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Army Educational Outreach Program

Science and Engineering Apprenticeship Program (SEAP)

2017 Annual Program Evaluation Report

PART 2: Evaluation Findings

February 2018

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

AEOP Priorities

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

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

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

This report documents the evaluation of one of the AEOP elements, the Science & Engineering Apprentice Program (SEAP). In FY17, SEAP was managed by the Academy of Applied Science (AAS). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

SEAP is an AEOP pre-collegiate program for talented high school students that matches these students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es) for an eight-week summer apprenticeship at an Army research facility. The use of the term "mentor" throughout this report will therefore refer to the Army S&E. This direct apprentice-mentor relationship provides apprentices with training that is unparalleled at most high schools. SEAP apprentices receive firsthand research experience and exposure to Army research laboratories. The intent of the program is that apprentices will return in future summers and continue their association with their original laboratories and mentors and, upon graduation from high school, participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue that relationship. Through their SEAP experiences, apprentices are exposed to the real world of research, experience valuable mentorship, and learn about

education and career opportunities in STEM. SEAP apprentices also learn how their research can benefit the Army as well as the civilian community.

In 2017, SEAP was guided by the following objectives:

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

As can be seen in Table 1, apprenticeships were completed at 11 Army research laboratories. The number of enrolled participants remained at 113, the same number of students enrolled in FY16 (compared to 92 in FY15). The number of applicants increased from 2016 to 2017, with 852 individual applicants in FY17 as compared to 690 applicants in FY16.

Table 2 displays demographics for enrolled SEAP apprentices. Over half (54%) of participants were female and the most frequently represented races/ethnicities were White (42%) and Asian (32%). Fewer students identified themselves as Black or African American (17%) or Hispanic or Latino (3%). Most students (71%) attended suburban schools and only a small number (4%) indicated that they received free or reduced-price lunch, a commonly used indicator of low income status.

Table 1. 2017 SEAP Site Applicant and Enrollment Numbers

2017 SEAP Site	No. of Applicants	No. of Enrolled Participants	Placement Rate
U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) - Redstone, AL	70	7	10%
U.S. Army Engineer Research & Development Center – Construction Engineering Research Laboratory (ERDC-CERL) - Champaign, IL	44	4	9%
U.S. Army Edgewood Chemical Biological Center (ECBC-RI) – Rock Island, IL	61	5	8%
U.S. Army Research Laboratory (ARL) - Aberdeen Proving Ground, MD	147	10	7%
U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) – Aberdeen Proving Ground/Edgewood, MD	147	13	9%

U.S. Army Edgewood Chemical Biological Center (ECBC-APG) – Aberdeen Proving Ground/Edgewood, MD	237	16	4%
U.S. Army Research Laboratory (ARL) – Adelphi, MD	101	11	7%
U.S. Army Center for Environmental Health Research (USACEHR) – Fort Detrick, MD	17	0	0%
U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) – Fort Detrick, MD	132	14	11%
Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD	341	29	9%
U.S. Army Engineer Research & Development Center (ERDC) – Vicksburg, MS	32	8	25%
U.S. Army Engineer Research & Development Center – Geospatial Research Laboratory (ERDC-GRL) – Alexandria, VA	150	1	<1%
TOTAL	1,523 (852 individuals†)	113	13% actual placement rate

†Applicants could apply for up to three locations

Table 2. 2017 SEAP Student Participant Profile		
Demographic Category		
Participant Gender (n = 113)		
Female	621	54%
Male	52	46%
Not Reported	0	0%
Respondent Race/Ethnicity (n = 113)		
Asian	37	32%
Black or African American	19	17%
Hispanic or Latino	3	3%
Native American or Alaska Native †	NA	NA
White	48	42%
Other race or ethnicity	3	3%
Choose not to report	3	3%
School Setting (n = 113)		
Urban	19	17%
Suburban	80	71%
Rural	12	11%
Frontier or Tribal School †	NA	NA
DoDDS/DoDEA School	0	0%
Home school	1	<1%
Choose not to report	0	0%
Free/Reduced Lunch Status (n = 113)		
Yes	4	4%
No	106	93%
Choose Not to Report	3	3%

†Not included as choices at application/registration

The total cost of the 2017 SEAP program was $419,955. This cost includes administrative costs of $59,180 and $356,132 for participant stipends. The average cost per participant was $3,717. Table 3 summarizes these and other 2017 SEAP program costs.

Table 3. 2017 SEAP Program Costs	
2017 SEAP - Cost Per Participant	
Total Student Participants	113
Total Program Cost	$419,955
Cost Per Participant	$3,717
Administrative Cost to AAS	$59,180
Participant Stipends	$356,132
Other Operational Costs	$4,643

4 | Evidence-Based Program Change

All AEOP apprenticeship programs are administered by the Academy of Applied Science and are combined into an overall apprenticeship portfolio. Objectives and activities for the apprenticeship programs were developed and implemented collectively for all programs and included the following:

1. 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 more diverse audience. (Supports Priority 1)

- Distributed program information to various organizations to increase diverse audience:
    - Published apprenticeship opportunities to high schools and universities located near Army labs and universities using direct mail and email campaigns.
    - Expanded outreach efforts to include superintendents of Title I high schools close to universities and DoD laboratories.
    - Received high school and community outreach assistance from The SEED School of Maryland, Center for Excellence in Education in McLean, Virginia, Iowa Education Services Officer (National Guard) and Educational Services Specialist (Army) in New Jersey.
    - Approximately 300 universities posted apprenticeship opportunities on career assistance pages.
    - University host directors distributed flyers to college students to promote URAP and CQL, as well as mentorship.
- Improved program awareness and mentor participation by:
    - Sending mentors certificates of appreciation and letters of appreciation, as well as sending letters to the university deans, as appropriate.
    - Working with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights – 10 in FY17 with 7 more apprenticeship spotlights in development. It is anticipated that mentor blogs and spotlights will spark interest in future program participation.
    - Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
        - STEM Career links and FY17 STEM Career flyer
        - DoD STEM Webinar
        - Other AEOP programs
        - AEOP Travel Award
        - 21st Century Skill Assessment Pilot Program
        - Program Evaluation

- Poster tips

2. Expand cross-marketing and outreach of apprenticeship programs to include other AEOP programs to mentors and LPCs. (Supports Priority 1 & 3)

- Published AEOP program and DoD opportunities to directors/mentors and students through email throughout the summer such as, DoD STEM Webinar information, STEM Career links and the FY17 STEM Career flyer.
- Assisted CAM office to implement a new STEM Career Opportunity Webinar; encouraged mentors and students to participate.
- All directors/mentors, students and lab coordinators received AEOP brochures/rack cards, AEOP notebooks, flash drives and pens. In addition, students received lab coats to promote all AEOP programs.
- Continued with social media campaign, including AAS Instagram account and hashtag campaign to engage participants.
- Cross marketing by sharing posts about all AEOP programs.
- Participated on marketing committee to share program content and cross promote AEOP.
- Supplied news stories and photos to Widmeyer and assisted with AEOP blogs and Alumni spotlights
- AEOP program information and outreach was done at the following events/site locations in FY17:
  - Massachusetts STEM Summit
  - The SEED School of Maryland
  - Vermont Tech Jam
  - NSTA conference
  - eCYBERMISSION 9th grade students
  - Young Inventors' Program Regional Invention Convention
  - All JSHS Regions
  - NC A&T University - 4 sites
  - City University of NY - 2 sites
  - Fayetteville State University
  - Duke University
  - University of Houston
  - University of Houston, Downtown
  - UNC Charlotte

3. Encourage apprentices to continue pursuit of AEOP STEM/Army STEM careers (Supports Priority 1)

- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Students learned about Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.
- Worked with Widmeyer and Metriks to profile mentors in universities and DoD laboratories to showcase STEM careers in AEOP blogs and Alumni Spotlights.

- Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
    - STEM Career links and FY17 STEM Career flyer
    - DoD STEM Webinar
    - Alumni Survey Link
    - Other AEOP programs
    - AEOP Travel Award
    - 21st Century Skill Assessment Pilot Program
    - Program Evaluation
    - Poster tips

4. Encourage more students already in the AEOP pipeline to continue with an apprenticeship program by utilizing Alumni and CVENT databases to collect past participant information in order to send out alert emails of program application openings. (Supports Priority 1 & 3)

- Worked with Metriks to secure Alumni information. Apprenticeship announcement flyers were sent to over 3,000 alumni from the GEMS, UNITE, JSS, SEAP, HSAP, REAP, JSHS.
- Distributed alumni survey link to directors, mentors and students.
- Distributed Alumni Spotlight to current participants to showcase other programs.
- Worked with partners (eCYBERMISSION, UNITE and JSHS) to distribute program information to cross promote.
- Reviewed and provided feedback to Widmeyer regarding updates to the AEOP website.
- 26% of student participants in apprentice programs participated in GEMS or SEAP. However, it is important to note that 243 students (or 42%) participated in at least one other AEOP program.

5. Increase participant's knowledge of other AEOP programs and STEM careers (Supports Priority 1)

- Apprenticeship flyers were distributed to high schools, alumni and after school programs located near underserved communities close to universities and DoD laboratories. Emails also included a link to the AEOP website outlining other AEOP opportunities.
- Welcome packets were distributed to participants comprised of: Lab coats, flash drives, notebooks, pens/pencils, AEOP brochures/rack cards and all AEOP program opportunities.
- Weekly communication to participants highlighted all AEOP programs and AEOP 2017 STEM Career Guide, AEOP blogs, AEOP social media info about other AEOP opportunities.
- Visited WRAIR and spoke with mentors and apprentices about the student experience in a DoD laboratory, their research project, and their overall apprenticeship experience. Students indicated that this experience has increased their STEM knowledge and affirmed their choice to continue in a STEM related field in the future.
- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Worked with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights.

6. Improve the overall participant and mentor apprenticeship experience. (Supports Priority 1 & 3)

- Worked with university directors/mentors to develop best practices.
- Developed and distributed poster guidelines to students and mentors.
- Assisted mentors with the 21st Century Pilot Program Evaluations.
- Developed student orientation & welcome document.
- Worked with the CAM office to research, develop, and present the DoD STEM Career webinar series to showcase Army scientists and engineers.
- Instituted a new stipend policy to ensure prompt stipend processing.
- Regular communication with students and mentors regarding program outcomes and expectations.
- Applications opened earlier, and in some cases, closed earlier to allow for more time to complete security clearance and issuing of CAC cards at DoD laboratories. One of the primary goals of an earlier close date was to implement the notification process for selected and non-selected participants so that students would have time to apply to other summer STEM opportunities.
- The Mentor Toolkit provided valuable ideas for assisting mentors. The Toolkit suggested ideas to develop an ongoing conversation with mentors about how to assist students in research and life skills, develop best practices in mentoring, and security issues. The Toolkit is a resource for IPA's and LC's to use in helping mentors.
- Distributed AEOP travel award information to participations. Twelve (12) apprenticeship participants were awarded in FY17.
- Assisted mentors with the 21st Century Pilot Program Evaluations.
- Developed student orientation & welcome document.
- Worked with the Army to research, develop, and present the DoD STEM Career webinar series to showcase Army scientists and engineers.
- Instituted a new stipend policy to ensure prompt stipend processing.
- Regular communication with students and mentors regarding program outcomes and expectations.
- Disseminated information about the AEOP Travel Award and received several interests.

