Army Educational Outreach Program

Science & Engineering Apprenticeship Program

2013 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

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Executive Summary

The Science & Engineering Apprenticeship Program (SEAP), managed by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) that matches talented high school students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentice 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 laboratory and mentor and upon graduation from high school participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue their relationship with the laboratory. Through their SEAP experience, apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM. SEAP apprentices learn how their research can benefit the Army as well as the civilian community.

In 2013, SEAP provided outreach to 101 apprentices and their mentors at 11 Army laboratory sites (herein called SEAP sites). This is a decline of 34% from the 154 apprentices in 2012. In 2013, 814 students submitted applications to the program, up 2% from 796 student applicants in 2012.

This report documents the evaluation of the 2013 SEAP program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for SEAP included: in-person focus groups with apprentices and mentors at 4 SEAP sites and online post-program questionnaires distributed to all apprentices and mentors.

Table 1. 2013 SEAP Fast Facts	
Major Participant Group	High School Students
Participating Students	101
Represented K-12 Schools	59 (5 'Title 1' Schools)
Participating Army S&Es	101
Participating Army Agencies	11
Total Administrative Cost	$66,644
Total Stipends	$250,888
Cost Per Student Participant	$3,144

Summary of Findings

The 2013 evaluation of SEAP collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 2.

Table 2. 2013 SEAP Evaluation Findings	
Participant Profiles	
Low participation of SEAP apprentices and mentors in evaluation assessments limit the reliability of findings.	• Statistical reliabilities achieved for questionnaire samples (±11.7% margin of error for apprentices, ±23.5% margin of error for mentors) suggest limited representativeness of samples. However, alternate methods for establishing representativeness suggest we may sufficiently generalize findings from the apprentice questionnaire respondents to the apprentice population.
	• Findings from mentor questionnaires should be cautiously generalized with consideration given to the calculated margins of error and with triangulation of findings with other data.
SEAP had some success in providing outreach to participants from historically underrepresented and underserved populations.	• Apprentices included female students (30%)—a population that is historically underrepresented in some STEM fields.
	• Apprentices included students who identified as Black or African American (3%) or Hispanic or Latino (3%)—these populations are among those historically considered underserved and underrepresented in STEM education.
	• While apprentices attended schools in urban (10%) and rural (13%) settings, no apprentices reported qualifying for free or reduced lunch at school, a common indicator of low-income status.
	• Mentors identified as predominantly male (67%) and White or Caucasian (67%). Less than 10% identified as Black or African American (3%) and Hispanic or Latino (3%).
SEAP apprentices intend to pursue post-secondary education in STEM.	• 97% of apprentices planned to pursue a degree in a STEM field (10% Bachelors, 31% Masters, and 56% Doctorate)
	• Large proportions of apprentices planned to pursue engineering (39%) and medicine/health-related fields (26%). Apprentices also intended to pursue math/computer science (16%), chemistry (11%), physical science (3%) and life science (3%).
Actionable Program Evaluation	
SEAP marketing and recruitment was largely a site-based endeavor.	• SEAP sites market SEAP to local schools and universities, to local educators, and to participants of their GEMS programs.
	• Apprentices most frequently reported learning about SEAP through family, family friends, or school staff with connections to the SEAP mentor and/or Army research facility. 30% of apprentices reported having a family member or family friend at the Army research facility where the SEAP apprenticeship took place.
	• Apprentices who identified as GEMS alumni reported learning about SEAP through GEMS activities and staff.
	• Many mentors reported selecting apprentices that had been "vetted" by a personal or professional connection of the mentor.
SEAP apprentices seek opportunities to clarify and advance their STEM pathways.	• Apprentices were motivated to participate in SEAP by encouragement they received from others who have connections to the SEAP program, by their own positive experiences in GEMS programs, and by opportunities SEAP could provide to clarify and advance their STEM pathways.
SEAP mentors seek opportunities to engage with STEM learners in their work.	• Mentors were motivated to participate in SEAP because of positive experiences as CQL, SEAP, or GEMS mentors, by opportunities to re-engage former apprentices in the research project, and by opportunities to have project needs met by hosting an apprentice.

SEAP mentors engaged their apprentices in STEM research and provided limited guidance about educational and career pathways during the SEAP apprenticeship.	• Apprentices and mentors reported similar types and frequencies of mentor activities related to engaging apprentices in STEM research. Most frequently they reported training the apprentice to perform laboratory tasks and procedures; providing apprentices with constructive feedback; and efforts to ground the apprentices' laboratory-based work in scientific principles (e.g., assigning readings, teaching sessions, participation in journal club).
	• A large significant difference was found in proportions of apprentices and mentors reporting mentorship around careers (apprentices = 67%, mentors = 100%). Mentor interviewee comments possibly clarify this finding, suggesting that career-related guidance is more frequently provided to CQL apprentices than to SEAP apprentices, or is provided after the apprenticeship through ongoing communication with SEAP apprentices.
SEAP mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers outside of the SEAP site.	• Most mentor interviewees had limited awareness of AEOP initiatives beyond the GEMS, SEAP, and CQL programs running at their Army research facility. Subsequently, mentors did not consistently educate their apprentices or encourage their participation in those AEOP initiatives.
	• Mentors suggested that informational resources, mentor training, and a command-level emphasis on promoting other AEOPS were necessary to accomplish this objective.
	• Mentors reported a variety of strategies for mentoring apprentices about STEM careers, with a strong emphasis on Army/DoD STEM careers.
	• Mentors perceived that furloughs, their own lack of awareness about STEM careers (beyond their own), lack of resources, and apprentice disinterest in STEM or Army STEM careers were challenges to providing career mentorship.
SEAP benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that SEAP benefits apprentices by providing authentic research opportunities not available typical school settings, opportunities to clarify or advance their STEM pathway, and opportunities to develop and expand research skills.
	• Mentors also perceived benefits of SEAP to their laboratories and to themselves. Most notably, mentors indicated that apprentices are low-cost yet highly effective members of the lab, and apprentices have made meaningful contributions to research with near-term impact on Army processes or procedures.
SEAP's administrative processes and support are a possible area for improvement.	• Apprentices and mentors alike perceived challenges with the "cumbersome" and "time-consuming" administrative tasks associated with the SEAP program, suggesting they detract from work that can be accomplished during an already short (and furlough-disrupted) summer apprenticeship. Mentors perceived low organization of and support for these tasks.
Outcomes Evaluation	
SEAP engaged apprentices in authentic STEM activities more frequently than their school environment.	• Apprentices reported that SEAP provides more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (32%-66% in SEAP, 17-39% in school) and hands-on research activities (35%-62% in SEAP, 8%-39% at school).
	• Moderate to large significant differences were found in apprentices perceptions of how frequently they did the following in SEAP as compared to school: used, cared for, and calibrated equipment; employed advanced measurement techniques; defined research questions; and worked as part of a research team.

	• Apprentice and mentor data suggested SEAP had a larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
SEAP apprentices become more confident in STEM, and mentors rate their research skills highly.	• A majority of apprentices (58%-79%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (48%-59%) rated their apprentices at near expert or expert levels of the development continuum across 6 key STEM skills and abilities: information literacy, scientific reasoning, laboratory, data collection, quantitative literacy, and teamwork and collaboration. Most mentors (57%-79%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels.
SEAP apprentices will serve as STEM role models for their peers	• 50-81% of SEAP apprentices intend to serve as a role models by sharing their SEAP experiences with friends, recommending SEAP to friends, encouraging friends to study more STEM, and mentoring younger STEM learners.
SEAP apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Many apprentices (32%-97%) and mentors (13-78%) were unaware of other AEOP initiatives, with higher proportions lacking awareness for programs occurring outside of the Army research facility.
	• SEAP apprentices are interested in participating in other AEOP opportunities: high school STEM competitions (5-21%), high school apprenticeships (36%), college apprenticeships (60%), and college scholarship programs (60%). This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
SEAP apprentices have positive attitudes toward the defense community and a view toward potential government service.	• A majority of apprentices had opportunities to learn about new STEM careers during SEAP as reported by apprentices and mentors (64% apprentices, 53% mentors). Army/DoD STEM careers received substantial attention (69% apprentices, 54% mentors).
	• SEAP served to inspire interest in new STEM careers, with 44% of apprentices expressing new interest in Army/DoD STEM careers in particular. 85% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society.
	• Most apprentices (87%) credited SEAP with improving their understanding Army/DoD STEM contributions. Most mentors (73%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Greater commitment should be made to producing more reliable and valid evaluation of SEAP activities and benefits to participants. The 2013 evaluation provides valuable information regarding how SEAP is perceived by less than half of participants, and begins to provide evidence for how the program has impacted SEAP apprentices. However, the low response rate from both SEAP apprentices and mentors poses the most significant threat to the validity of these findings. In other words, we have limited confidence that these findings of questionnaire respondents are representative of or can be generalized to the full population of participants. Mentors provide an authoritative, albeit subjective, assessment of apprentices' performance (STEM competencies) at the end of the program that is otherwise not possible; future evaluation will further rely on mentors to assess *growth* in apprentices' STEM competencies. Their

participation in SEAP's evaluation is vital. Coordinated efforts should be made by the Army, ASEE managers, and site coordinators to encourage and improve apprentice and mentor participation in the SEAP evaluation efforts. Subsequently, evaluators should endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments to further maximize participation.

2. The number of applications for SEAP apprenticeships (814 applications for 101 funded apprenticeships) is indicative of unmet need. Of particular note, the rate of participation varied from 0% to 35% at SEAP sites having greater than 4 applicants. To the extent allowed by annual budget constraints, SEAP should endeavor to engage more Army S&E mentors, thereby creating more apprenticeship positions to populate. SEAP programming may benefit from a careful examination of and attention to program- and site-level structures, processes, and resources that both enable and discourage Army S&Es' participation in SEAP. Program- and site-level accommodations may be required to further improve Army S&Es' awareness of SEAP, feasibility of their participation, and overall motivation to participate in SEAP. Simultaneous with this effort, ASEE and SEAP sites should consider how to effectively recruit a more demographically diverse mentor pool to provide apprentices with greater access to same-demographic role models and mentors.

3. SEAP and AEOP objectives include expanding participation of historically underrepresented and underserved populations. While ASEE conducts targeted marketing of SEAP to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in determining SEAP apprentices. SEAP may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide, including but not limited to maximizing the recruitment and repeated engagement of female, racial/ethnic minorities, and low- income students in GEMS programming, and subsequent recruitment of those individual GEMS alumni as SEAP apprentices. Guidance may also be provided to ensure other "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and SEAP sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site).

