --GEMS Mentor

*"I am very impressed by every single hard-working researcher in our group. Each of them contributed to my learning experience and were always willing to address any questions I had. I am especially thankful for my mentor, who worked closely with every day and helped me discover all the theories behind our optical pressure sensor research project. He ensured that I always had the opportunity to involve myself in cutting-edge research and allowed me to make the most of my **HSAP** experience. I was exposed to areas of the engineering world, such as resonances, semiconductor fabrication process, and so much more, that I never knew existed. I am endlessly grateful for AEOP for this eye-opening opportunity, and I am confident that this experience will lead me to unimaginable paths and direct my future for the better."* --HSAP Apprentice

*"I am very happy with the three excellent **HSAP** students worked in my lab not only for the work they have done (two manuscripts in preparation with them as co-authors), but also their passions and hard works in learning. I could see the changes in them within this short 8 weeks of lab experience and all three will pursue STEM in college (Physics, Engineering and pre-med)."* --HSAP Mentor

*"I realized how much I love my research project and understanding how the universe [works], so I've decided to go into theoretical physics instead of computer science. I changed my mind after being inspired by the Nobel Laureate and speaking with **JSHS** alumni on Saturday morning*." --N-JSHS Student

*"**JSHS** is a wonderful competition and symposium. It is worthwhile for all students that participate; regardless if chosen to present or move on to national level."* --JSHS Mentor

*"I am very pleased with my **JSS** experience. It taught me so many things and made me confident in complicated scenarios. All of the people I met and my mentors helped me out so much. I loved my experience and had a great time."* --JSS National Student

*"For [students in **JSS**] to have an opportunity to go and do something – fail at it, do well at it, or whatever – and then be pushed the next year to learn from those experiences, that is what life is all about."* --JSS Mentor

*"I am extremely satisfied with [**REAP**]. I have learned a lot in very little time, and the program has definitely increased my interest in STEM! I also appreciate and respect the inclusion of minority groups in STEM. As a Hispanic woman, I know my demographic is vastly underrepresented in STEM careers, and it is very important that we change that. I very much enjoy being a part of this program and definitely will apply again next year. Thank you so much for allowing me to participate; **REAP** has definitely changed my life for the better!"* --REAP Apprentice

*"The [**REAP**] students were all brilliant, and we grew as a group over the summer. The students furthered my interest in research by helping me understand problems from different points of view."* --REAP Mentor

*"My [**SEAP**] mentor was very helpful throughout the entire process and worked with me through every step. He helped me understand science concepts relating to my project and taught me various lab skills. Overall, the program was very beneficial and has allowed me to expand my knowledge in the areas relating to the STEM field*." --SEAP Apprentice

*"The **SEAP** program was simple and provided a great opportunity for the student to learn more about Engineering and research prior to beginning a degree program in Mechanical Engineering. As a PhD researcher in engineering, I wish I had been afforded a similar opportunity. The program is a great way for the Army and ERDC to market ourselves to the community, gain summer help from eager students, and continue to build a pool of recruits for the future."* --SEAP Mentor

*"I loved [**Unite**]. It was the perfect mix of learning and fun. Also, it was amazing to meet so many people also interested in similar topics. Over all it has helped me narrow down my career choices as it showed me what interests and skills I have in various forms of engineering."* --Unite Student

*"This year my **Unite** experience was excellent! The curriculum that was designed strongly supported the goals of the program and there was clear growth and development in the participants from the beginning of the program to the end of the program. We incorporated several enrichment components that allowed students to explore their creativity, build teamwork and effective communication skills, improve their math and problem-solving abilities, and gain valuable knowledge about STEM careers."* --Unite Mentor

*"The [**URAP**] apprenticeship program was one of the most inspiring and challenging experiences I have had as an engineering student. It will help me to grow as a Mechanical Engineer and also to be a scientist. I learned that we should not be afraid to be wrong during experiments. Not only is knowledge important, but patience, imagination, and creativity are important, too. I would love to be in a program like this again."* --URAP Apprentice

*"[**URAP**] is very beneficial for undergraduate students interesting in exploring STEM research. This also gives them a chance to think and work independently, as well as in collaboration with other researchers, thereby preparing them for a future career in STEM research."* --URAP Mentor

Recommendations for FY18 Program Improvement/Growth

While the successes for AEOP detailed above are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY18 and beyond.