5 | Evaluation At-A-Glance

Purdue University, in collaboration with AAS, conducted a comprehensive evaluation of the SEAP program. The SEAP logic model below presents a summary of the expected outputs and outcomes for the SEAP program in relation to the AEOP and SEAP-specific priorities. This logic model provided guidance for the overall SEAP evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• ARO and AEOP co-sponsorship • ARO providing administration of program • Operations conducted by 12 Army-funded university/ college labs • 113 apprentices participating in SEAP apprenticeships • 119 university/college S&Es serving as SEAP mentors • Apprenticeship funds administered to university/college research labs to support apprentice participation • Centralized branding and comprehensive marketing • Centralized evaluation	• Apprentices engage in authentic STEM research experiences through hands-on summer apprenticeships at Army-funded university/college labs • University/college S&Es supervise and mentor apprentices' research • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of apprentice participants engaged in SEAP • Number and diversity of university / college S&Es engaged in SEAP • Apprentices, university / college S&Es, and ARO contributing to evaluation	• Increased apprentice STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased apprentice interest in future STEM engagement • Increased apprentice awareness of and interest in other AEOP opportunities • Increased apprentice awareness of and interest in STEM research and careers • Increased apprentice awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve URAP programs	• Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased apprentice pursuit of STEM degrees • Increased apprentice pursuit of STEM careers • Increased apprentice pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of SEAP

The SEAP evaluation study gathered information from apprentice and mentor participants about SEAP processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and SEAP program objectives.

Key Evaluation Questions

- What aspects of SEAP motivate participation?
- What aspects of SEAP structure and processes are working well?
- What aspects of SEAP could be improved?
- Did participation in SEAP:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for SEAP included post-program apprentice and mentor questionnaires, site visits to 2 SEAP sites, 2 focus groups with apprentices, 2 focus groups with mentors, and an Annual Program Report (APR) prepared by AAS using data from all SEAP sites. Tables 4-8 outline the information collected in apprentice and mentor questionnaires and focus groups, as well as information from the APR that is relevant to this evaluation report.

Table 4. 2017 Apprentice Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, grade level, and race/ethnicity
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Apprentice Experience:** In-school vs. In-program experience; mentored research experience and products
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources
	Army/DoD STEM: Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies (apprentices respond to a subset)
	Comprehensive Marketing Strategy: How apprentices learn about AEOP, motivating factors for participation, impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 5. 2017 Mentor Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of SEAP, motivating factors for participation, satisfaction with and suggestions for improving SEAP programs, benefits to participants

AEOP Goal 1	**Capturing the Apprentice Experience:** In-program experience
	STEM Competencies: Gains in their apprentices' Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in their apprentices' 21st Century Skills
	AEOP Opportunities: Past participation, awareness of other AEOP programs; efforts to expose apprentices to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice AEOP metrics
	Army/DoD STEM: Attitudes toward Army/DoD STEM research and careers, efforts to expose apprentices to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers

Table 6. 2017 Apprentice Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, grade level, past participation in CQL, past participation in other AEOP programs
Satisfaction & Suggestions	Awareness of SEAP, motivating factors for participation, satisfaction with and suggestions for improving SEAP programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which apprentices were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which apprentices were exposed to STEM and Army/DoD STEM jobs

Table 7. 2017 Mentor Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, occupation, organization, role in SEAP, past participation in SEAP, past participation in other AEOP programs
Satisfaction & Suggestions	Perceived value of SEAP, benefits to participants, suggestions for improving SEAP programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in SEAP

Table 8. 2017 Annual Program Report	
Category	**Description**
Program	Description of program content, activities, and academic level
AEOP Goal 1 and 2 Program Efforts	**Underserved Populations:** Mechanisms for marketing to and recruitment of apprentices from underserved populations
	Army STEM: Army/DoD STEM Careers –Participation of Army engineers and/or Army research facilities in career fair activities
	Mentor Capacity: Local Educators - University faculty and apprentice involvement

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in the report narrative, with tables and footnotes providing results from tests for significance. Findings of statistical and/or practical significance are noted in respective data summaries. Part 3 of the report includes appendices with information relevant to the SEAP evaluation: Appendix A outlines the evaluation plan; focus group protocols are provided in Appendix B (apprentice) and Appendix C (mentor); apprentice and mentor questionnaire instruments are located in Appendix D and Appendix E, respectively. Major trends in data analyses are reported herein.

Study Sample

Table 9 provides an analysis of apprentice and mentor participation in the SEAP questionnaires, the response rate, and the margin of error at the 95% confidence level[1] (a measure of how representative the sample is of the population). The margin of error for both the apprentice and mentor surveys is larger than generally acceptable, indicating that the samples may not be representative of their respective populations. The apprentice response rate (54% for FY17) decreased as compared to FY16 when 66% of apprentices responded, however the mentor response rate (29% for FY17) increased substantially as compared to FY16 when only 6% of mentors responded to the questionnaire.

Table 9. 2017 SEAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[2]
Apprentices	61	113	54%	±8.55%
Mentors	35	119	29%	±13.98%

Two apprentice focus groups and two mentor focus groups were conducted at two SEAP sites. Fifteen apprentices participated in the two apprentice focus groups. Of these apprentices, four were male and 11 were female. Ten students were White, 3 were Black or African American, one was Asian, and one was "other" race or ethnicity. Four apprentices were college juniors, seven were 12th graders, and 4 were high school graduates. Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire

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

data. They add to the overall narrative of SEAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Apprentice Demographics

Demographic information for apprentices who responded to the questionnaire is summarized in Tables 10 and 11. More females (58%) than males (42%) completed the FY17 questionnaire. While 48% of responding apprentice participants identified themselves as White and 31% as Asian, 12% of responding apprentices identified with the Black or African American racial/ethnic category and 3% as Hispanic or Latino. Most responding apprentices were 12th grade students (51%), another 16% were 11th grade students, and 6% were 10th grade students. While 7.5% reported qualifying for free or reduced-price lunch (FRL)—a common indicator of low-income status – only 4% of enrolled students fell into this category. Most students (70%) reported attending suburban schools. Overall, these data are similar to those of SEAP participants, suggesting that responding students are representative of the population of enrolled apprentices.

Apprentices reported limited past participation in AEOP programs (see Table 12). Over a third (36%) of respondents reported having participating in GEMS in the past, followed by SEAP (13%) and Camp Invention (13%). This suggests that participation in GEMS may influence students' awareness of and/or decisions to participate in SEAP. Approximately 40% of SEAP apprentices reported having never participated in any other AEOP (a decrease from 54% in 2016).

Table 10. 2017 SEAP Apprentice Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n=67)		
Female	39	58%
Male	28	42%
Choose not to report	0	0%
Respondent Race/Ethnicity (n=67)		
Hispanic or Latino	2	3%
Asian	21	31%
Black or African American	8	12%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	32	48%
Choose not to report	2	3%
Other race or ethnicity	2	3%

Respondent Grade Level (n=61)		
9th	0	0%
10th	4	6%
11th	10	16%
12th	31	51%
Choose to not report	1	2%
Other	15	25%
Respondent Eligible for Free/Reduced-Price Lunch (n=67)		
Yes	5	7.5%
No	61	91%
Choose not to report	1	1.5%

Table 11. 2017 SEAP Apprentice Respondent School Information		
Demographic Category	**Questionnaire Respondents**	
Respondent School Location (n = 67)		
Department of Defense	0	0%
Home School	1	2%
Suburban	47	70%
Rural (country)	8	12%
Urban (city)	11	16%

Table 12. Apprentice Reports of Participation in AEOPs (n=67)

	Response Percent	Response Total
Camp Invention	13.43%	9
eCYBERMISSION	2.99%	2
Junior Solar Sprint (JSS)	1.49%	1
Gains in the Education of Mathematics and Science (GEMS)	35.82%	24
UNITE	0.00%	0
Junior Science & Humanities Symposium (JSHS)	0.00%	0
Science & Engineering Apprenticeship Program (SEAP)	13.43%	9
Research & Engineering Apprenticeship Program (REAP)	0.00%	0
High School Apprenticeship Program (HSAP)	0.00%	0
College Qualified Leaders (CQL)	0.00%	0
Undergraduate Research Apprenticeship Program (URAP)	0.00%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.00%	0
I've never participated in any AEOP programs	40.30%	27
Other STEM Program	26.87%	18

Mentor Demographics

Demographic information for mentors who responded to the 2017 questionnaire is summarized in Table 13. The majority of responding mentors were scientists, engineers, or mathematics professionals (91%), male (74%), and white (63%). Nearly all identified themselves as research mentors (97%).

Table 13. 2017 SEAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 35)		
Female	7	20%
Male	26	74%
Choose Not to Report	2	6%
Respondent Race/Ethnicity (n = 35)		
Hispanic or Latino	0	0%
Asian	8	23%
Black or African American	0	0%
Native American or Alaskan Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	22	63%
Other	0	0%
Choose not to report	5	14%
Respondent Occupation (n = 35)		
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	2	6%
Scientist, Engineer, or Mathematics professional	32	91%
Other, (specify) †	1	3%
Role in SEAP (n = 35)		
Research Mentor	34	97%
Other (Research Civil Engineer)	1	3%

6 | Actionable Program Evaluation

The Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. A focus of the Actionable Program Evaluation is to inform the long-term goal of CQL and all of the AEOPs to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technological progress. Thus, it is important to consider how CQL is marketed and ultimately recruits participants, the factors that motivate them to participate in CQL, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The following sections report perceptions of apprentices and mentors that pertain to current programmatic efforts and recommend evidence-based improvements to help CQL achieve outcomes related to AEOP programs and objects.

Marketing and Recruiting Underrepresented and Underserved Populations

In FY17, outreach was conducted through a coordinated effort among apprenticeships. Marketing was conducted for apprenticeship programs overall rather than for individual programs, a strategy that AAS has reported to be successful. In particular, AAS noted that consistent messaging to directors, mentors, and students continues to be a successful way to keep participants informed of other AEOP programs. According to the annual program report submitted by AAS, a number of strategies were used to disseminate information about the apprenticeship programs to diverse audiences:

- Worked with CAM office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Students learned about Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.
- Worked with Widmeyer and Metriks to profile mentors in universities and DoD laboratories to showcase STEM careers in AEOP blogs and Alumni Spotlights.
- Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
    - STEM Career links and FY17 STEM Career flyer
    - DoD STEM Webinar
    - Alumni Survey Link
    - Other AEOP programs
    - AEOP Travel Award
    - 21st Century Skill Assessment Pilot Program

        - Program Evaluation
        - Poster tips
- Monthly marketing efforts were targeted to high schools located within a two-hour radius of each SEAP lab.
- Updated the Apprenticeship flyer showing diversity and individual program descriptions.
- Cross marketing and outreach for all AEOP programs, in addition to specific cross promotion, such as:
    - Provided apprenticeship flyers to the National Science Teachers Association (NSTA) and the Junior Science Humanities Symposium (JSHS) for distribution at events.
    - Assisted eCYBERMISSION with virtual judge recruitment by notifying apprenticeship directors and mentors of the opportunity.
    - Assisted RESET in recruiting mentors in Army labs to mentor a teacher, in addition to an apprentice. This resulted in recruiting some interested mentors for RESET.

In order to understand the effectiveness of various marketing methods, apprentices were asked to indicate all of the ways they had learned about AEOP (see Table 14). Personal connections were the primary means of information for most apprentices, with the most frequently reported source of information being a family member (43%), followed by someone who works for the DoD (34%), and a friend (30%). Other sources of information that a quarter or more of respondents selected were the AEOP website (27%) and a school or university newsletter, email or website (25%).

Table 14. How Participants Learned About AEOP (n=67)

	Response Percent	Response Total
Teacher or professor encouragement	19.40%	13
An academic requirement or school grade	2.99%	2
Desire to learn something new or interesting	82.09%	55
The mentor(s)	38.81%	26
Building college application or résumé	59.70%	40
Networking opportunities	53.73%	36
Interest in science, technology, engineering, or mathematics (STEM)	98.51%	66
Interest in STEM careers with the Army	55.22%	37
Having fun	56.72%	38
Earning stipends or awards for doing STEM	40.30%	27
Opportunity to do something with friends	8.96%	6
Opportunity to use advanced laboratory technology	79.10%	53
Desire to expand laboratory or research skills	80.60%	54
Learning in ways that are not possible in school	79.10%	53

Serving the community or country	50.75%	34
Exploring a unique work environment	70.15%	47
Figuring out education or career goals	77.61%	52
Seeing how school learning applies to real life	55.22%	37
Recommendations of past participants	19.40%	13
Choose Not to Report	0.00%	0

Mentors were asked to report how apprentices were recruited (see Table 15). While more than a third of mentors (37%) reported not knowing how apprentices were recruited, those who were aware of recruitment strategies indicated that personal and professional relationships are key means of SEAP apprentice recruitment. The two recruitment sources most frequently chosen by mentors were personal acquaintance(s) (31%) and colleague(s) in their workplace (23%).