4. Apprentice and mentor data suggested that SEAP apprentices have more opportunities to participate in the hands-on aspects of research and fewer opportunities to participate in the academic (minds-on) aspects of research, including technical writing. Site coordinators and mentors might explore strategies that appropriately and meaningfully expand apprentices' opportunities to engage in all aspects of the research under the tutelage of their mentor, including opportunities to generate research questions, design experiments, analyze and interpret data, formulate conclusions, and contribute to technical writing about the research in which they are engaged. Whether these strategies are mentors modeling such practices for apprentices, scaffolding "thought exercises" to be completed by apprentices, or coaching apprentices through making real contributions in these areas, such efforts will maximize apprentices' professional development as STEM apprentices, better mirror the day to day practices of scientists and engineers, and more closely align with current research and best practices identified for effective STEM learning.

5. ASEE, SEAP sites, and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encouraging continued participation in programs for which apprentices qualify. Evaluation data suggests that SEAP apprentices and mentors were largely unaware of other AEOP initiatives, especially those offered outside of the Army research facilities. Yet, substantial apprentice interest exists in AEOPs. This interest would benefit from more robust attention by site coordinators and mentors during SEAP program activities. Continued guidance by ASEE is needed for educating SEAP site coordinators and mentors about AEOP opportunities, especially beyond the SEAP sites. Adequate resources and guidance for using them with apprentices should be provided to all site coordinators and mentors in order that all apprentices leave SEAP with an idea of their next steps in AEOP, whether at or outside of the Army site.

6. Most apprentices had opportunities to learn about STEM research and careers during SEAP, especially Army/DoD STEM research and careers to which they are exposed daily. However, many mentors reported lack of awareness of STEM careers beyond their own, lack of informational resources, and lack of time for educating apprentices about other STEM careers. We strongly recommend a SEAP- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[1]

7. As reflected in the apprentice respondent profile Table 9 (and footnote 6), the evaluation assessments revealed that a number of college students were supported through SEAP apprenticeships, rather than through CQL apprenticeships that are expressly intended for college students. Support of college students in SEAP programming does not align with the intent or objectives of the program, and may impact other aspects of programming, including discrepancy in program budget versus expenditures due to different pay scales offered to high school and college students, as well as lack of consistency or coherence in the SEAP experiences of apprentices. During the summer 2013 evaluators communicated these findings to ASEE and to the Army, and the development of a standard operating procedure (SOP) has since been initiated. It will be important for ASEE and the Army to closely monitor and support SEAP sites for compliance of the SOP during FY14 programing and beyond.

[1] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

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 them 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.

This report documents the evaluation of one of the AEOP elements, the Science & Engineering Apprentice Program (SEAP). SEAP is managed by the American Society for Engineering Education (ASEE). The evaluation was performed by Virginia Tech, the Lead Organization (LO) in the AEOP CA consortium.

AEOP Goals

Goal 1: STEM Literate Citizenry.

- Broaden, deepen, and diversity 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.

Program Overview

The Science & Engineering Apprenticeship Program (SEAP), managed by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) that matches talented high school students (herein referred to as apprentices) with practicing Army Scientists and Engineers (S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentices 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 laboratory and mentor and upon graduation from high school participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue their relationship with the laboratory. Through their SEAP experience, apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM. SEAP apprentices learn how their research can benefit the Army as well as the civilian community.

In 2013, 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 those students to DoD research and engineering activities and goals in a way that encourages a positive image and supportive attitude toward our defense community;
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.

Apprenticeships were completed at 11 Army research laboratories in 5 states, summarized in Table 3.

Table 3. 2013 SEAP Sites

Laboratory	Command*	Location
US Army Center for Environmental Health Research (USACEHR)	MRMC	Fort Detrick, MD
US Army Medical Research Institute of Chemical Defense (USAMRICD)	MRMC	Aberdeen, MD
US Army Medical Research Institute for Infectious Diseases (USAMRIID)	MRMC	Fort Detrick, MD
US Army Research Institute of Environmental Medicine (USARIEM)	MRMC	Natick, MA
US Army Walter Reed Army Institute of Research (WRAIR)	MRMC	Silver Spring, MD
US Army Edgewood Chemical Biological Center (ECBC)	RDECOM	Edgewood, MD
US Army Aviation & Missile Research Development and Engineering Center-Redstone Arsenal (AMRDEC)	RDECOM	Huntsville, AL
US Army Research Laboratory- Aberdeen Proving Ground (ARL-APG)	RDECOM	Aberdeen, MD
US Army Research Laboratory – Adelphi (ARL-A)	RDECOM	Adelphi, MD
US Army Engineer Research & Development Center-Construction Engineering Research Laboratory (ERDC-CERL)	USACE	Champaign, IL
US Army Engineer Research & Development Center- Vicksburg, MS (ERDC-MS)	USACE	Vicksburg, MS

Commands: "MRMC" is the Medical Research and Materiel Command, "RDECOM" is the Research Development and Engineering Command, and "USACE" is the US Army Corps of Engineers.

In 2013, SEAP provided outreach to 101 apprentices and their mentors at 11 Army laboratory sites (herein called SEAP sites). This is a decline of 34% from the 154 apprentices in 2012. In 2013, 814 students submitted applications to the program, up 2% from 796 student applicants in 2012. Table 4 provides the application (App) and participation (Part) data by SEAP site for 2011-2013.

Table 4. 2011-2013[2] SEAP Participation by Command										
Command	**Lab**	**2011**			**2012**			**2013**		
		# App	**# Part**	**Rate**	**# App**	**# Part**	**Rate**	**# App**	**# Part**	**Rate**
CID	**USACIL**			**%**			**%**	0	0	0%
MRMC	**USAARL**			**%**			**%**	0	0	0%
	ARL-CSID			**%**			**%**	30	0	0%
	USAFMES			**%**			**%**	0	0	0%
	USACEHR			**%**			**%**	4	4	100%
	USAMRICD			**%**			**%**	39	13	33%
	AMRIID			**%**			**%**	45	14	31%
	USARIEM			**%**			**%**	0	0	0%
	USAISR			**%**			**%**	0	0	0%
	WRAIR			**%**			**%**	227	12	5%
RDECOM	**ECBC**			**%**			**%**	40	0	0%
	NVESD			**%**			**%**	52	0	0%
	AMRDEC			**%**			**%**	107	13	12%
	ARL-APG			**%**			**%**	73	19	26%
	ARL-A			**%**			**%**	99	12	12%
	NSRDEC			**%**			**%**	2	2	100%
	ARL-WSMR			**%**			**%**	0	0	0%
ASACE	**ERCD-CERL**			**%**			**%**	29	10	35%
	ERCD-MS			**%**			**%**	1	1	100%
	ERDC-TEC			**%**			**%**	43	2	5%
Lab N/A				**%**			**%**	23	0	0%
Total				**%**	**796**	**154**	**19%**	**814**	**102[3]**	**13%**

[2] 2011 and 2012 are unavailable at the time of this report. This data collection effort is underway, directed by Army Cooperative Agreement Managers. These data will be included in an amended report that is submitted to the Army, when they become available.

[3] ASEE reported after the writing of this report that one participant included in this figure did not participate. The actual number of participants is 101 as reported elsewhere in the report, but we do not know which of the labs should reflect one less apprentice.

The total cost of 2013 SEAP was approximately $317,531. This cost includes administrative costs of $66,644 (calculated as half of ASEE's expenditures for the administration of SEAP and CQL) and $250,888 for participant stipends. The average cost per 2013 SEAP participant taken across all SEAP sites was $3,144. Table 5 summarizes these expenditures.

Table 5. 2013 SEAP Costs	
2013 SEAP - Cost Per Participant	
Total Participants	101
Total Program Cost	$66,644
Cost Per Participant	**$3,144**
2013 SEAP - Cost Breakdown	
Administrative Cost	$66,644
Participant Stipends	$250,888
Total Program Cost	**$317,531**

Evidence Based Program Change

ASEE's efforts primarily focused on tasks associated with transitioning the SEAP program administration from George Washington University to ASEE, including:

1. collaborating with SEAP site coordinators for program promotion, applicant selection, applicant security/access approval, payment of stipends, and administration of evaluation assessments;
2. marketing to high schools in areas surrounding participating Army laboratories; and
3. cross-promotion of the Army SEAP program to applicants of the Navy SEAP program, also managed by ASEE.

The 2013 evaluation assessed recommendations of the 2012 evaluation and included other changes that were made to assessments AEOP-wide, including:

1. Focus groups conducted with apprentices and mentors at 4 SEAP sites;
2. Enhanced Actionable Program Evaluation, including participants perceptions of:
    - Marketing and recruitment to the SEAP program;
    - Motivation to participate in SEAP;
    - Satisfaction with SEAP activities;
    - Benefits of SEAP; and
    - Suggestions for improvement to SEAP.
3. Baseline data collection from mentors on current activities, challenges, and additional support needed related to
    - Educating apprentices about AEOP opportunities; and
    - Educating apprentices about AEOP opportunities STEM jobs and careers, and specifically those within the Army or DoD sectors.

2013 Evaluation At-A-Glance

Virginia Tech, in collaboration with ASEE, conducted a comprehensive evaluation study 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)
• Army sponsorship • ASEE providing oversight of site programming • Operations conducted by 12 Army labs • 101 Students participating in SEAP apprenticeships • 101 Army S&Es serving as SEAP mentors • Stipends for students to support meals and travel • Centralized branding and comprehensive marketing • Centralized evaluation	• Students engage in authentic STEM research experiences through hands-on summer apprenticeships at Army labs • Army S&Es supervise and mentor students' research	• Number and diversity of student participants engaged in SEAP • Number and diversity of Army S&Es engaged in SEAP • Number and Title 1 status of high schools served through student engagement • Students, Army S&Es, site coordinators, and ASEE contributing to evaluation	• Increased student STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased student interest in future STEM engagement • Increased students awareness of and interest in other AEOP opportunities • Increased student awareness of and interest in STEM research and careers • Increased student awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve SEAP programs	• Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased student pursuit of STEM coursework in secondary and post-secondary schooling • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of SEAP

The SEAP evaluation 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 onsite focus groups with apprentices and mentors at 4 SEAP sites, a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubrics.

Tables 6 and 7 outline the information collected in apprentice and mentor assessments that are relevant to this evaluation report.