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. In FY17, AEOP experienced a 6% growth in participation, increasing to nearly 33,000 participants. The positive momentum should be catalyzed moving in to FY18. It is recommended that additional resources and efforts be expended in regards to eCM and JSHS specifically. Both of these programs produced growth in participation this year. eCM has the flexibility within the e-model to grow participation relatively easily. JSHS has large (~3,000 applications in Cvent alone in FY17) unmet need that could be transformed into additional participation if infrastructure is in place to accommodate more participants. This is likely just a percentage of the actual number of applications, as only a subset of the overall total regions used Cvent for registration in FY17. It

is suggested that these programs examine strategies that programs such as Unite and JSS have used to produce growth in FY17 (over 20%). AEOPs should continue to work to grow the percentage and number of underserved students who are participating in the program. Unite, REAP and JSS can serve as potential models for the consortium of how to achieve this in a more rapid and impactful manner.

Examine means for increasing infrastructure to grow placement rates in JSHS and apprenticeship programs. An important first step in examining strategies to increase enrollment for AEOP overall may be to take a look at the current unmet need and demand for programs within the portfolio that may not have the infrastructure (personnel and resources) to be able to accommodate additional participants. Any potential resources that may be redirected in the way of these programs, or from other potential future proceeds, could be used to translate into increased participation in FY18.

Strengthen programs ability to impact STEM outcomes and awareness of DoD/AEOP. In FY17, most programs had significant impacts on STEM outcomes and awareness for participants. Two of the AEOPs that did not produce as large of gains as the others were JSS and eCM NJ&EE. It is recommended that the AEOP examine the format, delivery, and feedback from these programs in partnership with the other consortium partners to determine how there could be improvement in this area in FY18 and beyond.

Continue to examine impact of AEOP participation on growth in skills beyond self-reports. The FY17 pilot of the 21st Century Skills Assessment has provided a powerful glimpse into the significant impact that AEOP participation is having on extended-time programs (more than one-week in duration)

including some of the apprenticeship programs and Unite. In FY18, the AEOP should continue to build upon this pilot to consider ways to implement a similar measure with other programs that have more sporadic or intermittent (not multiple-day) frequency. True independently assessed growth (not self-reported by the participant) in skills provides a more accurate measure of impact on skills and knowledge than self-reporting. However, self-reports (questionnaires) also serve as a data point that reveals participants attitudinal and interest data as well as their perceptions of growth in skills and knowledge.

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

Continue to focus on strengthening role of adults in mentoring and instruction. In FY17, there was considerable improvement in the support of mentor use of effective mentoring strategies within and across AEOPs, in part due to increased focus and investment of AEOP to the findings of the FY16 evaluation. However, there is still room for more growth, as reported use of effective strategies still remains less than 50% for some programs and strategy areas. This is an area that should continue to be a key component of the continued efforts to provide more resources, onboarding, and potential mentoring (of mentors) to continue to make even greater impacts on student desired outcomes of the AEOP.

Grow adult and youth participant awareness through support and innovative programming from AEOPs. An area of concern that was prevalent across the majority of AEOPs in FY17 was the persistence of lack of information availability and/or utilization regarding AEOPs, as well as Army/DoD opportunities

and information by mentors and/or adults leading programs. While we are cognizant of the increased focus this area has received over the past couple of years, it appears that mentors need more support and/or resources/programming/speakers/etc. to provide to students in multiple modes so that participants become more deeply aware of AEOPs, and Army/DoD opportunities. It is recommended that the AEOP examine best-in-class practices such as what eCM NJ&EE uses and consider scaling-up effective strategies across the consortium.

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

Expand reach of AEOP marketing, recruitment strategies beyond current local networks. Over the past three years of the AEOP evaluation, it has become increasingly clear that the portfolio has a vibrant, grass-roots network that has served the AEOP very well in the past and currently. It is important to note how difficult it often is to get deeply rooted within local contexts and communities to be able to produce such powerful networking and recruitment efforts year after year. However, it is the time to look to go beyond these networks to reach out to tap underserved populations that have little to no awareness of the outstanding opportunities that await them within the AEOP. This is not to say that the current AEOP network be disregarded – it should continue to be nurtured and leveraged. It is recommended that the consortium work to develop, at a minimum, a targeted plan for outreach and participation for FY18. The consortium began this work with the integration of Strategic Outreach Partners in FY16 and continued in FY17. To date 15 organizations have received funding to work with the AEOP to broaden participation through outreach to underserved communities. Additionally, in FY17 eCM awarded mini-grants to 183 team advisors to support participation in the program. Nearly 100 of those awards were to teachers at Title One schools. Potentially some of the strategic partners should be filling this role to help expand the reach of AEOP.