Mentor participants in one focus group indicated out that personal relationships or "nepotism" had been a factor in participant selection at their lab. A mentor reported being assigned to work with "my boss's daughter and her best friend" without having any input into the selection process in spite of a lab policy of blind review of applicants.

Table 15. Mentor Reports of Strategies Used to Recruit Apprentices (n = 35)

	Response Percent	Response Total
Applications from the Army Educational Outreach Program (AEOP) Website	17.14 %	6
Personal acquaintance(s) (friend, family, neighbor, etc.)	31.43 %	11
Colleague(s) in my workplace	22.86 %	8
K-12 school teacher(s) outside of my workplace	2.86 %	1
University faculty outside of my workplace	5.71 %	2
Informational materials sent to K-12 schools or Universities outside of my workplace	2.86 %	1
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	2.86 %	1
Communication(s) generated by a university or faculty (newsletter, email blast, website)	2.86 %	1
STEM or STEM Education conference(s) or event(s)	11.43 %	4
Organization(s) that serve underserved or underrepresented populations	5.71 %	2

The student contacted me (the mentor) about the program	14.29 %	5
I do not know how student(s) were recruited for SEAP	37.14 %	13
Other, (specify): †	5.71 %	2

To examine whether mentors are expanding their participation in AEOP programs, the questionnaire asked mentors how many times they had participated in each of the AEOPs. Approximately a third of mentors (32%) reported having previously participated in SEAP. Smaller numbers of mentors reported participating in GEMS (11%), CQL (8%), and eCybermission (8%), however 24% of current SEAP mentors indicated they had not participated previously in any AEOP programs.

Factors Motivating Apprentice Participation

The questionnaire included a question to explore what motivated apprentices to participate in SEAP (see Table 16). Apprentices were motivated by a variety of factors. Frequently identified motivators include interest in STEM (99%), the desire to learn something new or interesting (82%), the desire to expand laboratory or research skills (81%), learning in ways that are not possible in school (79%), the opportunity to use advanced laboratory technology (79%), and figuring out career or education goals (78%).

Table 16. Factors Motivating Apprentices to Participate in SEAP (n=67)

	Response Percent	Response Total
Teacher or professor encouragement	19.40%	13
An academic requirement or school grade	2.99%	2
Desire to learn something new or interesting	82.09%	55
The mentor(s)	38.81%	26
Building college application or résumé	59.70%	40
Networking opportunities	53.73%	36
Interest in science, technology, engineering, or mathematics (STEM)	98.51%	66
Interest in STEM careers with the Army	55.22%	37
Having fun	56.72%	38
Earning stipends or awards for doing STEM	40.30%	27
Opportunity to do something with friends	8.96%	6
Opportunity to use advanced laboratory technology	79.10%	53
Desire to expand laboratory or research skills	80.60%	54
Learning in ways that are not possible in school	79.10%	53
Serving the community or country	50.75%	34
Exploring a unique work environment	70.15%	47
Figuring out education or career goals	77.61%	52
Seeing how school learning applies to real life	55.22%	37
Recommendations of past participants	19.40%	13
Choose Not to Report	0.00%	0

Apprentices participating in focus groups were also asked about how they learned about SEAP and their reasons for participating. These apprentices echoed the responses of questionnaire participants, indicating that they had learned about SEAP from personal connections such as friends, neighbors, other students, and advisors and robotics mentors. One focus group participant reported learning about SEAP through the AEOP website. Students emphasized the learning opportunities, the value of lab experience, career information, and networking opportunities as motivators for participating in SEAP. For example,

> *I did it just to do something new, to learn something, see what it was about.* (SEAP Apprentice)

> *I needed the experience for next year because I'm majoring in chemical engineering.* (SEAP Apprentice)

The SEAP Experience

Apprentices were asked to report on the nature of their SEAP experiences on the questionnaire. Table 17 provides student responses to a question about their input in their SEAP project design. Nearly half (44%) reported being assigned a project by their mentor. The remaining apprentices reported working with their mentor and members of a research team to design a project (16%), worked with their mentor to design a project (16%), or chose from projects suggested by their mentor (13%). A small number of participants (10%) indicated they did not have a project.

Table 17. Apprentice Input on Design of Their Project (n=61)

	Response Percent	Response Total
I did not have a project	9.84 %	6
I was assigned a project by my mentor	44.26 %	27
I worked with my mentor to design a project	16.39 %	10
I had a choice among various projects suggested by my mentor	13.11 %	8
I worked with my mentor and members of a research team to design a project	16.39 %	10
I designed the entire project on my own	0.00 %	0

Table 18 displays apprentice responses about their participation in research groups. Apprentices most frequently reported working with others in a shared laboratory space, but on different projects (41%). A quarter (25%) of apprentices indicated they worked with a group who all worked on the same project. The remaining apprentices worked alone on projects (or alone with their mentor) (15%), worked alone on a project that was closely connected with the projects of others in their group (12%), or worked alone and met with others regularly for general reporting or discussion (8%).

Table 18. Apprentice Participation in a Research Group (n=61)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	14.75 %	9
I worked with others in a shared laboratory or other space, but we worked on different projects	40.98 %	25
I worked alone on my project and I met with others regularly for general reporting or discussion	8.20 %	5
I worked alone on a project that was closely connected with projects of others in my group	11.48 %	7
I worked with a group who all worked on the same project	24.59 %	15

Increasing the number of qualified students who pursue STEM careers is one goal of the SEAP program, and therefore exposure to STEM careers is an important component of the SEAP experience. Apprentices were asked how many jobs/careers in STEM in general and STEM jobs/careers in the DoD more specifically they learned about during their SEAP experiences (see Tables 19 and 20). All but four responding apprentices reported learning about at least one STEM job/career during their SEAP experience, while all but eight apprentices reported learning about at least one DoD STEM job/career. Approximately two-thirds of apprentices (62%) reported learning about four or more STEM jobs/careers and 59% of apprentices learned about four or more DoD STEM jobs/careers, suggesting that SEAP successfully exposes apprenticeships to jobs and careers in STEM.

Table 19. Number of STEM Jobs/Careers Apprentices Learned About During SEAP (n=61)

	Response Percent	Response Total
None	6.56 %	4
1	6.56 %	4
2	6.56 %	4
3	18.03 %	11
4	6.56 %	4
5 or more	55.74 %	34

Table 20. Number of Army of DoD STEM Jobs/Careers Apprentices Learned About During SEAP (n=61)

	Response Percent	Response Total
None	13.11 %	8
1	1.64 %	1
2	9.84 %	6
3	16.39 %	10
4	4.92 %	3
5 or more	54.10 %	33

In order to understand which resources are useful in increasing awareness of Army or DoD STEM careers, apprentices were asked to indicate which resources impacted their awareness of these careers (see Table 21). Participation in SEAP (85%) and mentors (75%) were most often reported as being somewhat or very much impactful. On the other hand, more than half of apprentices reported having not experienced resources such as AEOP on social media (75%) and the ARO website (61%).

Apprentices were also asked how often they engaged in various STEM practices during their SEAP experience (see Table 22). Apprentices reported consistently engaging in nearly all STEM practices listed weekly or every day. Large majorities of apprentices reported regularly (at least weekly) interacting with STEM researchers (97%), working with a STEM researcher or company on a real world STEM research project (95%), analyzing data or information and drawing conclusions (85%), working collaboratively as

part of a team (84%), and identifying questions or problems to investigate (84%). Apprentices engaged in some other activities less frequently, including presenting research to a panel of judges (61% reported doing this at least once, or monthly). Mentors' responses to questions regarding the frequency with which apprentices engaged in these STEM activities were similar overall to apprentice responses, although apprentices were more likely to report that they engaged in activities "every day." For example, 54% of mentors reported that students interacted with STEM researchers daily as compared to 90% of students, and 54% of mentors reported that students used laboratory procedures and tools daily as compared to 69% of students.

Table 21. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=61)

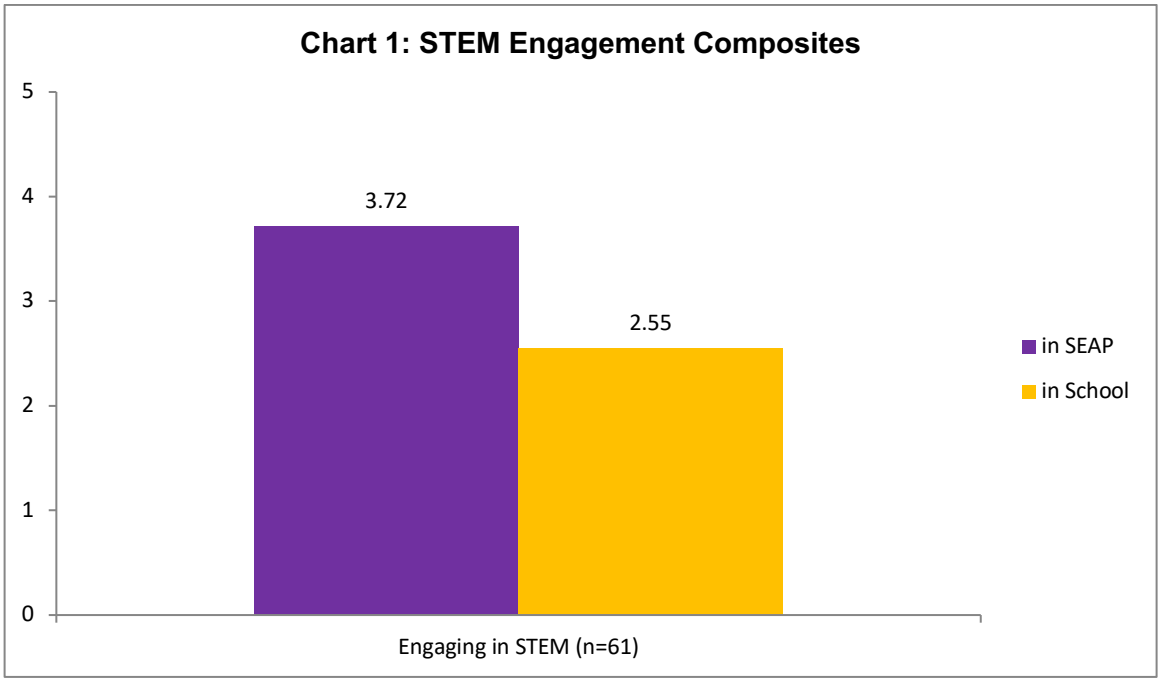
	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	31.1%	8.2%	24.6%	19.7%	16.4%	
	19	5	15	12	10	**61**
AEOP on Facebook, Twitter or other social media	75.4%	11.5%	6.6%	3.3%	3.3%	
	46	7	4	2	2	**61**
Army Research Office (ARO) website	60.7%	9.8%	4.9%	8.2%	16.4%	
	37	6	3	5	10	**61**
AEOP brochure	54.1%	6.6%	16.4%	9.8%	13.1%	
	33	4	10	6	8	**61**
My Apprenticeship Program mentor	3.3%	6.6%	14.8%	11.5%	63.9%	
	2	4	9	7	39	**61**
Presentations or information shared in the Apprenticeship Program	19.7%	6.6%	16.4%	24.6%	32.8%	
	12	4	10	15	20	**61**
Participation in the Apprenticeship Program	9.8%	0.0%	4.9%	14.8%	70.5%	
	6	0	3	9	43	**61**

Table 22. Apprentice Engagement in STEM Practices in SEAP (n=61)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	3.3%	1.6%	0.0%	11.5%	83.6%	
	2	1	0	7	51	**61**
Work with a STEM researcher on a research project of your own choosing	37.7%	8.2%	3.3%	13.1%	37.7%	
	23	5	2	8	23	**61**
Design my own research or investigation based on my own question(s)	42.6%	13.1%	14.8%	8.2%	21.3%	
	26	8	9	5	13	**61**
Present my STEM research to a panel of judges from industry or the military	29.5%	54.1%	6.6%	0.0%	9.8%	
	18	33	4	0	6	**61**
Interact with STEM researchers	1.6%	1.6%	0.0%	6.6%	90.2%	
	1	1	0	4	55	**61**
Use laboratory procedures and tools	9.8%	6.6%	4.9%	9.8%	68.9%	
	6	4	3	6	42	**61**
Identify questions or problems to investigate	6.6%	8.2%	1.6%	23.0%	60.7%	
	4	5	1	14	37	**61**
Design and carry out an investigation	11.5%	16.4%	3.3%	14.8%	54.1%	
	7	10	2	9	33	**61**
Analyze data or information and draw conclusions	1.6%	4.9%	8.2%	27.9%	57.4%	
	1	3	5	17	35	**61**
Work collaboratively as part of a team	6.6%	3.3%	6.6%	11.5%	72.1%	
	4	2	4	7	44	**61**
Build or make a computer model	54.1%	8.2%	14.8%	6.6%	16.4%	
	33	5	9	4	10	**61**
Solve real world problems	9.8%	4.9%	4.9%	16.4%	63.9%	
	6	3	3	10	39	**61**

A composite score[3] was calculated for the Engaging in STEM Practices in SEAP items.[4] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. Composite scores were used to test whether there were differences in student experiences by subgroups – gender and race/ethnicity. No significant differences by gender or race/ethnicity were found in terms of Engaging in STEM Practices in SEAP.