Table 6. 2013 Apprentice Assessments	
Category	**Description**
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
Satisfaction & Suggestions	Awareness of SEAP, motivating factors for participation, satisfaction with and suggestions for improving SEAP programs
AEOP Goal 1 Indicators of Program Achievement	**STEM Competencies:** Perceptions of opportunities to engage in STEM activities in SEAP (as compared to at school), self-reported change in confidence in their STEM competencies
	STEM Engagement –Interest in future STEM engagement, including as STEM role models
	Army STEM: AEOP Opportunities –Past participation, exposure to, and interest in participating in other AEOP programs
	Army STEM: Army/DoD STEM Careers –Exposure to STEM and Army/DoD STEM jobs, change in interest for STEM and Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers
AEOP Goal 2 Program Efforts	**Mentor Capacity: Army S&Es—**Apprentices' perceptions of day-to-day mentor activities

Table 7. 2013 Mentor Assessments	
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 Indicators of Program Achievement	**STEM Competencies:** Mentors' assessment of apprentices' STEM competencies after SEAP and final presentation/project
AEOP Goal 1 & 2 Program Efforts	**Army STEM: AEOP Opportunities –** Mentor awareness and efforts to expose apprentices to AEOP opportunities, perceptions of apprentice interest in AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Mentor efforts to expose apprentices to STEM and Army/DoD STEM careers, perceptions of apprentice interest in STEM and Army/DoD STEM research and careers
	Mentor Capacity: Army S&Es—Mentors' perceptions of day-to-day mentor activities

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data is summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the

report narrative, with tables and/or footnotes providing results from tests for significance.[4] Questionnaires and respective data summaries are provided in Appendix B (apprentice) and Appendix C (mentor). Focus group protocols are provided in Appendices D (apprentices) and E (mentors). Major trends in data and analyses are reported herein.

Study Sample

The post-SEAP questionnaires were provided to the 2013 SEAP sites in electronic format using the Qualtrics® survey system hosted by Virginia Tech. A total of 42 apprentices from 9 SEAP sites responded to the apprentice questionnaire. In addition, 15 mentors from 6 SEAP sites responded to the mentor questionnaire and rubrics.

Table 8 provides an analysis of apprentice and mentor participation in post-SEAP questionnaires, including the response rates and statistical reliability achieved with each sample, as given by the margin of error at the 95% confidence level. The margin of error calculated for both apprentices (±11.7%) and mentors (±23.5%) exceed acceptable levels and suggest limited representativeness of the respondent samples to the respective participant populations. However, a comparison of apprentice questionnaire respondents and apprentice participant demographics (obtained from ASEE's registration data) show no statistically significant differences in key demographic characteristics of gender, race or ethnicity, and grade. In addition, apprentice questionnaire respondents represent 82% of the 11 SEAP sites. These alternate methods for establishing representativeness suggest findings from the apprentice questionnaire respondents to the apprentice population may be sufficiently generalizable to the population. Similar demographic information is not available for the mentor participant population with which to make a similar determination of representativeness. Mentors contribute valuable perspective to CQL evaluation but should be cautiously generalized, with consideration given to the margin of error and to triangulation of findings with other data. Participation of apprentices and mentors are critical for establishing reliable evaluation and is a critical area for attention in future SEAP programming.

Table 8. 2013 SEAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[5]
Apprentices	42	104	40%	±11.7%
Mentors	15	104	14%	±23.5%

Focus groups were conducted at 4 SEAP sites in the Eastern, U.S. Mentor focus groups included 20 Army S&E mentors for SEAP and/or CQL (10 females, 10 males). SEAP and CQL mentors were interviewed together (as they often worked with both programs), but herein they will be referred to as SEAP mentors. Apprentice focus groups included 24 apprentices

[4] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

[5] "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, 95% of the time, between 42% (47-5) and 52% (47+5) would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

(12 females, 12 males). Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of questionnaire data.

All data collected contribute to the overall narrative of SEAP's efforts and potential benefit to participants, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Apprentice demographics. Demographic information collected from 2012 and 2013 SEAP apprentice questionnaire respondents are summarized in Table 9.

Table 9. 2012 and 2013 SEAP Apprentice Questionnaire Respondent Demographics

Demographic Category	2012 (n = 51/154)	2013 (n = 40-42/101)	
Gender			
Female	43%	12	30%
Male	46%	28	70%
Choose not to report	10%	0	0%
Race/Ethnicity			
American Indian or Alaskan Native	0%	0	0%
Asian or Other Pacific Islander[6]	18%	14	35%
Black or African American	7%	1	3%
Hispanic or Latino	3%	1	3%
White or Caucasian	41%	21	53%
Other	0%	1	3%
Choose not to report	31%	2	5%
Socioeconomic Indicators (most frequent responses given)			
Public School Type	57%	32	80%
Suburban School Setting	78%	31	78%
Do Not Qualify for Free or Reduced Lunch	88%	36	90%
Grade Level and Age			
Rising Grade 10		5	2%
Rising Grade 11		2	5%
Rising Grade 12		25	60%
Rising College Freshman		11	26%
Rising College Sophomore		0	0%
Rising College Junior[7]		2	5%
Rising College Senior		1	2%
Average Age	17 years	17.1 years	

[6] The 2012 demographic category consisted of Asian-Pacific American, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

[7] While SEAP is intended as a high school, summer apprenticeship program, onsite focus groups and these data revealed that at more than one site GEMS Near Peer Mentors and other college students engaged in summer apprenticeships were funded by the SEAP program.

In 2013 more males (70%) than females (30%) completed the apprentice questionnaire. More respondents identified with race/ethnicity category of White or Caucasian (53%) than any other single race/ethnic category. Respondents included only 3% of apprentices identifying as Black or African and 3% identifying as Hispanic or Latino. Respondents most frequently reported they do not qualify for free or reduced lunch (90%), which is a common indicator of low-income status. Most respondents attended public schools (80%). School settings reported were predominantly suburban settings (78%). The average age of apprentices was 17.1 years old, and most apprentices (67%) had one or more years of high school left.

One objective of SEAP (and all AEOPs) is to involve a larger percentage of students from previously underrepresented and underserved segments of our population, such as women, African Americans, and Hispanics, in pursuing science and engineering careers through participation in Army-sponsored programs. A comparison of 2012 and 2013 data might suggest that progress was not made in 2013 to expand the participation of underserved and underrepresented populations in SEAP. However, the limited statistical reliability of both 2012 and 2013 evaluation data (associated with the low response rates), does not allow for a conclusive determination.

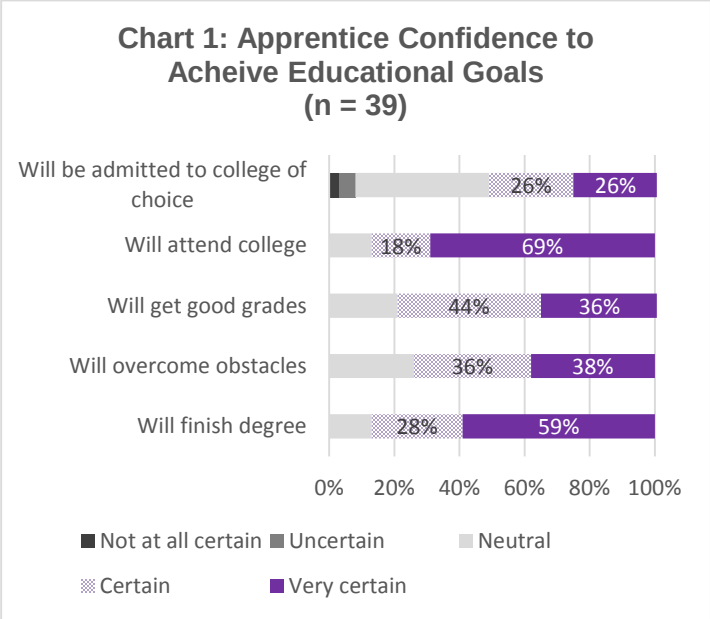
In summary, 2013 evaluation data (and registration data obtained from ASEE) reveal that SEAP had limited success in providing outreach to participants from historically underrepresented and underserved populations. SEAP had limited success engaging female students (30%)—a population that is historically underrepresented in certain STEM fields. SEAP had limited success in providing outreach to students from historically underserved minority race/ethnicity groups (6% of evaluation respondents, 8% of total participants) and low-income groups (0% of evaluation respondents), as determined by free or reduced lunch status. This remains an area for growth for SEAP, one that is partially dependent upon other AEOPs for appropriately preparing students and encouraging them to pursue these more competitive apprenticeships.

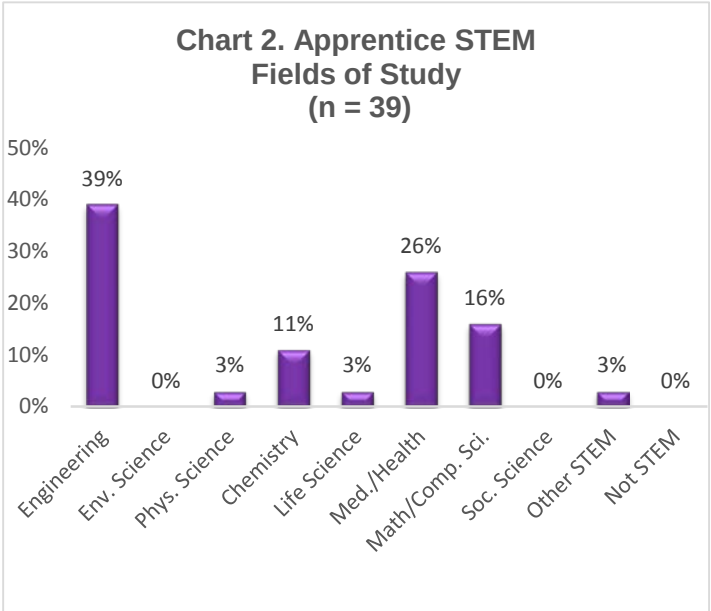
Apprentice education intentions. The apprentice questionnaire included items to elicit apprentices' education goals (highest degree sought), their confidence to achieve these goals, and the STEM field they intend to pursue. When reporting their confidence to achieve their educational goals, apprentices responded on a 6-point scale of 1 = "Not at All Certain" to 6 = "Very Certain." Charts 1 and 2 summarize these data.

All (100% of 39) SEAP apprentices who responded to the item intend to pursue a college degree, with most apprentices (97%) planning to pursue a degree in a STEM field. Most apprentices intended to pursue an advanced degree (31% Master's, 56% Doctorate.) More than 50% of apprentices claimed to be certain or very certain they will achieve educational goals, as summarized in Chart 1. Apprentices were most certain (85%) that they will attain their ultimate education goal—a degree. Apprentices were least certain (52%) they will be admitted to the college and their program of choice. Of the STEM fields of study, apprentices reported most frequently interest in engineering (39%) and medical/health fields (26%).

SEAP apprentices intend to pursue post-secondary education in STEM. However, these items pertaining to apprentices' degree intentions and pursuit of STEM fields do not discern whether SEAP apprentices' educational goals were established prior to participation, or to what extent their SEAP participation in any way affects their pre-SEAP goals. From other

findings within this report, we can surmise that most SEAP apprentices have well-established goals for their STEM pathway and seek out SEAP to advance in their STEM pathway.