Apprentices were also asked how often they engaged in the same activities in school to examine how the SEAP experience compares to their typical school experience. These items were also combined into a composite variable.[5] Chart 1 shows that student reported STEM Engagement scores were significantly higher on the "in SEAP" version than on the "in school" version (extremely large effect of d = 2.75 standard deviations).[6] This suggests that SEAP offers students more intensive STEM learning experiences than they would generally receive in school.



[3] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.

[4] The Cronbach's alpha reliability for the 12 STEM Engagement in Unite items was 0.816.

[5] The Cronbach's alpha reliability for the 12 STEM Engagement in School items was 0.872.

[6] Dependent Samples t-test for STEM Engagement: t(60)=10.66, p<.001.

This finding was supported by students' comments in focus groups indicating that their learning in SEAP differed from their school experiences in terms of the opportunity for hands-on experiences and depth of learning. As one focus group participant said,

> *[In SEAP] I'm going a lot more in depth in things I've learned in school and actually applying those things. It's just a different way of learning. It's just more hands-on. You're doing it all and not just studying about it.* (SEAP Apprentice)

The Role of Mentors

Mentors play a critical role in the SEAP program. The nature and quality of mentoring is a critical factor in maximizing apprentice participation in these opportunities and sustaining or inspiring apprentices' interest in future STEM work. Of the mentors responding to the questionnaire, 77% indicated working with one SEAP student, 17% indicated that they worked with two SEAP students, and 6% indicated they worked with three SEAP students.

Mentors were asked whether or not they used a number of strategies when working with their apprentices (note: the questionnaires used the term "students"; consequently, the data in this section are reported using that term as well). These strategies comprised five main areas of effective mentoring:[7]

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.

Mentors reported using most strategies associated with each of the five mentoring areas listed above. Mentor responses for each of the five areas of mentoring are presented in Tables 23 – 27.

[7] 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.

Large proportions of participating mentors reported using several strategies to help make learning activities relevant to students (Table 23). For example, more than 90% reported becoming familiar with their students' background sand interests (98%) and giving students real-life problems to investigate or solve (91%). Strategies used somewhat less frequently were helping students understand how STEM can help them improve their own community (63%) and helping students become aware of the role(s) that STEM plays in their everyday lives (52%).

Table 23. Mentors Using Strategies to Establish Relevance of Learning Activities (n=35)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the CQL experience	97.1%	2.9%	
	34	1	**35**
Giving students real-life problems to investigate or solve	94.3%	5.7%	
	33	2	**35**
Selecting readings or activities that relate to students' backgrounds	74.3%	25.7%	
	26	9	**35**
Encouraging students to suggest new readings, activities, or projects	65.7%	34.3%	
	23	12	**35**
Helping students become aware of the role(s) that STEM plays in their everyday lives	68.6%	31.4%	
	24	11	**35**
Helping students understand how STEM can help them improve their own community	51.4%	48.6%	
	18	17	**35**
Asking students to relate real-life events or activities to topics covered in CQL	51.4%	48.6%	
	18	17	**35**

Mentors also reported using an array of strategies to support the diverse needs of students as learners (see Table 24). A large majority of mentors (89%) reported using a variety of teaching and/or mentoring activities to meet the needs of all students, including interacting with students and other personnel the same way regardless of background (83%), directing students to other individuals or programs for additional support as needed (83%), and providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (80%). On the other hand, most mentors reported they did not highlight under-representation of women and racial/ethnic minority populations in STEM (71%) or integrate ideas from education literature to teach/mentor students from underrepresented groups in STEM (66%).

Table 24. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=35)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the SEAP experience	77.1%	22.9%	
	27	8	**35**
Interact with students and other personnel the same way regardless of their background	82.9%	17.1%	
	29	6	**35**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	88.6%	11.4%	
	31	4	**35**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	34.3%	65.7%	
	12	23	**35**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	80.0%	20.0%	
	28	7	**35**
Directing students to other individuals or programs for additional support as needed	82.9%	17.1%	
	29	6	**35**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	28.6%	71.4%	
	10	25	**35**

Two-thirds or more of SEAP mentors completing the questionnaire reported implementing all strategies to support students' development of collaboration and interpersonal skills (see Table 25). Strategies reportedly used most often were having students listen to the ideas of others with an open mind (94%), having students give and receive constructive feedback with others (86%), and having students work on collaborative activities or projects as members of a team (83%).

Table 25. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=35)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	71.4%	28.6%	
	25	10	**35**
Having my student(s) explain difficult ideas to others	77.1%	22.9%	
	27	8	**35**
Having my student(s) listen to the ideas of others with an open mind	94.3%	5.7%	
	33	2	**35**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	68.6%	31.4%	
	24	11	**35**
Having my student(s) give and receive constructive feedback with others	85.7%	14.3%	
	30	5	**35**
Having students work on collaborative activities or projects as a member of a team	82.9%	17.1%	
	29	6	**35**
Allowing my student(s) to resolve conflicts and reach agreement within their team	65.7%	34.3%	
	23	12	**35**

Two-thirds or more of mentor respondents reported using all strategies to support student engagement in "authentic" STEM activities (see Table 26). Four strategies were used very consistently among mentors, with more than 90% reporting implementing them: supervising students while they practice STEM research skills (94%), allowing students to work independently to improve their self-management abilities (94%), providing students with constructive feedback to improve their STEM competencies (91%), and demonstrating laboratory/field techniques, procedures, and tools for students (91%).

Table 26. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=35)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	80.0%	20.0%	
	28	7	**35**

Having my student(s) search for and review technical research to support their work	65.7%	34.3%	
	23	12	**35**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	91.4%	8.6%	
	32	3	**35**
Supervising my student(s) while they practice STEM research skills	94.3%	5.7%	
	33	2	**35**
Providing my student(s) with constructive feedback to improve their STEM competencies	91.4%	8.6%	
	32	3	**35**
Allowing students to work independently to improve their self-management abilities	94.3%	5.7%	
	33	2	**35**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	80.0%	20.0%	
	28	7	**35**
Encouraging students to seek support from other team members	88.6%	11.4%	
	31	4	**35**

The final section of items regarding mentoring strategies focused on mentors' support of students' STEM educational and career pathways (see Table 27). Mentors responses varied widely across strategies. While a large majority of mentors indicated using strategies such as asking students about their educational and/or career goals (91%) and providing guidance about educational pathways that will prepare students for a STEM career (80%), only 34% of mentors reported recommending AEOPs in alignment with student goals.

Table 27. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=35)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	91.4%	8.6%	**35**
	32	3	
Recommending extracurricular programs that align with students' goals	51.4%	48.6%	**35**
	18	17	
Recommending Army Educational Outreach Programs that align with students' goals	34.3%	65.7%	**35**
	12	23	
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	80.0%	20.0%	**35**
	28	7	

Discussing STEM career opportunities within the DoD or other government agencies	68.6%	31.4%	**35**
	24	11	
Discussing STEM career opportunities in private industry or academia	74.3%	25.7%	**35**
	26	9	
Discussing the economic, political, ethical, and/or social context of a STEM career	60.0%	40.0%	**35**
	21	14	
Recommending student and professional organizations in STEM to my student(s)	45.7%	54.3%	**35**
	16	19	
Helping students build a professional network in a STEM field	54.3%	45.7%	**35**
	19	16	
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	42.9%	57.1%	**35**
	15	20	**35**

Mentors were asked which of the AEOP programs they explicitly discussed with their apprentices during SEAP (see Table 28). Not surprisingly, the most frequently discussed program was SEAP, with 60% of mentors reporting that they discussed the program with their apprentices. More than a quarter of mentors reported discussing CQL (40%) and the SMART scholarship (26%). While a few mentors discussed some of the other AEOPs, over a quarter (29%) of mentors discussed AEOP with their students in general without reference to specific programs.

Table 28. Mentors Explicitly Discussing AEOPs with Apprentices (n=35)

	Yes - I discussed this program	No - I did not discuss this program	Response Total
Gains in the Education of Mathematics and Science (GEMS)	14.3%	85.7%	
	5	30	**35**
UNITE	0.0%	100.0%	
	0	35	**35**
Junior Science & Humanities Symposium (JSHS)	2.9%	97.1%	
	1	34	**35**
Science & Engineering Apprenticeship Program (SEAP)	60.0%	40.0%	
	21	14	**35**
Research & Engineering Apprenticeship Program (REAP)	2.9%	97.1%	
	1	34	**35**

High School Apprenticeship Program (HSAP)	2.9%	97.1%	
	1	34	**35**
College Qualified Leaders (CQL)	40.0%	60.0%	
	14	21	**35**
GEMS Near Peer Mentor Program	14.3%	85.7%	
	5	30	**35**
Undergraduate Research Apprenticeship Program (URAP)	5.7%	94.3%	
	2	33	**35**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	25.7%	74.3%	
	9	26	**35**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	5.7%	94.3%	
	2	33	**35**
I discussed AEOP with my student(s) but did not discuss any specific program	28.6%	71.4%	
	10	25	**35**

Mentors also responded to an item in which they indicated the usefulness of resources in exposing their apprentices to AEOPs (see Table 29). Few mentors reported that any resources were "very much" useful. However, more than half reported that participation in SEAP (69%) and the SEAP program administrator or site coordinator (54%) were at least somewhat useful. Most mentors had not experienced AEOP resources such as the AEOP website (60%), AEOP on social media (74%), the AEOP brochure (71%), and invited speakers or career events (57%).

Table 29. Usefulness of Resources for Exposing Students to AEOPs (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	60.0%	11.4%	11.4%	5.7%	11.4%	
	21	4	4	2	4	**35**
AEOP on Facebook, Twitter, Pinterest or other social media	74.3%	22.9%	0.0%	2.9%	0.0%	
	26	8	0	1	0	**35**
AEOP brochure	71.4%	17.1%	5.7%	2.9%	2.9%	
	25	6	2	1	1	**35**
CQL Program administrator or site coordinator	22.9%	5.7%	17.1%	34.3%	20.0%	
	8	2	6	12	7	**35**
Invited speakers or "career" events	57.1%	14.3%	11.4%	5.7%	11.4%	
	20	5	4	2	4	**35**
Participation in CQL	17.1%	2.9%	11.4%	28.6%	40.0%	
	6	1	4	10	14	**35**

Mentors were also asked to rate the usefulness of these same resources for exposing apprentices to DoD STEM careers (see Table 30). As with the previous item, mentors were most likely to rate participation in SEAP as at least somewhat useful (69%). A large majority of mentors indicated that all other resources were either not at all helpful or were not experienced for exposing students to DoD STEM careers during SEAP.

Table 30. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	65.7%	8.6%	14.3%	8.6%	2.9%	
	23	3	5	3	1	**35**
AEOP on Facebook, Twitter, Pinterest or other social media	77.1%	17.1%	0.0%	5.7%	0.0%	
	27	6	0	2	0	**35**
AEOP brochure	74.3%	11.4%	5.7%	5.7%	2.9%	
	26	4	2	2	1	**35**
It Starts Here! Magazine	45.7%	2.9%	20.0%	22.9%	8.6%	
	16	1	7	8	3	**35**
CQL Program administrator or site coordinator	51.4%	14.3%	11.4%	17.1%	5.7%	
	18	5	4	6	2	**35**
Invited speakers or "career" events	14.3%	0.0%	17.1%	28.6%	40.0%	
	5	0	6	10	14	**35**
Participation in CQL	65.7%	8.6%	14.3%	8.6%	2.9%	
	23	3	5	3	1	**35**

Satisfaction with SEAP

Apprentices and mentors were asked about their satisfaction with a number of features of the SEAP program. As can be seen in Table 31, a majority of apprentices reported they were somewhat or very much satisfied with all of the listed program features. For example, more than 90% of apprentices were at least somewhat satisfied with SEAP features such as the teaching or mentoring provided during SEAP activities (95%), the amount of stipends (93%), the timeliness of payment of stipends (93%), and the physical location of SEAP activities (93%). Some apprentices expressed dissatisfaction with some program features, however. The largest area of dissatisfaction was with administrative tasks such as in-processing, network access, etc. with 20% of participants indicating that they were "not at all" satisfied.

Table 31. Student Satisfaction with SEAP Program Features (n=61)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	4.9%	6.6%	29.5%	59.0%	
	0	3	4	18	36	**61**
Other administrative tasks (e.g. security clearances, issuing CAC cards)	3.3%	19.7%	23.0%	21.3%	32.8%	
	2	12	14	13	20	**61**
Communicating with your host site organizers	6.6%	6.6%	14.8%	16.4%	55.7%	
	4	4	9	10	34	**61**
The physical location(s) of Apprenticeship Program activities	0.0%	3.3%	3.3%	21.3%	72.1%	
	0	2	2	13	44	**61**
The variety of STEM topics available to you in the Apprenticeship Program	3.3%	3.3%	8.2%	16.4%	68.9%	
	2	2	5	10	42	**61**
Teaching or mentoring provided during Apprenticeship Program activities	0.0%	0.0%	4.9%	11.5%	83.6%	
	0	0	3	7	51	**61**
Amount of stipend (payment)	0.0%	0.0%	6.6%	18.0%	75.4%	
	0	0	4	11	46	**61**
Timeliness of receiving stipend (payment)	1.6%	1.6%	3.3%	26.2%	67.2%	
	1	1	2	16	41	**61**
Research abstract preparation requirements	3.3%	8.2%	16.4%	21.3%	50.8%	
	2	5	10	13	31	**61**

Apprentices were also asked about the availability of their mentors (see Table 32). Close to two-thirds of apprentices reported that their mentor was always available (61%). More than a quarter indicated that their mentors were available more than half of the time (28%).

Table 32. Apprentice Reports of Availability of Mentors (n=61)

	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	1.64 %	1
The mentor was available about half of the time of my project	9.84 %	6
The mentor was available more than half of the time	27.87 %	17
The mentor was always available	60.66 %	37

Students were asked to indicate their satisfaction with their research experience overall (See Table 33). Responses indicate a high level of satisfaction with most aspects of the research experience. More than 85% of responding apprentices indicated being somewhat or very much satisfied with each aspect of their research experience. Few apprentices expressed dissatisfaction with any features of their research experiences.

Table 33. Apprentice Satisfaction with Their Experience (n=61)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	0.0%	6.6%	11.5%	82.0%	
	0	0	4	7	50	**61**
My working relationship with the group or team	11.5%	0.0%	1.6%	11.5%	75.4%	
	7	0	1	7	46	**61**
The amount of time I spent doing meaningful research	0.0%	4.9%	6.6%	27.9%	60.7%	
	0	3	4	17	37	**61**
The amount of time I spent with my research mentor	0.0%	3.3%	6.6%	18.0%	72.1%	
	0	2	4	11	44	**61**
The research experience overall	0.0%	0.0%	3.3%	13.1%	83.6%	
	0	0	2	8	51	**61**

An open-ended item on the questionnaire asked apprentices to comment on their overall satisfaction with their SEAP experiences. All of the 43 apprentices who answered this question made positive comments, focusing on their learning, the career information they received, their hands-on experiences, and their mentors. For example:

> *I am very honored and pleased to have been part of this apprenticeship program. I am confident in the skills I learned from this 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)

> *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. My 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)

> *My overall experience has been wonderful and I know that my time at USAMRIID 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)

Seven of the apprentices who provided comments about their overall satisfaction (16%) responded with some positive comments, but offered some caveats as well. These caveats focused on a variety of issues including computer access and security clearance (2 comments), and issues such as (1 comment each) organization, communication, insufficient work, a desire for more information about other projects, comments about transportation and lodging, the format of websites for the application and survey, and communication with mentors about education and career goals. For example:

> *I am very pleased with the hands on portion of the apprenticeship. My experience with my mentor and his team were phenomenal. I was dissatisfied with the organization of the program and the lack of information flow. If the organization and information during the program had been better then it would have been a near perfect experience. Also the lack of clearance/access made the job for me and my mentor and his team very difficult to accomplish because of the reliance on computer network to complete tasks.* (SEAP Apprentice)

> *Overall, I was very satisfied. I would have liked to learn more about the other projects that are going on. I also would have liked to spend more time talking with my mentor about STEM in general and about education, not just the work that we are doing in the lab*. (SEAP Apprentice)

In another open-ended item, students were asked to share 3 benefits of SEAP. The 61 students who provided responses cited a wide variety of benefits. The most frequently cited benefits were gaining STEM knowledge and/or skills (mentioned in 30 responses), the opportunity for hands-on lab experiences (mentioned in 26 responses), career information and exposure (mentioned in 22 responses), the opportunity to gain workplace skills such as responsibility, teamwork, time management, patience, perseverance, and integrity (mentioned in 21 responses), the opportunity to learn how research is conducted and applied (mentioned in 19 responses) and the opportunity to network (mentioned in 18 responses).

Apprentices were also asked in an open-ended questionnaire item to list three ways in which the SEAP program could be improved. The 58 apprentices who responded offered a variety of suggestions. The most often mentioned improvements were as follows:

- provide opportunities for apprentices to interact with one another (mentioned 19 times);
- provide more exposure to other departments (tours, for example) and/or other research projects (mentioned 13 times);
- make improvements to the information mentors provided for apprentices (for example, schedules for apprentices' work and instructions for apprentices) (mentioned 12 times);
- streamline security clearance and computer access (mentioned 11 times);
- improve communication between the program coordinators and participants (mentioned 11 times);
- and provide more information to mentors about SEAP and AEOP (mentioned 10 times).

Other, less frequently mentioned improvements included providing brown bag lunches, seminars, or talks for apprentices (mentioned 7 times), providing a larger variety of projects or fields from which to choose (mentioned 6 times), streamlining paperwork and/or the application (mentioned 6 times), and having a longer program (mentioned 5 times). Five comments also focused on pay, with 3 apprentices suggesting higher stipends, 1 suggesting more frequent pay, and 1 requesting on-time pay.

Mentors were also asked to report on their satisfaction with features of the SEAP program (see Table 34). Approximately 70% of mentors were at least somewhat satisfied with the research abstract preparation requirements, the research presentation process, and communicating with SEAP organizers. Most mentors reported not having experienced communication with AAS (77%), stipend payment timeliness (69%), or amount of stipends (57%).

Table 34. Mentor Satisfaction with CQL Program Features (n=35)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	37.1%	2.9%	11.4%	25.7%	22.9%	
	13	1	4	9	8	**35**
Other administrative tasks (in-processing, network access, etc.)	34.3%	14.3%	14.3%	14.3%	22.9%	
	12	5	5	5	8	**35**
Communicating with Academy of Applied Science (AAS)	77.1%	5.7%	2.9%	14.3%	0.0%	
	27	2	1	5	0	**35**
Communicating with CQL organizers	22.9%	0.0%	8.6%	34.3%	34.3%	
	8	0	3	12	12	**35**
Support for instruction or mentorship during program activities	22.9%	2.9%	14.3%	28.6%	31.4%	
	8	1	5	10	11	**35**
Amount of Stipends (payment)	57.1%	0.0%	5.7%	22.9%	14.3%	
	20	0	2	8	5	**35**
Timeliness of stipend payment	68.6%	0.0%	0.0%	17.1%	14.3%	
	24	0	0	6	5	**35**
Research abstract preparation requirements	25.7%	0.0%	2.9%	40.0%	31.4%	
	9	0	1	14	11	**35**

Mentors were also asked to respond to open-ended questionnaire items asking them to comment on their overall satisfaction with SEAP. Of the twenty-three mentors who responded to this question, 15 responded with nothing but positive comments. These comments focused on the value of the program in establishing a pipeline of STEM talent, the opportunity to advance their research, and the opportunity to see student growth. For example,

> *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)

We truly enjoyed the experience of preparing an aspiring STEM researcher to enter into a college career with knowledge of lab techniques. We had a hard-working student who was very capable and learned very well. (SEAP Mentor)

Another five mentors responded with positive comments, but offered some caveats. The most frequently mentioned caveat was computer access and security clearance (mentioned 3 times). Other caveats included a desire for more mentor support and student preparation, better communication, and a longer program. For example,

'Twas a great experience overall. I had a motivated student and a relevant topic. The only needed improvement was getting my student's security paperwork processed. The administrators did not see that my student failed to turn in some required paperwork before he arrived. The result was that my student did not have full network computer privileges until 5 weeks into the experience. We found work-arounds and made the most of the time, but there were some unfortunate limitations. I'd also like to see a structured in-processing process where the entire group came in, got an in-brief, signed paperwork, then went straight over to a CAC appointment as a group. The requirements for the CAC appointment should be communicated ahead of time (i.e., 'bring the following items with you on your first day: driver's license, social security card, passport, etc.'). Overall, I'd definitely do this again! (SEAP Mentor)

I'm grateful for the opportunity to work with SEAP students. However, I do not feel like the SEAP program does anything besides deliver student applications to us. After that, everything becomes the responsibility of the mentor. I would like to see more involvement by the program, perhaps providing useful information about working in a laboratory setting. Examples could be how to take notes, how to give presentations, reading scientific papers. All these should be common to each project and would provide the mentors more time to focus specifically on the science of the project. (SEAP Mentor)

Two mentors had no positive comments about SEAP, focusing on a lack of mentor training and preparation, communication between the program and mentors and students, information about AEOPs, and transportation and housing issues. For example,

I didn't have a 'SEAP' experience; I had a 'here's a high school senior for the summer' experience. As a mentor, I received no guidance about what SEAP is, what the program goals were, what strategies I should use, or what other DoD opportunities I should mention to my students. Any program goals that my student and I met were just coincidental that I thought this was how a mentor should treat a summer student (e.g., giving career/college advice, introducing to a variety of professionals within my organization, etc.). I also didn't get half of the emails about things my student was supposed to be doing. I see from the survey that it seems that there was some intent for a more structured internship experience, but I just got a student plopped into my schedule by my boss. I have not heard of most of the outreach programs that this survey indicates I should tell

my student about. If this is not the intended experience, you need to do some serious rethinking about how to get word to mentors. (SEAP Mentor)

In another open-ended questionnaire item, mentors were asked to identify the three most important strengths of SEAP. The 34 mentors who responded cited a wide variety of strengths. The most frequently mentioned SEAP strengths were the laboratory/hands-on experiences apprentices gain (mentioned in 24 responses) and exposure to real-world research and STEM topics (mentioned in 15 responses). Other responses included the opportunity for apprentices to network (mentioned in 9 responses), the opportunity for apprentices to develop workplace skills (mentioned in 8 responses), development of the STEM talent pipeline (mentioned in 6 responses), and the opportunity for students to present (mentioned in 5 responses).