Past AEOP experiences. Apprentices were also asked about their past experiences in GEMS, SEAP, and Near Peer programs, which are all intended to provide repeated or long-term engagement in STEM activities at Army labs. Substantial proportions report past participation in GEMS (24%), SEAP (21%), and Near Peer (7%) programs. In addition 10% of SEAP apprentices are currently serving as Near Peer mentors for GEMS. These data potentially provide evidence of the success of site-based cross-promotion and recruiting practices from GEMS.

Mentor demographics. Demographic information collected from 2012 and 2013 SEAP mentor questionnaire respondents are summarized in Table 10.

SEAP mentors were predominantly male (67%) and White/Caucasian (67%). The poor statistical reliability associated with both 2012 and 2013 evaluation data do not allow for conclusive determinations about SEAP's progress in diversifying its mentor pool. However, a comparison of 2013 mentor and apprentice gender and race/ ethnicities reveal similar trends, including higher proportions of males and individuals identifying as White or Caucasian and Asian.

Of 15 mentor questionnaire respondents, only 1% were first-time SEAP mentors. One-third of mentors had mentored for SEAP only once before. The average number of SEAP apprentices mentored through the years was 5, ranging from 1 (the current apprentice) to 20 apprentices. Of the 15 mentors, 20% reported being a SEAP apprentice in the past. The proportions of new and returning mentors and the range in the numbers of apprentices mentored suggests that SEAP's primary mechanism for recruiting Army S&Es is accomplished through repeated engagement of former mentors.

Table 10. 2012 and 2013 SEAP Mentor Questionnaire Respondent Demographics			
Demographic Category	**2012 (n = 42)**	**2013 (n = 15)**	
Gender			
Female	43%	5	33%
Male	46%	10	67%
Choose not to report	10%	0	0%
Race/Ethnicity			
American Indian or Alaskan Native	0%	0	0%
Asian or Other Pacific Islander[8]	18%	2	13%
Black or African American	7%	1	7%
Hispanic or Latino	3%	1	7%
White or Caucasian	41%	10	67%
Other	0%	0	0%
Choose not to report	31%	1	7%
Past Participation			
Worked as a SEAP apprentice		3	20%
SEAP apprentices mentored historically		Avg = 5, Range = 1-20	

As SEAP endeavors to expand the participation of students from underserved and underrepresented populations in its programs, it might contemplate how to effectively expand inclusion of those same populations in its mentor pool, as access to mentors sharing the same gender or race/ethnicity characteristics has been suggested as a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.[9]

[8] The 2012 demographic category consisted only of Asian, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

[9] Limited access to and/or matching with role models and mentors of same gender or race/ethnicity have been suggested as possible factors contributing to the attrition of women and racial/ethnic minorities from STEM; however, research is not definitive regarding the issue of same-demographic mentorship. Recent studies suggest that female and minority mentees may prefer same-demographic role models and mentors (Syed, et al., 2012), that same-demographic matches can provide greater satisfaction with the mentee-mentor experience and fewer match failures (Spencer, 2007), and can provide a range of benefits to mentees including mitigation of stereotypes and higher performance (e.g., due to a reduction of achievement-limiting "stereotype threat") (Aronson & Steele, 2005; Young et al., 2013), positive attitudes and identity toward STEM (Stout, et al., 2011; Young, et al., 2013), and persistence in STEM pathways (Drury, et al., 2011). Other studies have demonstrated that cross-demographic matches can enjoy similar benefits as same-demographic matches under a variety of conditions, including: mentee access to non-stereotypical role models or strong perceptions of similarity with a role model or mentor (Cheryan, et al., 2011); mentee preference for cross-demographic matching (Jucovy, 2002); effective mentee-mentor navigation of cultural issues (Sanchez & Colon, 2005); mentee access to multiple mentors or strong protégé communities (Laursen, et al., 2010). Careful matching around other characteristics (e.g., proximity, shared interests, interpersonal preferences) and mentor training around issues of diversity and cultural sensitivity are encouraged for strengthening cross-demographic matches (Jucovy, 2002). For additional compilations, authoritative reviews, and evidence-based recommendations see also: Burke & Mattis, 2007; DuBois, et al., 2011; Halpern, et al, 2007; Jucovy, 2002; and Rhodes et al, 2002. Aronson, J., & Steele, (2005) Stereotypes and the fragility of human competence, motivation, and self-concept. In C. Dweck & E. Elliot (Eds.) *Handbook of competence and motivation*. New York: Guilford; Burke, R. and Mattis, M (2007) *Women and minorities in science, technology, engineering, and mathematics.* Northampton, MA: Edward Elgar Publishing; Drury, B., Siy, J. and Cheryan, S. (2011) When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry,* 22, 265-269; DuBois, D.L. Portillo, N., Rhodes, J.E., Silverthorn, N. & Valentine, J. (2011) How effective are mentoring programs for youth? A systematic assessment of the evidence. *Psychological Services in the Public Interest*, 12 57-91; Rhodes, J., Reddy, R., Grossman, J., & Lee, M. (2002) Volunteer mentoring relationships with minority youth: And analysis of same-versus cross-race matches. *Journal of Applied Social Psychology,* 32 (10) 2114-2133; Sanchez, B. & Colon, Y. (2005) Race, ethnicity, and culture in mentoring relationships. In D.L. DuiBois & M.J. Karcher (Eds), *Handbook on Youth Mentoring.* Thousand Oaks, CA: Sage; Stout, J., Dasgupta, N, Hunsinger, M., McManus, M (2011) STEMing the tide: Using in-group experts to inoculate women's self-concept in science, technology, engineering, and mathematics. *Journal of Personal Social Psychology,* 100 (2) 255-270; Syed, M, Goza, B., Chemers, M. & Zurbriggen, E. (2012) Individual differences in preferences for matched ethnic mentors among high-achieving ethnically diverse adolescents in STEM. *Child Development,* 83 (3) 896-910; Young, D., Rudman, L., Buettner, H., & McLean, M. (2013) The influence of female role models on women's implicit science cognitions, *Psychology of Women Quarterly*, 37 (3) 283-292.

Mentor research. Mentors were asked to describe their field of research with the same broad fields provided in the apprentice questionnaire.

The majority of mentors (80%) identified one of the three primary disciplines of science: Life Science (53%), Chemistry (20%), and Physical Science (7%). Mentors also worked in the field of Medicine/Health (20%). The reported mentor research fields are quite different than apprentice interests. Most notably, not a single mentor reported engineering, the most frequent field of interest reported by SEAP. This is not a surprising finding given the low response rate from mentors, but illuminates that even triangulated findings should be treated cautiously given these particular respondent samples may be reporting on distinct experiences from each other.

Actionable Program Evaluation

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. This section highlights information outlined in the Satisfaction & Suggestions and Goal 1 and 2 Program Efforts section of Tables 7 and 8.

A focus of the Actionable Program Evaluation are efforts toward the long-term goal of SEAP and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. Thus, it is important to consider how SEAP is marketed and ultimately recruits participants, the factors that motivate them to participate in SEAP, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. In the sections that follow, we report perceptions of apprentices and mentors, in an effort to both understand current efforts and recommend evidence-based improvements toward achieving outcomes related to AEOP and program objectives.

Marketing and Recruiting Underserved Populations

The SEAP manager, ASEE, reported conducting targeted marketing in communities and organizations serving high populations of minority and low-income students, including Prince George's County, MD and in Washington, DC through public schools, Boys and Girls Clubs, and other community groups. Specific illustrations of site efforts to market and recruit talented students from historically underserved or underrepresented populations in STEM include partnerships with minority-serving community organizations (e.g., 100 Black Men), cross-promoting SEAP to talented female and minority GEMS alumni at the site, and establishing a base for developing that talent through inclusion of female and minority students into GEMS programming. Additional site-level marketing and recruitment efforts included activities such as email and print advertising to surrounding public school districts and private high schools and flyers provided to teachers attending Army lab-sponsored events and workshops, though it is not clear whether these targeted underserved or underrepresented populations.

Online focus groups with apprentices asked why they chose to participate in SEAP, including any personal connections that led them to SEAP (or to a specific site or mentor), or any past experience participating in this or other AEOPs. Their responses revealed a variety of ways in which they became aware of and involved in SEAP, which helps us to understand how SEAP ultimately attracts apprentice participants. Mentors were asked how they became connected with their apprentice. This helps us to understand how participants are ultimately recruited and/or selected at the site level.

Most apprentices learned of SEAP through influential acquaintances who have a current or past connection to the program or SEAP site, including: personal or family connections to a mentor or other Army lab staff, university or high school educators having connections to the SEAP site, GEMS program coordinators or other staff, and other SEAP alumni. Almost half of apprentice interviewees learned of and/or became involved through personal or family connections with the mentor or site. Of 40 apprentice questionnaire respondents, 30% report a family member or family friend that works at

the SEAP site. Fewer apprentices came to SEAP independently (e.g., through the SEAP or AEOP website) or through cross-promotion with Navy's SEAP.

Nearly half of mentor interviewees reported selecting their apprentices that were recommended by or related to a personal or professional acquaintance (e.g., child of another staff member, student recommended by a school or university contact). About the same number of mentor interviewees reported being assigned to an apprentice by the SEAP site coordinator or selecting from an unknown ("un-vetted") applicant pool. Several mentor interviewees described having "more success" with apprentices that had been previously "vetted" through personal or professional connections.

From apprentice and mentor accounts, we can surmise that marketing and recruitment is largely a site-based endeavor, or at least a primary mechanism for attracting students. Existing connections to the SEAP site, program, or mentor are the more likely conduits by which those students learn about and are ultimately selected for SEAP apprenticeships.

Motivating Factors for Participation

Focus groups elicited apprentices' and mentors' motivation to participate in SEAP. The following trends emerged from their responses to why they chose to participate in SEAP.

Motivating factors for apprentices. Apprentice interviewees offered a number of factors motivating their participation. Other people motivated apprentices' participation. For example, apprentices received encouragement and/or had assistance in pursuing a SEAP apprenticeship through personal connections to a mentor or an Army site, through GEMS program coordinators and other staff, through university or high school staff with connections to the SEAP site. Past experience in this or other AEOPs motivated apprentices' participation. Specifically, apprentices cited their own positive experiences in GEMS, as well as the positive experiences of other SEAP alumni as motivating their participation in SEAP. Opportunities for professional growth motivated participation in SEAP. SEAP apprentices anticipated that SEAP would help them progress in their intended STEM pathways, including providing authentic research experiences in a professional laboratory setting; experiences that would build applications or resumes; opportunities to expand their skill sets; exploration or clarification of a future field of study. Several apprentice interviewees cited that opportunities to advancing their STEM pathways while getting paid and/or while fulfilling other academic requirements (e.g., a capstone research experience) made participation in SEAP particularly motivating.

Motivating factors for mentors. Mentors also expressed a variety of factors that motivated their participation. A number of mentors reported that their past participation as a SEAP mentor or GEMS instructor motivated their participation in 2013. Specifically, several mentors wanted to re-engage SEAP apprentices in the research project for a second or third year. In addition, some mentors wanted to help referred students secure a SEAP apprenticeship. Other mentors described having project needs they deemed appropriate for SEAP apprentices. One mentor was motivated by teaching in the research setting; subsequently, the apprentices "blew [his] expectations out of the water."

SEAP apprentices and mentors have a variety of reasons for participating. However, apprentices frequently chose SEAP to clarify or advance their STEM pathway in the unique setting of the SEAP site, and mentors frequently chose SEAP to engage younger STEM learners in their work.

Mentor Capacity

SEAP's second objective is to provide students with opportunities in and exposure to scientific and engineering practices and personnel not available in their school environment. The nature and quality of mentoring provided is a critical factor to maximizing students' participation in these opportunities and sustaining or inspiring their interest in future STEM work. Understanding mentor activities from the perspectives of apprentices and mentors can inform programmatic improvement for sustaining apprentices' interest and participation in STEM.

All of the apprentice and mentor assessments included a number of closed-scale and open-ended items addressing mentor activities. The next section summarizes some of these data, including apprentice and mentor perceptions of general mentor activities, and mentors' reflections about mentoring apprentices from underserved populations and mentoring apprentices about AEOP opportunities and Army/DoD STEM careers.

General mentor activities. Mentor and apprentice questionnaires included seven items to elicit perceptions of general mentor activities. These activities included activities related to both engaging apprentices productively in STEM research and encouraging educational and career pathways. Mentors and apprentices responded on a 6-point scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree." Chart 3 summarizes the proportions of mentors and apprentices that selected "Agree" or "Strongly Agree" for each item. The full data are summarized in Appendices B and C. Interview and focus group assessments also included items asking apprentices and mentors to think about a typical day in SEAP and describe mentoring received or provided, respectively.

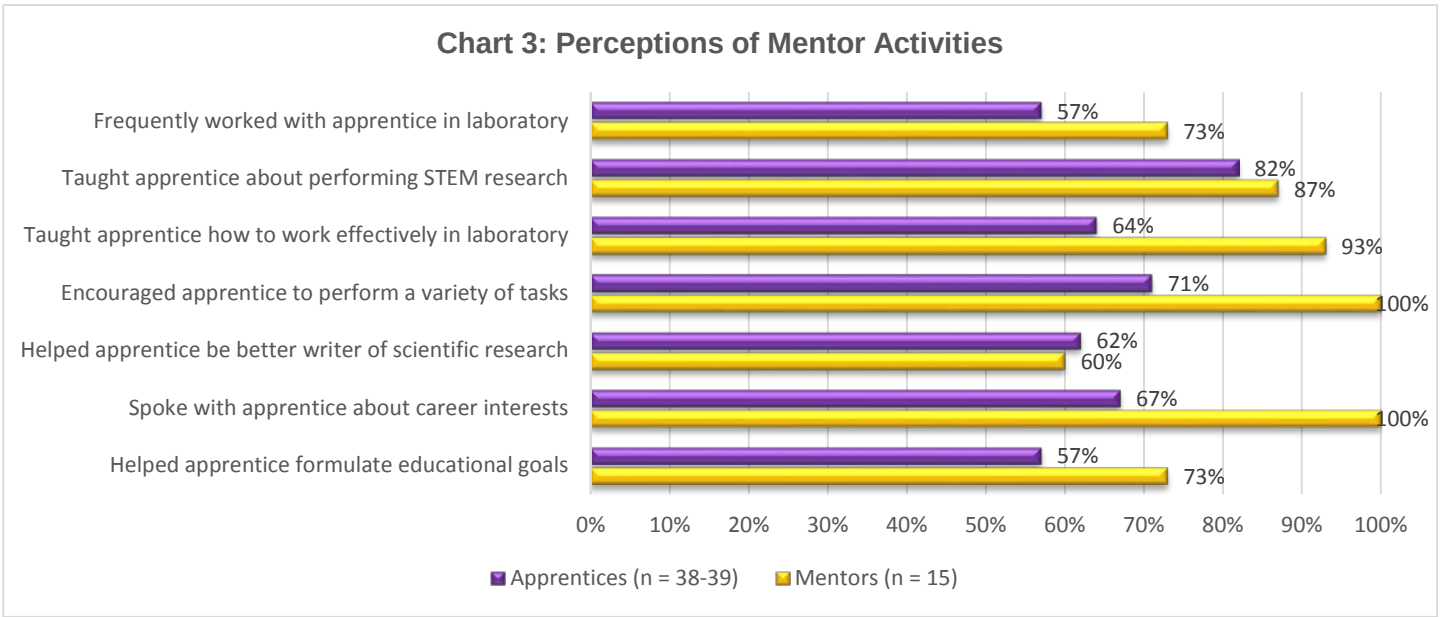


Chart 3 illustrates that the majority of apprentices and mentors report that each of these basic mentor activities occurred. Only a small proportion of apprentices (3-10%) reported that any of these mentor activities did not occur (refer to Appendix B.) Chart 3 suggests that apprentices and mentors perceive occurrence of these activities differently, as across most items, larger proportions of mentors reported occurrence of these mentor activities than did apprentices. However,

the only statistically significant differences found were between how apprentices and mentors perceived activities related to teaching apprentices to work effectively in a laboratory [10] and speaking about apprentices' career interests. [11] Significantly larger proportions of mentors reported occurrence of these activities.

When asked in focus group to describe the mentoring received or provided in a typical day, apprentice and mentor interviewees described similar mentor activities occurring frequently, including mechanisms for:

- training apprentices to conduct laboratory tasks and procedures;
- providing apprentices with constructive feedback; and
- grounding apprentices' laboratory-based work in scientific principles (e.g., assigned readings, teaching sessions, journal club).

Chart 3 suggests that mentorship around academic/scientific writing was less prevalent than mentorship around laboratory-based work. However, focus group data suggests this trend may be site specific. At one site, second time SEAP apprentices, a CQL apprentice (also past SEAP apprentice), and a SEAP mentor interviewees described opportunities for SEAP apprentices to first- or co-author publications and/or or technical reports. In contrast, apprentices and mentors at the other SEAP sites described such efforts less frequently, if at all. In several focus groups mentors lamented that extensive written and oral requirements of SEAP (and the completion deadlines) that, in their opinion, prevented much laboratory work from being accomplished.

Significant differences in mentors' and apprentices' perceptions related to mentoring around apprentices' career interests. A similar trend was found in focus group data, albeit somewhat nuanced. Only 1 apprentice interviewee mentioned discussing educational goals with their mentor during their SEAP apprenticeship in a typical day. In contrast, 5 mentors described efforts to help clarify and/or advance their apprentices' career pathways in a typical day. However, we must remember that focus groups included mentors for the SEAP and CQL programs, and some mentors participated in both programs. We might assume, based on the specific comments about professional networking, interview preparation, and career advice, that these mentors are likely referring to mentor activities associated with their CQL apprentices than with their SEAP apprentices.

SEAP mentors engaged their apprentices in STEM research and provided limited guidance about educational and career pathways during the SEAP apprenticeship. Apprentices and mentors reported similar types and frequencies of mentor activities related to engaging apprentices in STEM research. A significant difference was found in perceptions of mentorship around careers. These differences could be due to lack of mentors' differentiation between their SEAP and CQL apprentices, as demonstrated in focus groups. Subsequent sections further elaborate mentors' attempts at career mentorship and perceived challenges encountered.

Mentoring about AEOP opportunities. The mentor assessments asked about strategies used, challenges faced, and ways in which SEAP could support mentors in educating apprentices about AEOP opportunities. Only 3-5 mentors responded to the questionnaire items. They reported referring apprentices to the website, educating them about the SMART

[10] $p < 0.05$ with independent samples t-test (two tailed); Mean Diff. = .80, $p = .01$, $d = .83$, strong effect

[11] $p < 0.05$ with independent samples t-test (two tailed); Mean Diff. = .78, $p = .02$, $d = .72$, moderate to strong effect

scholarship, and encouraging participation in eCYBERMISSION (another AEOP initiative). More than 2/3 of the mentor interviewees did not educate apprentices about AEOPs outside of the SEAP site; they cited a lack of awareness of those programs as the primary challenge preventing them from educating apprentices the AEOPs.

In online surveys and focus groups, mentors suggested the following programmatic revisions for supporting them in educating their apprentices about AEOP initiatives:

- Provide informational resources about other AEOP initiatives that mentors can provide to apprentices;
- Provide on-site training or presentations to increase mentor awareness about AEOP initiatives; and
- Increase the emphasis on all AEOP initiatives at the command level.

Questionnaires included additional items which allow for comparisons between mentor and apprentice perceptions about efforts to expose apprentices to AEOP opportunities, and interest generated from that exposure. These are reported in the Outcomes Evaluation section.

Mentoring about Army/DoD STEM careers. The mentor assessments asked about strategies used, challenged faced, and ways in which SEAP could support mentors in educating apprentices about STEM and specifically Army/DoD STEM careers. Mentors used different strategies in mentoring apprentices about STEM careers, including: highlighting the research of collaborators or other DoD institutions, discussing the Army's interest in the research apprentice was engaged in, sharing job search options, engaging the apprentice in lunchtime seminars with DoD researchers, and other informal conversations about STEM careers. Some questionnaire respondents and interviewees reported that they limited their STEM pathway discussions with apprentices to majors, undergraduate or graduate programs, and schools rather than STEM careers.

Mentors cited a few challenges in educating apprentices about STEM and Army/DoD STEM careers, including: furloughs (e.g., lack of time to discuss careers when furloughed and furloughs impart negative perceptions of Army/DoD work), lack of awareness and resources about careers other than their own, apprentice's lack of understanding about various STEM fields, apprentice's general disinterest in Army/DoD STEM careers, difficulties engaging apprentices in discussion about careers, and mentors feeling unqualified to speak about other jobs/careers.

In the mentor questionnaire and focus groups the recommendation was made for SEAP to provide resources, such as a slide presentation, that mentors could share with apprentices to introduce Army/DoD STEM careers.

Questionnaires included additional items which allow for comparisons between mentor and apprentice perceptions about efforts to expose apprentices to STEM and Army/DoD STEM careers, and interest generated from that exposure. These are reported in the Outcomes Evaluation section.

Perceptions of SEAP

Assessments elicited apprentice and mentor perceptions of SEAP, including perceived value of SEAP, successes and challenges in the SEAP experience (mentors only), overall satisfaction with program activities and perceived areas for improvement.

Value of SEAP. Apprentices and mentors were asked in focus groups what they perceive as the value of the SEAP program. The apprentice questionnaire also asked what they perceived as the most valuable part of the research project or final presentation.