Mentors participating in focus groups echoed these themes, citing apprentices' opportunities to apply knowledge, their exposure to research, their opportunity to gain workplace skills, and develop the STEM talent pipeline. Several focus group participants added that besides the value of the program to apprentices, they feel that they benefit from the program. One participant noted that SEAP apprentices can provide a fresh perspective on research and lab practices. Another mentor said "[SEAP] is a blast for me – they keep me on my toes!"

Mentors were also asked in a questionnaire item to suggest three ways in which SEAP could be improved for future participants. The thirty mentors who responded provided a range of improvements including better defining mentor responsibilities and/or providing mentor training (mentioned in 11 responses), streamlining apprentice in-processing (mentioned in 6 responses), improving communication from program coordinators (mentioned in 5 responses), and suggesting that the program length be extended (mentioned in 5 responses).

Mentors participating in focus groups also offered suggestions for program improvements. These included providing resources for apprentice safety equipment and clothing, providing more outreach or marketing for the program, requiring a summative report or project from apprentices, recognition of the time commitment required of mentors to work with SEAP apprentices, providing learning opportunities for students outside of work with mentors (for example, seminars or workshops about conducting literature searches or bioinformatics), and addressing nepotism in apprentice selection.

Mentors in focus groups were also asked to comment on ways that the program might be marketed to underserved populations. While most mentors had little knowledge of current programmatic efforts to reach these populations, mentor responses focused on increasing marketing and outreach efforts. Several participants noted the role of personal connections in student awareness of SEAP and recruitment of applicants. As one mentor said, "Our students found out about the program because someone on the station knew their parents and told them about the program."

Overall, findings from the Actionable Program Evaluation indicate that apprentices in the SEAP program are actively engaged in working independently and collaboratively on research projects and that they are more engaged in STEM practices in SEAP than they typically are in school. Apprentices interact consistently with STEM professionals, have satisfying relationships with their mentors, learn about new STEM topics, and apply STEM to real-life situations. Apprentices also learn about DoD or STEM jobs and careers during their SEAP experiences and there is evidence that mentors engage in a wide range of mentoring activities with apprentices.

Apprentices and mentors expressed high levels of satisfaction with the program. Apprentices suggested ways to broaden their SEAP experiences including providing opportunities to interact with other apprentices and to learn about other apprentices' and researchers' projects and streamlining computer access. Mentors offered suggestions focused on improving the flow of information between the program and participants and providing more mentor support and information.

7 | Outcomes Evaluation

The evaluation of SEAP included measurement of several outcomes relating to AEOP and program objectives, including impacts on apprentices' STEM knowledge and skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes toward research, and knowledge of and interest in participating in additional AEOP opportunities.[8] STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. These competencies are important not only for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of SEAP included students' self-reported gains in STEM competencies and engagement in opportunities intended to develop skills such as collaboration, teamwork, and communication that are considered to be critical STEM skills in the 21st century.

STEM Knowledge and Skills

Apprentices reported gains in STEM knowledge as a result of participating in SEAP (see Table 35). Large majorities (nearly 90% or more) of apprentices indicated that they had experienced some gains or large gains for each item listed. For example, 92% reported at least some gain in their in-depth knowledge of a STEM field, and 93% reported at least some gain in their knowledge of how scientists and engineers work on real problems in STEM. Mentors were also asked about impacts on apprentices' gains in STEM knowledge, and responded favorably as well. Mentors were less likely to report large gains than were apprentices although they were more likely to report some gains in STEM knowledge items.

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[8] The outcomes measured in the evaluation study were informed by the following documents:

Committee on STEM Education. (2013*). Federal Science, Technology, Engineering, and Mathematics (STEM) education 5-year strategic plan: A report from the Committee on STEM Education, National Science and Technology Council.* Washington, DC: The White House, Office of Science and Technology Policy.

National Research Council. (2009). Learning Science in Informal Environments: People, Places, and Pursuits. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* Executive Office of the President.

Report of the Academic Competitiveness Council (ACC). (2007). U.S. Department of Education. Available on the Department's Web site at: http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html.

Table 35. Student Report of Impacts on STEM Knowledge (n=61)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	8.2%	37.7%	54.1%	
	0	5	23	33	**61**
Knowledge of research conducted in a STEM topic or field	0.0%	4.9%	23.0%	72.1%	
	0	3	14	44	**61**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.3%	8.2%	26.2%	62.3%	
	2	5	16	38	**61**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	6.6%	18.0%	75.4%	
	0	4	11	46	**61**
Knowledge of what everyday research work is like in STEM	1.6%	3.3%	19.7%	75.4%	
	1	2	12	46	**61**

STEM Knowledge items were combined into a composite variable[9] to test for differential impacts across subgroups of apprentices. No significant differences by gender or race/ethnicity were found for the STEM Knowledge composite variable.

Apprentices were asked to respond to a question about impacts of SEAP participation on their STEM competencies, or abilities to use STEM practices (see Table 35). Approximately two-thirds or more of apprentices reported at least some gains for all areas listed, with many reporting large gains. For example, 84% reported at least some gains in communicating about their experiments and explanations in different ways, 84% in identifying strengths and limitations of data, and 80% in supporting an explanation for an observation with data from experiments.

Composite scores for gains in STEM Competencies items[10] were calculated to examine whether the SEAP program had differential impacts on subgroups of apprentices. No significant differences by gender or race/ethnicity were found in terms of STEM Competency gains.

[9] The Cronbach's alpha reliability for these 5 items was 0.857.
[10] The STEM Competencies composite for 10 items has a Cronbach's alpha reliability of 0.939.

Table 36. Apprentices Reporting Gains in Their STEM Competencies (n=61)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	8.2% 5	13.1% 8	34.4% 21	44.3% 27	61
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	8.2% 5	14.8% 9	31.1% 19	45.9% 28	61
Considering different interpretations of data when deciding how the data answer a question	1.6% 1	19.7% 12	34.4% 21	44.3% 27	61
Supporting an explanation for an observation with data from experiments	6.6% 4	13.1% 8	21.3% 13	59.0% 36	61
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	4.9% 3	19.7% 12	26.2% 16	49.2% 30	61
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	6.6% 4	16.4% 10	31.1% 19	45.9% 28	61
Defending an argument that conveys how an explanation best describes an observation	18.0% 11	18.0% 11	29.5% 18	34.4% 21	61
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	4.9% 3	11.5% 7	32.8% 20	50.8% 31	61
Integrating information from technical or scientific texts and other media to support your explanation of an observation	14.8% 9	19.7% 12	29.5% 18	36.1% 22	61
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	6.6% 4	9.8% 6	23.0% 14	60.7% 37	61

Apprentices were also asked about the impact of SEAP on their "21st Century Skills" - skills and abilities that are necessary across a wide variety of fields (see Table 37). More than three-quarters of responding apprentices reported at least some gains in each of these skills. For example, 84% of apprentices reported at least some gain in sticking with a task until it is finished, 85% in making changes when things do not go as planned, and 75% in learning to work independently. Mentor reports of apprentice gains in this area were generally similar to those of the apprentices. Items from the survey were used to create a 21st Century Skills composite score.[11] Significant differences did not exist by race/ethnicity. However, there was a significant difference by gender with females reporting higher impact on their 21st Century Skills as a result of SEAP compared to males (effect size is considered medium with d=0.561).[12]

Table 37. Apprentice Report of Impacts on 21st Century Skills (n=61)

	No gain	A little gain	Some gain	Large gain	Response Total
Learning to work independently	6.6%	18.0%	19.7%	55.7%	
	4	11	12	34	**61**
Setting goals and reflecting on performance	6.6%	11.5%	32.8%	49.2%	
	4	7	20	30	**61**
Sticking with a task until it is finished	6.6%	9.8%	26.2%	57.4%	
	4	6	16	35	**61**
Making changes when things do not go as planned	6.6%	8.2%	21.3%	63.9%	
	4	5	13	39	**61**
Working well with people from all backgrounds	9.8%	6.6%	21.3%	62.3%	
	6	4	13	38	**61**
Including others' perspectives when making decisions	13.1%	4.9%	29.5%	52.5%	
	8	3	18	32	**61**
Communicating effectively with others	6.6%	6.6%	18.0%	68.9%	
	4	4	11	42	**61**
Viewing failure as an opportunity to learn	9.8%	11.5%	11.5%	67.2%	
	6	7	7	41	**61**

[11] The 21st Century Skills composite for 8 items has a Cronbach's alpha reliability of 0.935.
[12] Independent Samples *t*-test for 21st Century Skills by gender; $t(54)=2.06$, $p=.044$

STEM Identity and Confidence

STEM knowledge and skills are key factors in increasing the likelihood that apprentices will pursue STEM further in their education and/or careers. However, apprentices are unlikely to do so if they do not see themselves as capable of succeeding in STEM.[13] As such, apprentices were asked about SEAP's impact on their STEM identities. Responses to these items (see Table 38) suggest that SEAP positively impacted apprentices' STEM identities. Large majorities of apprentices reported at least some gains in areas such as their desire to build relationships with mentors who work in STEM (94%) and sense of accomplishing something in STEM (89%). Few apprentices reported no gain in any areas of STEM identity. No differences between gender and race/ethnicity were found on a composite variable created from the STEM Identity items.[14]

Table 38. Apprentice Report of Impacts on STEM Identity (n=61)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	6.6%	18.0%	29.5%	45.9%	
	4	11	18	28	**61**
Deciding on a path to pursue a STEM career	6.6%	16.4%	39.3%	37.7%	
	4	10	24	23	**61**
Sense of accomplishing something in STEM	0.0%	11.5%	26.2%	62.3%	
	0	7	16	38	**61**
Feeling prepared for more challenging STEM activities	3.3%	11.5%	26.2%	59.0%	
	2	7	16	36	**61**
Confidence to try out new ideas or procedures on my own in a STEM project	8.2%	18.0%	21.3%	52.5%	
	5	11	13	32	**61**
Patience for the slow pace of STEM research	6.6%	9.8%	31.1%	52.5%	
	4	6	19	32	**61**
Desire to build relationships with mentors who work in STEM	4.9%	1.6%	24.6%	68.9%	
	3	1	15	42	**61**
Connecting a STEM topic or field to my personal values	6.6%	13.1%	31.1%	49.2%	
	4	8	19	30	**61**

Interest and Future Engagement in STEM

[13] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.
[14] The Cronbach's alpha reliability for these 8 STEM Identity items was 0.911.

A key goal of the AEOP program is to develop a STEM-literate citizenry. To do this, participants need to be engaged both in and out of school with high quality STEM activities. In order to examine the impact of SEAP on apprentice interest in future engagement in STEM, apprentices were asked whether the likelihood of their engaging in various STEM activities changed as a result of their SEAP experiences (see Table 39). Apprentices indicated they were more likely to engage in many of these activities after participating in SEAP. For example, 74% reported being more likely or much more likely to work on a STEM project or experiment in a university or professional setting; 74% to talk with friends or family about STEM; and 71% take an elective (not required) STEM class. A composite score was created from these items,[15] and compared by gender and race/ethnicity; no significant differences were found.

Table 39. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=61)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	1.6%	4.9%	44.3%	36.1%	13.1%	
	1	3	27	22	8	**61**
Tinker (play) with a mechanical or electrical device	0.0%	1.6%	49.2%	36.1%	13.1%	
	0	1	30	22	8	**61**
Work on solving mathematical or scientific puzzles	0.0%	1.6%	47.5%	27.9%	23.0%	
	0	1	29	17	14	**61**
Use a computer to design or program something	3.3%	3.3%	50.8%	23.0%	19.7%	
	2	2	31	14	12	**61**
Talk with friends or family about STEM	0.0%	0.0%	26.2%	27.9%	45.9%	
	0	0	16	17	28	**61**
Mentor or teach other students about STEM	0.0%	3.3%	26.2%	39.3%	31.1%	
	0	2	16	24	19	**61**
Help with a community service project related to STEM	0.0%	0.0%	31.1%	41.0%	27.9%	
	0	0	19	25	17	**61**
Participate in a STEM camp, club, or competition	0.0%	0.0%	31.1%	36.1%	32.8%	
	0	0	19	22	20	**61**
Take an elective (not required) STEM class	0.0%	0.0%	29.5%	27.9%	42.6%	
	0	0	18	17	26	**61**
	0.0%	3.3%	23.0%	27.9%	45.9%	

[15] These 10 items about Likeliness to Engage in STEM Activities had a Cronbach's alpha reliability of 0.911.