Apprentices described a range of benefits to them, including

- Opportunities to clarify and/or advance their STEM pathway (e.g., clarifying education or career goals, building application or resume, professional networking, and previewing job or workplace);
- Authentic research experiences within a professional research setting, including using resources, tools, and techniques not typically encountered in school classrooms;
- Expanding STEM competencies (e.g., including laboratory, critical thinking, information literacy, writing skills, programming skills) in ways that are not possible in school;
- Access to effective mentorship (e.g., appropriate balance of mentor responsiveness yet apprentice autonomy, opportunities for apprentices to become better mentor and/or teacher themselves, opportunities to learn from peers); and
- More confidence in STEM competencies, including scientific knowledge and research skills.

Mentors most frequently described the ways in which SEAP benefits participants. Mentors reported that SEAP

- Engages apprentices in authentic research experiences and opportunities to develop hands-on and academic research skills in a professional laboratory setting, which are not possible in school;
- Helps apprentices clarify and/or advance their STEM pathway (e.g., decisions about education or career goals, building application or resume); and
- Improves apprentice confidence in research skills and abilities.

Evaluators also elicited SEAP's value in terms of its benefit to mentors or to their laboratories. Mentors reported that during SEAP

- Apprentices were low-cost yet highly effective members of the lab, especially "post-baccs;"[12]
- Mentors were able to "pay it forward" (a common phrase used by mentors to describe repaying their past mentor(s)' efforts by mentoring others in turn);
- Mentors developed or expanded their teaching and mentoring skills; and,
- Mentors found it especially rewarding when high-risk or disadvantaged apprentices succeeded.

[12] As noted previously, while SEAP is intended as a high school, summer apprenticeship program, onsite focus groups and these data revealed that at more than one site GEMS Near Peer Mentors and other college students engaged in summer apprenticeships were funded by the SEAP program. Because mentor focus groups often included mentors who were supporting both SEAP and CQL apprentices, we believe but cannot confirm that this statement was in reference to CQL programming.

Successes and challenges in SEAP. The questionnaire asked mentors to report successes and challenges they or their apprentices experienced. Of 6 respondents, mentors perceived apprentice successes, including that apprentices developed as STEM researchers and contributed to research with near-term impact Army processes or procedures.

Some mentors described challenges they encountered, including

- Inadequate administrative or laboratory-level support and organization;
- Short time frame of the summer apprenticeship;
- Disruptions due to furloughs during the apprenticeship;
- Dissatisfaction with under-performing apprentices; and
- Difficulties finding research projects and/or tasks that are appropriate for a high school apprentice.

The short duration of the summer apprenticeship and the disruptions posed by furloughs made site-level support and organization more challenging this summer. Outside of focus groups, several mentors reported the importance of having access to site-specific staff to shepherd mentors and apprentices of SEAP and CQL programs through program-related requirements.

When asked about their mentors, most apprentices expressed high levels of satisfaction, however a small number of apprentices wanted more mentor involvement, greater structure and substance to their project, and alternative mentors for when mentor absence was necessary.

Overall satisfaction and areas for improvement. Apprentices and mentors were asked several items to gauge their overall satisfaction with SEAP. These items also provided opportunity for participants to voice concerns and identify areas for improvement. Table 11 summarizes these items.

Table 11. 2013 Assessment Satisfaction and Improvement Items

Assessment	Item
Apprentice and Mentor Focus Groups	If you had one minute to talk to an Army decision maker about SEAP, what would you say?
Apprentice Questionnaire	Given the opportunity, would you participate in SEAP again? Why or why not?

Most mentors wanted to share with Army decision makers the benefits that SEAP affords to apprentices, mentors, and laboratories. In addition to the benefits already listed by mentors as the value of SEAP (see above), mentors suggested:

- The Army facility and resources are truly unique in what they can offer apprentices;
- Apprentices have a better understanding of and appreciation for the work of Army/DoD after their apprenticeship; and
- The apprentices offer fresh perspectives at SEAP sites;

Mentors also would share their recommendations for improving SEAP's impact, including that SEAP should

- Improve visibility of SEAP;
- Expand SEAP's outreach to other demographics and outside of the DoD community;
- Reduce the administrative "burden" associated with the SEAP and CQL apprenticeships, or provide a site- or program-specific liaison to provide support to mentors for completing this work efficiently and accurately; and
- Provide guidance for handling vacation time for apprentices, especially those in 6, 9 or 12 month appointments.[13]

Most SEAP apprentice spoke highly of their experience. SEAP apprentices would share with Army decision makers the many benefits shared as the value of SEAP (see above). In addition they highlighted these areas for potential improvement:

- in-processing and other administrative tasks are "cumbersome" and "time-consuming";
- marketing is limited and local (e.g., awareness most consistently through personal connections);
- could be expanded to allow more apprentices and more diverse apprentices;
- alumni are not formally being used in schools to promote the AEOP, and could be;
- information was not provided about on-base requirements, in-processing, and local housing; and
- acceptance and rejection notifications were distributed too late.

[13] As noted previously, while SEAP is intended as a high school, summer apprenticeship program, onsite focus groups and these data revealed that at more than one site GEMS Near Peer Mentors and other college students engaged in summer apprenticeships were funded by the SEAP program. Because mentor focus groups often included mentors who were supporting both SEAP and CQL apprentices, we believe but cannot confirm that this statement was in reference to CQL programming.

Outcomes Evaluation

The evaluation of SEAP included measurement of several outcomes relating to AEOP and program objectives aligned with AEOP Goal 1: STEM Literate Citizenry. Toward AEOP Goal 1, the evaluation measured the following: apprentices' perceptions of engagement in STEM activities in SEAP; apprentices' and mentors' post-SEAP perceptions of apprentices' STEM competencies; apprentices' interest in future STEM engagement; and apprentices' awareness and interest in educational and career opportunities in Army STEM.

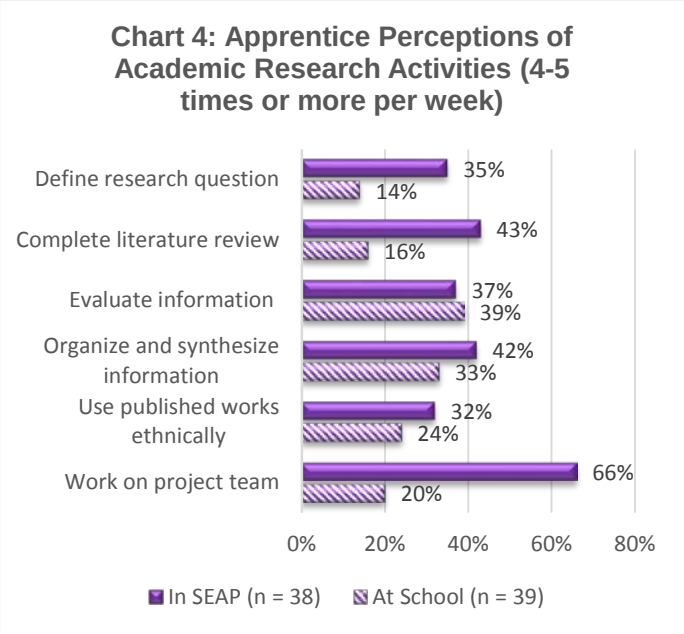
STEM Competencies

STEM competencies are necessary for a STEM-literate citizenry. STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important 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. Apprentice questionnaires measured apprentices' and mentors' perceptions of apprentices' engagement in authentic STEM activities, apprentice's self-reported change in confidence in their STEM competencies, and mentors' expert assessment of apprentices' STEM competencies. These measures also align with SEAP Objective 2: Provide students with opportunities in and exposure to scientific and engineering practices and personnel not available in their school environment.

Engagement in authentic STEM activities. Twelve items measured apprentices' perceptions of opportunities to engage in STEM activities in SEAP as compared to in school. Six of the items included minds-on or academic research activities, such synthesizing and evaluating information. Six of the items included hands-on research activities, such as using equipment and procedures. Apprentices responded on a 6-point frequency scale of 1 = "Never," 2 = Once per week," 3 = "2-3 times per week," 4 = 4-5 times per week," 5 = "Every day," and 6 = "Multiple times per day." Mentors responded to a similar battery of 9 items using the same response scale.

Charts 4 and 5 on the next page summarize the proportions of apprentices reporting engaging in each activity 4-5 times per week or more in SEAP and at school. More detailed data summaries are provided in Appendix B. A statistical comparison of the frequency with which apprentices reported engaging in STEM activities in SEAP and at school is provided in Table 12.

As illustrated in Charts 4 and 5, the proportion of apprentices reporting engaging in these activities 4-5 times per week during SEAP exceeds 30% for all activities (32%-66%). For all but one item, smaller proportions of apprentices engaged in these kinds of activities at school with similar frequency (8%-39%). Apprentices most frequently report working on a project team (66%) and handling equipment and materials safely (62%). On average, apprentices engaged in these activities more than 2-3 per week in SEAP (Avg ~3.3/6.0) and less than 2-3 times per week at school (Avg ~2.7/6.0).



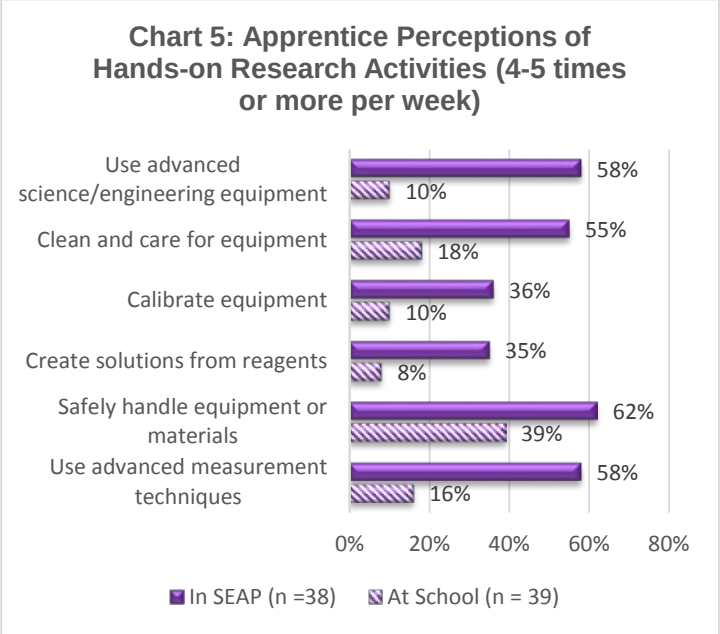


Table 12. Engagement in STEM activities, matched cases At school vs. In SEAP

Item	At school Avg. (SD)	In SEAP Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I had to define a research question or thesis and determine its critical concepts	2.26 (1.45)	3.16 (1.46)	38	**.895***	3.20	.003	.520
I had to use academic search strategies (e.g., databases and journals) to complete a literature review	2.53 (1.41)	3.05 (1.69)	38	**.526**	1.60	.117	.260
I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	3.08 (1.63)	3.26 (1.64)	38	**.184**	0.65	.517	.106
I had to organize and synthesize information across academic sources	3.21 (1.53)	3.24 (1.60)	38	**.026**	0.08	.938	.013
I had to determine appropriate ethical and legal uses of published academic research for my own work	2.74 (1.48)	2.97 (1.65)	38	**.237**	0.80	.428	.130
I had to work as part of a team on research projects	2.71 (1.37)	4.03 (1.78)	38	**1.316***	3.97	.000	.645
I used advanced science or engineering equipment	2.26 (1.35)	4.11 (1.87)	38	**1.842***	5.94	.000	.964
I cleaned and cared for the equipment in a science or engineering laboratory	2.47 (1.47)	3.61 (2.06)	38	**1.132***	3.58	.001	.581
I calibrated laboratory equipment for experimentation	1.84 (1.42)	3.08 (1.95)	38	**1.237***	4.02	.000	.653
I created solutions from reagents in preparation for experimental procedures	2.14 (1.27)	2.73 (2.02)	37	**.595**	1.91	.064	.314
I used proper safety procedures when handling equipment and material in the lab	3.37 (1.6)	4.16 (1.98)	38	**.789***	2.57	.014	.417
I employed advanced measurement techniques in science or engineering procedures	4.00 (1.86)	2.47 (1.41)	38	**1.526***	5.07	.000	.822

NOTE: ** = p < .05 with paired samples t-test (two-tailed)*

Table 12 reveals that these differences between SEAP and school are statistically significant ($p < .05$) across most of the hands-on activities, with effects ranging from weak to strong. For example, the difference in handling equipment and material safely in SEAP and at school is real but weak ($d = .417$). The difference in using advanced science or engineering equipment in SEAP and at school shows a strong effect ($d = .964$). The comparisons revealed two differences, moderately large in effect, between academic research activities in SEAP and at school: defining a research question ($d = .520$) and working on a project team ($d = .645$). In general, significance testing suggests that SEAP had more effect in providing apprentices with opportunities for hands-on research activities than it did the academic (minds-on) research activities. This is a potential area for growth.[14]

[14] Recent policy recommendations call for coordination of STEM learning across formal (e.g., K-12, college) and informal (e.g., designed, outreach) settings to advance the national goal of a STEM-literate citizenry. Shared STEM standards and metrics are central to those coordinated efforts (NSB, 2007; U.S. DoE, 2007; PCAST, 2010; CoSTEM 2013). PCAST (2010) calls for widespread support of the state-led standards movement, *Next Generation Science Standards* (NGSS), not only among all K-12 agencies, but by academic, non-profit, business and other sectors providing outreach to students and teachers. U.S. DoE (2007) and more recently CoSTEM (2013) call for measurement of both learning and affective outcomes in STEM engagement investments. U.S. DoE (2007) and NRC (2009) have suggested similar frameworks defining those learning and affective outcomes across STEM engagement investments, and they recommend widespread adoption of such frameworks to support the ongoing assessment of the nation's progress toward achieving its goal of a STEM-literate citizenry. Although the evaluation frameworks preceded the NGSS, they generally reflect NGSS' vision (and supporting evidence base) for authentic and inspiring STEM learning through the symbiotic development and application of core disciplinary ideas, cross-discipline concepts, and science and engineering practices. Those practices include: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computations thinking; constructing explanations and designing solutions; engaging in argument from evidence; obtaining, evaluating, and communicating information (e.g., NGSS Lead States, 2013). Similar notions of learning are recommended at the college level (AAAS 2009; NRC, 2003). While the field of science education has been more prolific in its advancement of these policy recommendations, other teacher associations, accrediting organizations, and multi-sector partnerships have recommended similar frameworks that call for similar learning experiences and outcomes in those fields (e.g., ABET, 2011; NCTM, 2000, P21, 2010). Accreditation Board for Engineering and Technology (ABET, 2011) *Criteria for Accrediting Engineering Programs*; American Association for the Advancement of Science (AAAS, 2011) *Vision and Change in Undergraduate Biology Education: A Call to Action*. Washington, DC: Author; Committee on STEM Education National Science and Technology Council (CoSTEM, 2013) *Federal Science, Technology, Engineering, and Mathematics Education 5 Year Strategic Plan*. Washington, DC: Author; National Council for Teachers of Mathematics (NCTM, 2000) *Principles and Standards for School Mathematics*; National Research Council (NRC, 2003) *Transforming Undergraduate Education for Future Research Biologists.* Washington DC: The National Academies Press; National Research Council (NRC, 2009) *Learning Science in Informal Environments: People, Places, Pursuits.* Washington DC: The National Academies Press; National Science Board (2007) Science, technology, engineering, and mathematics (STEM) education issues and legislative options. In R. Nata (Ed), *Progress in education* (vol. 14, pp. 161-189). Washington, DC: Author; NGSS Lead States (2013) *Next Generation Science Standards: For States, By States.* Washington DC: The National Academies Press; Partnership for 21st Century Skills, *Framework for 21st Century Learning;* President's Council of Advisors on Science and Technology (PCAST, 2010) *Prepare and Inspire: K012 Education in Science, Technology, Engineering and Math for America's Future*. Washington, DC: Author; U.S. Department of Education (U.S. DoE, 2007) *Report of the Academic Competitiveness Council*. Washington, DC: Author.

STEM skills and abilities. Seven items measured apprentices' self-reported gains in confidence with a range of academic and hands-on research skills and abilities, as a result of the SEAP program. In addition, six rubrics in the SEAP mentor questionnaire leveraged mentors' expertise as researchers and observations of apprentices during the program to provide expert ratings of apprentices' academic and hands-on research skills and abilities. The STEM skills and abilities assessed by both apprentices and mentors have sufficient overlap to allow for some triangulation of findings. The apprentice items and mentor rubric items (defined at the expert level) are summarized in Table 13.

Table 13. Apprentice and Mentor Assessments of STEM Skills and Abilities

Apprentice Confidence Item	Mentor Rubric Item: Expert Level
I am more confident in my ability to complete academic literature reviews for my own research projects	**Information literacy skills/abilities:** Expertly determines, searches for, and accesses needed information. Synthesizes and uses information from credible sources in a highly ethical manner.
I am more confident in my ability to formulate hypotheses and design experiments to test them	**Scientific reasoning skills/abilities:** Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research.
I am more confident in my ability to effectively and safely use a science or engineering laboratory I am more confident in my ability to perform equipment calibration and perform complex laboratory techniques	**Laboratory skills/abilities:** Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed. **Data Collection Techniques:** Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques.
I am more confident that I can analyze data and understand the results of an experiment I am more confident that I can identify and account for limitations and assumptions when formulating conclusions	**Quantitative literacy skills/abilities:** Expertly converts and interprets quantitative information into an accurate set of results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation.
I am more confident that I can make significant research contributions as an effective part of a research team	**Teamwork and collaboration skills/abilities:** Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole.

Apprentices responded to items on a 6-point scale of 1 = “Not at all like me” to 6 = “Just like me.” In contrast, mentor rubrics defined a development continuum on a scale of 1 (reflecting novice behaviors) to 6 (reflecting expert behaviors) unique to each STEM skill or ability. Actual scales and data from each mentor rubric items are provided in Appendix C. For ease of visualizing mentor rubric responses here, we will assign a more generic scale across all of the rubrics of 1 = “Novice,” 2 = “Near novice,” 3-4 = “Developing expertise/supervision needed”, 5 = “Near expert,” 6 = “Expert.” The rubrics were completed for each apprentice mentored, so the “n” represents the number of apprentice assessments conducted by mentors, and is, therefore, greater than the total number of mentor questionnaire respondents. Charts 6 and 7 summarize apprentices’ and mentors’ responses to the STEM Competency items.

Chart 6: Apprentice - More Confidence in STEM Competencies (n = 37-38)

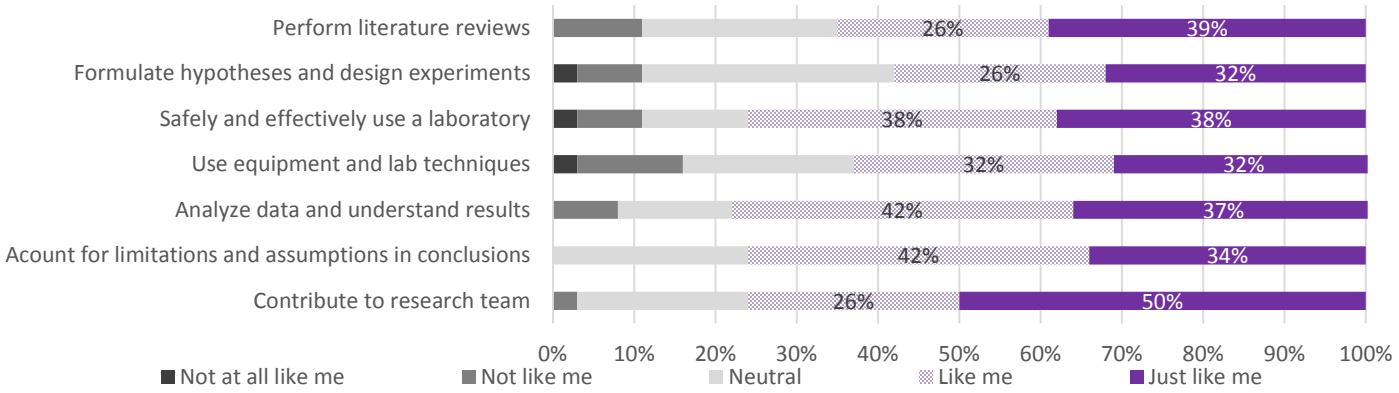


Chart 7: Mentor - Assessment of Apprentice STEM Competencies (n = 17)

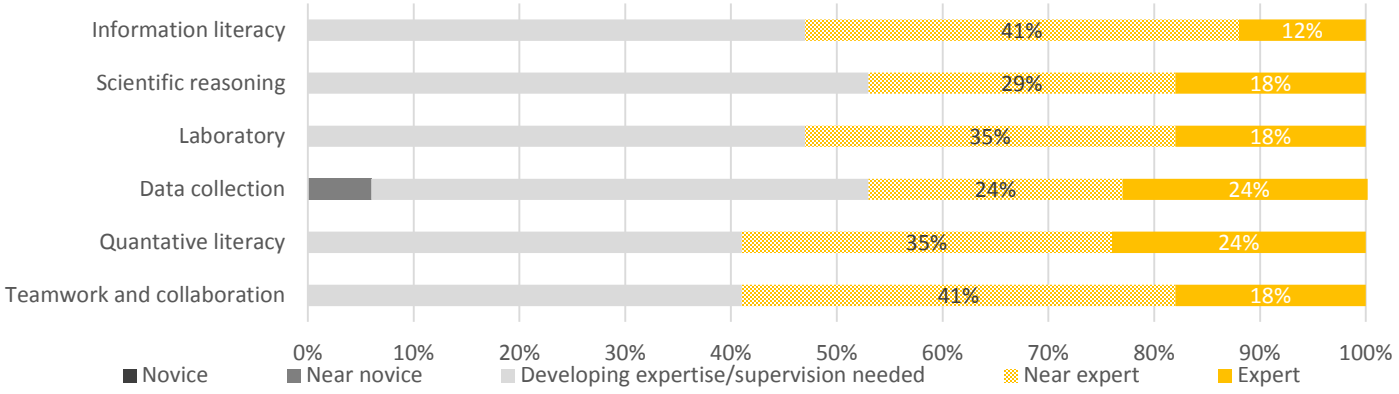


Chart 6 suggests that the majority of apprentices (58%-79%) perceived growth in their confidence across the range of skills and abilities. Larger proportions of apprentices perceived gains in their confidence to analyze data and understand results (79%), account for limitations and assumptions in conclusions (76%), safely and effectively use the laboratory (76%), and contribute to the research team (76%).