Work on a STEM project or experiment in a university or professional setting	0	2	14	17	28	**61**

Keeping students engaged across the portfolio of AEOP initiatives is another key AEOP goal. As such, students were asked about their interest in participating in future AEOPs (see Table 40). Over half of respondents indicated being at least somewhat interested in participating in programs, such as 4 few students indicated having no interest in participating in AEOPs in the future, although nearly a third or more of respondents had not heard of CQL (31%), URAP, (36%), and the NDSEG Fellowship (41%).

Table 40. Student Interest in Future AEOP Programs (n=61)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
College Qualified Leaders (CQL)	31.1%	3.3%	13.1%	8.2%	44.3%	
	19	2	8	5	27	**61**
Undergraduate Research Apprenticeship Program (URAP)	36.1%	3.3%	14.8%	11.5%	34.4%	
	22	2	9	7	21	**61**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	29.5%	4.9%	8.2%	13.1%	44.3%	
	18	3	5	8	27	**61**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	41.0%	11.5%	11.5%	3.3%	32.8%	
	25	7	7	2	20	**61**
GEMS Near Peer Mentor Program	14.8%	16.4%	18.0%	19.7%	31.1%	
	9	10	11	12	19	**61**

In order to understand what resources are most effective in providing information about AEOPs, apprentices were asked to identify the resources that impacted their awareness of the various AEOPs (see Table 41). Responses indicate that participating in SEAP was most likely to impact apprentice awareness, with 75% of apprentices indicating that this impacted their awareness at least somewhat. Mentors were also identified by over half of apprentices (62%) as having had at least some impact on their awareness of AEOPs. About half of apprentices (51%) reported that presentations or information shared through SEAP were useful in promoting awareness of AEOPs. On the other hand, the majority of apprentices indicated that they had not experienced AEOP resources including AEOP on social media (79%) and the AEOP brochure (61%).

Table 41. Impact of Resources on Student Awareness of AEOPs (n=61)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	27.9%	3.3%	19.7%	18.0%	31.1%	
	17	2	12	11	19	**61**
AEOP on Facebook, Twitter or other social media	78.7%	11.5%	3.3%	1.6%	4.9%	
	48	7	2	1	3	**61**
AEOP brochure	60.7%	4.9%	13.1%	13.1%	8.2%	
	37	3	8	8	5	**61**
My Apprenticeship Mentor	11.5%	6.6%	19.7%	14.8%	47.5%	
	7	4	12	9	29	**61**
Presentations or information shared through the Apprenticeship Program	21.3%	8.2%	19.7%	21.3%	29.5%	
	13	5	12	13	18	**61**
Participation in the Apprenticeship Program	13.1%	0.0%	11.5%	13.1%	62.3%	
	8	0	7	8	38	**61**

Attitudes toward Research

Apprentices' attitudes about the importance of DoD research are an important prerequisite to their continued interest in the field and potential involvement in future DoD research. In order to gauge attitudes in this area, apprentices were asked about their opinions of what DoD researchers do and the value of DoD research more broadly (see Table 42). Apprentice perceptions of DoD researchers and research were very positive. More than 90% of apprentices reporting indicated that they agreed or strongly agreed with statements such as DoD researchers advance science and engineering fields and DoD research is valuable to society.

Table 42. Student Opinions about DoD Researchers and Research (n=61)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.6%	0.0%	6.6%	14.8%	77.0%	
	1	0	4	9	47	**61**
DoD researchers develop new, cutting edge technologies	1.6%	0.0%	6.6%	31.1%	60.7%	
	1	0	4	19	37	**61**
DoD researchers solve real-world problems	1.6%	0.0%	3.3%	19.7%	75.4%	
	1	0	2	12	46	**61**
DoD research is valuable to society	1.6%	0.0%	0.0%	21.3%	77.0%	
	1	0	0	13	47	**61**

Education and Career Aspirations

SEAP apprentices were asked about their educational aspirations after participating in the program (see Table 43). All apprentices indicated they would, at a minimum, finish college (get a Bachelor's degree). More than three-quarter of apprentices reported they aspired to get a master's degree or higher (82%). More than half of apprentices (59%) indicated they intend to obtain a terminal level degree (e.g., PhD, MD, other professional degree).

Table 43. Apprentice Education Aspirations After SEAP (n=61)

Choice	Response Percent	Response Total
Go to a trade or vocational school	0.0%	0
Go to college for a little while	0.0%	0
Finish college (get a Bachelor's degree)	8.2%	5
Get more education after college	9.8%	6
Get a master's degree	23.0%	14
Get a Ph.D.	29.5%	18
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	16.4%	10
Get a combined M.D. / Ph.D.	9.8%	6
Get another professional degree (law, business, etc.)	3.3%	2

Overall Impact

Apprentices reported on the impacts of participating in SEAP more broadly and indicated SEAP had substantial overall impacts on them (see Table 44). More than two-thirds of apprentices agreed that SEAP contributed to all their growth in each item listed. Large majorities of apprentices credited SEAP with increasing their confidence in their STEM knowledge, skills, and abilities (93%), their greater appreciation for army or DoD STEM research (93%), their increased awareness of Army or DoD STEM research and careers (89%), and an increased interested in participating in other AEOPs (85%). These items were combined into a composite variable[16] to test for differences by gender and race/ethnicity. Again, no differences by subgroups were found.

Table 44. Apprentice Opinions of SEAP Impacts (n=61)

	Disagree - This did not happen	Disagree - This happened but not because of SEAP	Agree - SEAP contributed	Agree - SEAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	6.6%	55.7%	37.7%	
	0	4	34	23	**61**
I am more interested in participating in STEM activities outside of school requirements	3.3%	19.7%	52.5%	24.6%	
	2	12	32	15	**61**
I am more aware of other AEOPs	16.4%	4.9%	37.7%	41.0%	
	10	3	23	25	**61**
I am more interested in participating in other AEOPs	8.2%	6.6%	37.7%	47.5%	
	5	4	23	29	**61**
I am more interested in taking STEM classes in school	6.6%	26.2%	44.3%	23.0%	
	4	16	27	14	**61**
I am more interested in earning a STEM degree	8.2%	24.6%	41.0%	26.2%	
	5	15	25	16	**61**

[16] The Cronbach's alpha reliability for these 10 Overall Impact items was 0.911.

I am more interested in pursuing a career in STEM	6.6%	24.6%	42.6%	26.2%	
	4	15	26	16	**61**
I am more aware of Army or DoD STEM research and careers	3.3%	8.2%	36.1%	52.5%	
	2	5	22	32	**61**
I have a greater appreciation of Army or DoD STEM research	3.3%	3.3%	37.7%	55.7%	
	2	2	23	34	**61**
I am more interested in pursuing a STEM career with the Army or DoD	13.1%	11.5%	41.0%	34.4%	
	8	7	25	21	**61**

In summary, SEAP apprentices reported positive outcomes in alignment with SEAP and AEOP objectives. SEAP apprentices experienced growth in their STEM knowledge and skills and in their 21st century skills as a result of their SEAP experiences. Apprentices had positive opinions about DoD research and researchers, and most expressed a desire to continue their education beyond a bachelor's degree after participating in SEAP. Apprentices reported increased interest in engaging in STEM activities in the future including an increased interest in participating in other AEOPs.

8 | Findings and Recommendations

Summary of Findings

The FY17 evaluation of SEAP collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP's and SEAP's objectives and intended outcomes. A summary of findings is provided in Table 45.

2017 SEAP Evaluation Findings	
Participant Profiles	
SEAP enrollment and participation of apprentices from historically underserved populations remained relatively constant at FY16 levels. The number of SEAP mentors declined slightly in FY17.	There was a 20% increase in SEAP applications received in FY17 (852). However, the number of apprentices enrolled remained at FY16 levels (113) due to the limited number of mentors available. The number of SEAP mentors decreased slightly from 128 in FY16 to 119 in FY17 (8%).
	SEAP continued to serve students from groups underserved in STEM. As in FY16, slightly over half of apprentices were female (54% in FY17 compared to 55% in FY16). The proportion Black or African American apprentices dropped slightly to 17% (compared to 19% in FY16), as did the proportion of Hispanic or Latino apprentices (3% in FY17 compared to 5% in FY16).
SEAP continued to have limited success in recruiting students from other AEOPs.	As in FY16, just over a third of students (36% in FY17 compared to 35% in FY16) had participated in GEMS in the past. Another 13% of students reported participating in Camp Invention. No students had participated in JSHS, however, and 40% had never participated in another AEOP.
Actionable Program Evaluation	
SEAP apprentices continued to learn about AEOP most frequently through personal connections.	Personal connections were primary means of information for most apprentices, with the most frequently reported sources of information being a family member (43%), someone who works for the DoD (34%), and a friend (30%).
	Mentors who were aware of how apprentices were recruited most often cited personal and professional connections as apprentice recruitment strategies. The two recruitment sources most frequently chosen by mentors were personal acquaintance(s) (31%) and colleague(s) in their workplace (23%).
SEAP apprentices were motivated to participate in the program by a variety of factors.	A range of factors motivated apprentices to participate in SEAP. Nearly all responding apprentices identified interest in STEM as a motivator (99%), and a large majority (78%-82%) identified a desire to learn something new or interesting, learning in ways that are not possible in school, the desire to expand laboratory or research skills, the opportunity to use advanced laboratory technology, and figuring out education or career goals as motivators.

SEAP exposes apprentices to STEM jobs and careers, both in general and within the DoD.	Large majorities of students had learned about at least one STEM job or career (93%) and about at least one DoD STEM job or career (87%). Over half of apprentices had learned about 5 or more STEM jobs or careers (56%) and about 5 or more DoD STEM jobs or careers (55%).
	Apprentices cited their participation in SEAP (71% reported this as "very much" impactful) and their mentors (64% reported this as "very much" impactful) as the most impactful resources for their awareness of DoD STEM jobs or careers.
SEAP engaged apprentices in STEM activities regularly.	Large majorities of apprentices reported engaging regularly (at least weekly) in STEM activities such as interacting with STEM researchers (97%), working with a STEM researcher or company on a real-world STEM research project (95%), analyzing data or information and drawing conclusions (85%), working collaboratively as part of a team (84%), and identifying questions or problems to investigate (84%).
	Apprentices reported significantly more intensive engagement in STEM in SEAP as compared to their typical school experiences.
Mentors used a variety of mentoring strategies when working with apprentices.	Mentors reported using a variety of teaching and/or mentoring strategies to establish relevance of learning activities, support the diverse needs of their students as learners, to support student collaboration and interpersonal skills, support apprentices' engagement in authentic STEM activities, and to support STEM educational and career pathways.
	The most commonly used mentoring strategies included becoming familiar with students' backgrounds at the beginning of the SEAP experience (97%), giving students real-life problems to investigate (94%), having students listen to the ideas of others with an open mind (94%), supervising students while they practiced STEM skills (94%), and allowing students to work independently (94%).
SEAP apprentices expressed interest in participating in AEOPs in the future, however mentors provided only limited information about AEOPs.	Over three-quarters of apprentices reported being more aware of AEOPs (79%) and more interested in participating in them in the future (85%) after participating in SEAP. Over half of respondents indicated being at least somewhat interested in participating in programs such as CQL (53%), the SMART Scholarship (57%), and the GEMS Near Peer Mentor program (51%). Nearly a third or more of respondents (31%-41%) had not heard of CQL, URAP, and the NDSEG Fellowship.
	Participation in SEAP and their mentors were cited by apprentices as the most important sources of information about AEOPs (75% reported this was at least somewhat impactful), however two-thirds of mentors reported that they did not recommend AEOPs to students that aligned with students' goals. In spite of this, more than a quarter of mentors reported discussing CQL (40%) and the SMART scholarship (26%) with students.
	More than half of mentors (69%) reported that the SEAP program administrator or site coordinator was a somewhat or very much useful resource in efforts to inform students about AEOPs, however most had not experienced AEOP resources such as the AEOP website (60%), AEOP on social media (74%), the AEOP brochure (71%), and invited speakers or career events (57%).

Apprentices expressed high levels of satisfaction with SEAP program features, citing various program benefits and providing suggestions for improvements.	A large majority of apprentices were satisfied with all SEAP features about which they were asked. For example, more than 90% of apprentices were at least somewhat satisfied with SEAP features such as the teaching or mentoring provided during SEAP activities (95%), the stipend amount (93%), the timeliness of payment of stipends (93%), and the physical location of SEAP activities (93%).
	Large majorities of apprentices were satisfied with all aspects of the research experience such as their relationship with their mentors, the amount of time they spent doing meaningful research, and the research experience overall. More than 85% of responding apprentices indicated being somewhat or very much satisfied with each aspect of their research experience.
	Students were most likely to cite gains in their STEM knowledge or skills, opportunities for hands-on experiences, career information, and the opportunity to develop workplace skills as benefits of SEAP.
	About a fifth of apprentices expressed dissatisfaction with administrative tasks associated with SEAP such as security clearances and issuance of CAC cards. Apprentices suggested improvements to the program including providing more opportunities for apprentices to interact with one another, providing opportunities to learn about other research projects and other departments, and improving the information mentors provided to apprentices.
Mentors expressed high levels of satisfaction with SEAP program features, citing various program strengths and providing suggestions for improvements.	Most mentors were at least somewhat satisfied with the SEAP features they had experienced. Approximately 70% of mentors were at least somewhat satisfied with the research abstract preparation requirements, the research presentation process, and communicating with SEAP organizers. Most mentors reported not having experienced communication with AAS (77%), stipend payment timeliness (69%), or stipend amount (57%).
	Mentors cited a variety of strengths of SEAP including apprentices' opportunities for laboratory/hands-on experiences, exposure to real-world research and STEM topics, networking, and the opportunity to build the STEM talent pipeline.
	Mentors suggested various program improvements including better defining mentor responsibilities and/or providing mentor training, streamlining apprentice in-processing and computer access, and improving communication from program coordinators.

Outcomes Evaluation	
SEAP apprentices reported gains in STEM knowledge and STEM competencies.	Nearly all apprentices reported some level of gains in their STEM knowledge. Large majorities (nearly 90% or more) of apprentices indicated that they had experienced some gains or large gains for each area of STEM knowledge. For example, 92% reported at least some gain in their in-depth knowledge of a STEM field, and 93% reported at least some gain in their knowledge of how scientists and engineers work on real problems in STEM.
	A large majority of apprentices reported some level of gains in a variety of STEM competencies. Approximately two-thirds or more of apprentices reported at least some gains for all STEM competencies, with many reporting large gains. For example, 84% reported at least some gains in communicating about their experiments and explanations in different ways, 84% in identifying strengths and limitations of data, and 80% in supporting an explanation for an observation with data from experiments.
SEAP participants reported gains in 21st Century Skills.	More than three-quarters of responding apprentices reported at least some gains in each of the 21st Century Skills. For example, 84% of apprentices reported at least some gain in sticking with a task until it is finished, 85% in making changes when things do not go as planned, and 75% in learning to work independently.
SEAP apprentices reported gains in their STEM identities and confidence.	Large majorities of apprentices reported at least some gains in areas of STEM identity such as their desire to build relationships with mentors who work in STEM (94%) and sense of accomplishing something in STEM (89%). Few apprentices reported no gain in any areas of STEM identity. Nearly all apprentices (93%) reported increased confidence in their STEM knowledge, skills, and abilities as a result of their SEAP experiences.
SEAP participants reported increased interest in future STEM activities.	Apprentices reported that after participating in SEAP they were more likely to engage in STEM activities outside of school. For example, 74% reported being more likely or much more likely to work on a STEM project or experiment in a university or professional setting; 74% to talk with friends or family about STEM; and 71% take an elective (not required) STEM class.
SEAP apprentices had positive opinions about DoD Research and Researchers.	A large majority of apprentices reported that they believe that DoD researchers advance science and engineering fields (92%) and DoD research is valuable to society (98%).
	Nearly all apprentices (93%) reported having a greater appreciation of Army or DoD STEM research after participating in SEAP and 69% were more interested in pursuing a STEM career with the Army and DoD as a result of their SEAP experiences.

Responsiveness to FY16 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY16 to programs and summarize efforts and outcomes reflected in the FY17 APR toward these areas.

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

FY16 Finding: The AEOP goal of attracting students from groups historically underserved in STEM continues to be met with limited success in SEAP. Many apprentices reported learning about SEAP through personal connections, suggesting that marketing efforts may have limited effectiveness. Since the lack of growth in SEAP apprentices from groups historically underserved groups is influenced by various factors including the recruitment and selection process and the marketing of SEAP to target groups, it is recommended that AAS review these processes and identify ways to ensure that SEAP information reaches these students and that the apprentice selection process is not unduly influenced by personal connections. The AAS may also wish to consider mentor's suggestions that targeting funding specifically to provide outreach and logistical support (for example bus passes) for students from underserved groups may support these students' participation in SEAP. In sum, the program should consider additional/alternate means of broadening the pool of applicants and consider devising strategies/suggestions to offer Army personnel for recruiting and selecting apprentices to ensure that SEAP includes diverse groups of highly talented participants.

SEAP FY17 Efforts and Outcomes: Monthly marketing efforts were targeted to high schools located within a two-hour radius of each lab. This effort increased SEAP applications and increased students who attend Title I schools from 17% in FY16 to 26% in FY17. However, student participation for this population continues to be a challenge in DoD laboratories.

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

FY16 Finding: There is a continued need for SEAP to grow the number of participating mentors in the program. There is a substantial unmet need in terms of mentor capacity with only 113 students (16% of applicants) being placed out of 690 applicants. Program expansion will require active recruitment of additional Army S&Es to serve as mentors. Mentor suggestions to this end include providing more outreach to Army S&Es about the program and providing overhead hour pay to mentors. The AAS may wish to investigate the procedures and resources used to recruit SEAP mentors and identify factors that motivate and discourage Army S&Es from assuming this role.

SEAP FY17 Efforts & Outcomes: FY17 saw an even greater applicant interest in the program. The "line of sight" and funding continues to be an issue for the labs. To address the time delay in getting CAC cards, AAS opened the application two months early. This gave more time for selections and necessary paperwork to be completed earlier.

FY16 Finding: Apprentices and mentors reported that students lacked computer access for long periods of time during their apprenticeships. This lack of access to technology may interfere with apprentices' work and learning experiences and is likely to limit their involvement in research activities. The AAS should work with SEAP site coordinators to identify ways to expedite computer access for students.

SEAP FY17 Efforts and Outcomes: None noted in APR.

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

FY16 Finding: Some features of SEAP program administration continues to be a concern. Student dissatisfaction with timeliness of stipend payments continues to be an issue as do the computer access issues referenced above. The AAS should be mindful of these issues and leverage its past experience with administering apprenticeship programs to streamline processes. It is recommended that AAS work with SEAP site coordinators to identify ways to expedite computer access for students and ensure timeliness of stipend payments.

SEAP FY17 Efforts and Outcomes: In FY17, AAS and Battelle collaborated to develop a streamlined stipend funding process which has worked well. There were few delays in stipend payments and students expressed satisfaction with the timeliness of payments.

FY16 Finding: Marketing of SEAP and dissemination of information about AEOPs is an area with continued room for growth within the SEAP program. Although apprentices identify mentors as a key source of information about AEOPs, few mentors or apprentices reported being familiar with most AEOPs for which students currently are or will soon be eligible. This suggests that the program may benefit from targeting AEOP information to mentors as well as apprentices. In order to meet the AEOP objective of creating a robust pipeline of AEOP programs in which students' progress from other AEOPs into SEAP and from SEAP into CQL and other programs, the program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. In particular, SEAP administrators may wish to target GEMS alumni to participate in SEAP, devising ways to disseminate SEAP information to GEMS participants and alumni. Given the limited apprentice awareness of resources such as the AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with targeted program information.

SEAP FY17 Efforts and Outcomes: In FY17 special effort was made to market the apprenticeships to alumni of GEMS, UNITE, REAP, HSAP, and JSHS. This outreach and marketing effort resulted in a greater number of applications to all the apprenticeships.

FY16 Finding: The SEAP program's participation in the overall AEOP evaluation continues to be lower than desired. The continued low response rates for both apprentice and mentor questionnaires (36% and 6% in FY16) continue to be a challenge which may be attributed to the schedule for apprenticeships compared to the annual AEOP reporting schedule. It is notable that FY16 participation rates represent a substantial decrease from FY15 rates when response rates were 50% for apprentices and 21% for mentors. It is recommended that SEAP/AAS continue to emphasize the importance of these evaluations with individual program sites and communicating expectations for evaluation activities to take place on-site during the program. The evaluation team will work with AAS to administer the survey to more apprentices and earlier in their experience if necessary.

SEAP FY17 Efforts and Outcomes: Weekly communication with Lab coordinators, mentors and students has been done regarding the completion of the evaluation. Mentors are not motivated to complete the survey because it offers no useful feedback such as, specific ways to improve interaction between mentor and student and organization at the lab, according to discussions held with lab coordinators.

Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that FY17 was a successful year overall for the SEAP program. There continues to be increased interest in SEAP, noted by 20% growth in applicants for FY17. Notable successes for the year include high levels of mentor and apprentice satisfaction with program features; evidence of strong apprentice gains in STEM knowledge, skills, and competencies; and apprentice interest in participating in AEOPs in the future. Apprentices and mentors continue to report high levels of satisfaction with mentor-apprentice relationships, and both groups likewise report strong apprentice gains in 21st Century skills. While these successes 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

The AEOP goal of attracting students from groups historically underserved in STEM continues to be met with limited success in SEAP. As in FY16, many apprentices report learning about SEAP through personal connections, suggesting that marketing efforts may have limited effectiveness and may not be widely reaching outside of laboratory connections. Participation of underserved groups decreased somewhat in FY17. There was a 2% decrease (17% compared to 19%) in Black or African-American apprentices and similarly, Hispanic or Latino participation also decreased 2% (3% compared to 5%). In sum, the program should consider additional/alternate means of broadening the pool of applicants and consider devising

strategies for recruiting and selecting apprentices to ensure that SEAP includes diverse groups of highly talented participants.

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

As in FY16, there is a continued need for SEAP to grow the number of participating mentors in the program. There was an 8% decrease in the number of mentors for SEAP in FY17 with a 20% increase in applicants, resulting in a substantial unmet need in terms of mentor capacity with only 113 students (16% of applicants) being placed out of 852 applicants. Program expansion will require active recruitment of additional Army S&Es to serve as mentors. It is recommended that AAS investigate the procedures and resources used to recruit SEAP mentors and identify factors that motivate and discourage Army S&Es from assuming this role.

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

1. Both apprentices and mentors reported lack of information regarding other AEOPs being conveyed in SEAP in FY17. Two-thirds (66%) of mentors reported they did not discuss other AEOPs to apprentices. More than 33% of apprentices had not heard of CQL, URAP, and the NDSEG Fellowship. SEAP should work to invest efforts in FY18 to address this communication and marketing issue. It is critical that participants are informed of other opportunities available to them in the AEOP pipeline.

2. Apprentice participation in the SEAP evaluation improved in FY17 to 54%. However, mentor participation should be increased in FY18 to reach a level of at least 40% participation (compared to 29% in FY16).