Chart 7 suggests that for all but two items (data collection and scientific reasoning), the majority of mentors rated their apprentice's skills and abilities in the near expert or expert levels of the development continuum. Mentors gave higher proportions of near expert and expert ratings for apprentices' quantitative literacy (59%) and teamwork and collaboration (59%). Average ratings generally approach near expert across all skills and abilities (4.47-4.76/6.0).

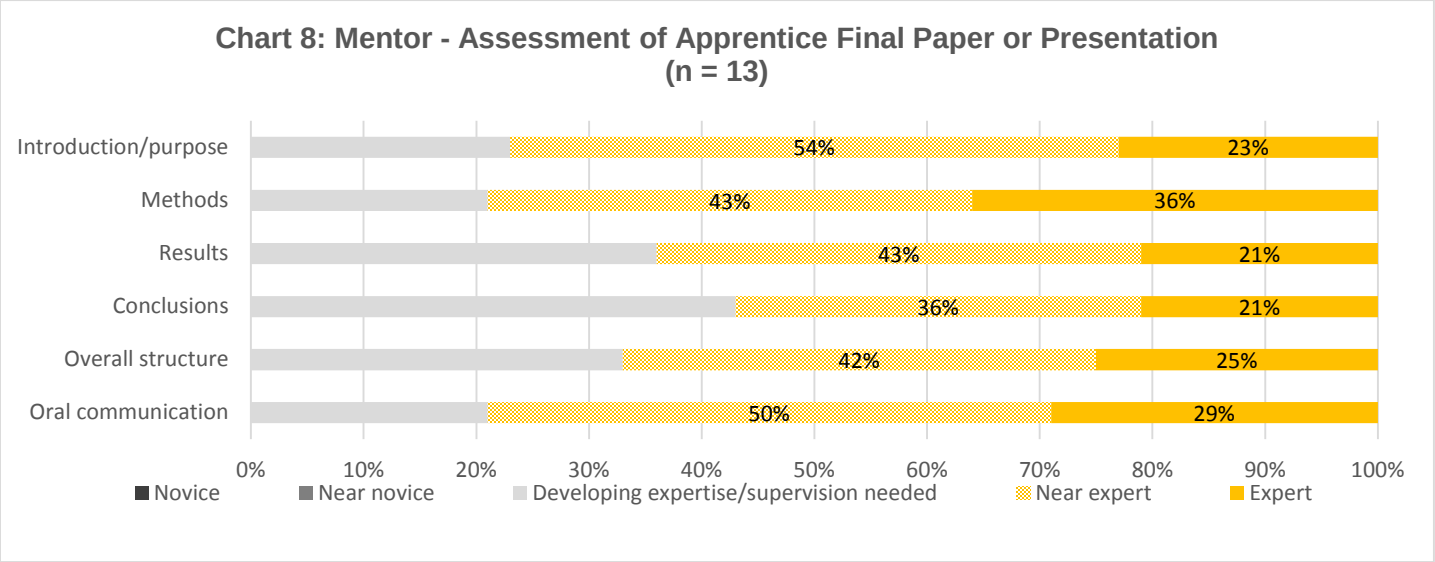
There is considerable agreement between perceptions of apprentice growth in confidence and mentor assessment of STEM skills and abilities. For example, using the alignment of apprentice and mentor items provided in Table 13, we observe higher ratings in the including in the two highest rated items by each participant group (associated with teamwork and collaboration and quantitative literacy in the mentor rubrics) and the two lowest rated by each participant group (associated with data collection and scientific reasoning in the mentor rubrics). Taken together, we would conclude that apprentices perceived growth in their STEM skills, and mentor assessment of their performance potentially corroborates those perceptions. Apprentices' perceived growth and mentor rubric ratings are also consistent with what we might expect given the difference in frequencies for which apprentices conduct these activities in SEAP and in the school settings.

STEM research project or presentation. Additionally, six rubrics were given to mentors to rate the quality of their apprentice's final research paper or presentation. Each rubric represents one of six dimensions of typical of STEM research papers or presentations. Much like the aforementioned mentor rubrics, each rubric defined a development continuum on a scale of 1, reflecting novice behaviors, to 6, reflecting expert behaviors, unique to each component of the research paper or presentation. Table 14 summarizes each dimension as it is defined at the expert level.

Table 14. Mentor Assessments of Final Paper or Presentation
Mentor Rubric Item: Expert Level
Introduction/Purpose: Completely Identifies and articulates the purpose of the research. Fully understands and connects with existing research.
Methods: Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report.
Results: Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts.
Conclusions: Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond finding to guide future research.
Overall structure: Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labelled and clear. Grammar is impeccable.
Oral Communication: Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility.

Chart 8 summarizes mentors' responses to the Final Paper or Presentation rubrics. For ease of visualizing mentor rubric responses here, we will again assign a more generic scale across all of the rubrics of 1 = "Novice," 2 = "Near novice," 3-4 = "Developing expertise/supervision needed", 5 = "Near expert," 6 = "Expert." Actual scales and data from each mentor rubric items are provided in Appendix C.

Mentors rated all six components of their apprentices' final research project very highly. The average apprentice received a rating approaching near expert (5.6/6.0) for all components of their research program (Avg. 4.79-5.14/6.0). These data suggest that most SEAP apprentices not only conduct research, but are also capable of producing high level research papers and presentations within the Army laboratories where they worked.



Future STEM Engagement

The ideology of exposing students to different real-world applications and careers employing STEM early in students' academic career is rooted in the belief that exposing students might unearth hidden curiosity and passion that students never knew existed. Separate studies from University of Indiana[15] and University of Virginia[16] found that exposure to STEM as adolescents peaked immediate interest in near-term STEM-related pursuits and had a significant effect on future pursuit of STEM degrees and careers, respectively. In addition, SEAP aims to prepare these students to serve as positive role models for their peers through their near-term STEM-related pursuits, such as encouraging other high school students to take more science and math courses (SEAP Objective 5).

[15] Alexander, J. M. & Johnson, K. E. (2012) Longitudinal analysis of the relations between opportunities to learn about science and the development of interests related to science. *Science Education 96 (5)* 763-786

[16] Dabney, K. P., Tai, R. H., Almarode, J.T., Miller-Friedmann, J.L., Sonnert, G., Sadler, P. M. & Hazari, Z. (2012) Out of school time science activities and their association with career interest in STEM. *International Journal of Science Education 2 (1)* 63-79.

Eleven items[17] in the SEAP apprentice questionnaire measured apprentice attitudes toward STEM, SEAP, and future STEM activities after their experience of participating in SEAP.

Future STEM engagement. Four items elicited apprentices' desire to pursue additional STEM activities after participating in the SEAP program. Four other items relate their attitudes toward STEM and SEAP to ways they may serve as role models to peers and to younger STEM learners. Apprentices responded to items on a 6-point scale of 1 = "Strongly disagree" to 6 = "Strongly agree." Summaries of these items are contained in Charts 9 and 10 below.

Chart 9: Apprentice STEM Activities after SEAP (n = 40)

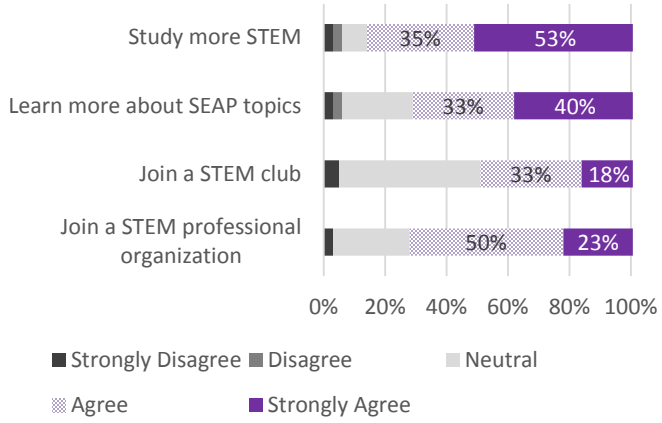


Chart 10: Apprentice Role Model Activities after SEAP (n = 40)

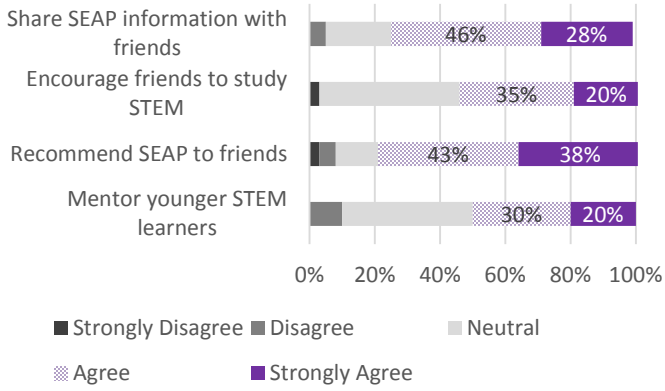


Chart 9 shows that most apprentices agree or strongly agree that they want to study more STEM after participating in SEAP (88%), that they want to learn more about the STEM topics that they were exposed to during SEAP (73%), and that they are interested in joining a STEM-related professional organization after SEAP (73%). Fewer apprentices, though still a substantial proportion of respondents, wish to join a STEM club (51%) after SEAP.

As summarized in Chart 10, apprentices like to share the information that they learned in SEAP with their friends and family (74%) and will recommend SEAP to their friends (81%). Fewer apprentices report that they will encourage their friends to study more STEM courses after SEAP (55%). Half (50%) of SEAP apprentices desired to mentor younger students in the future. It is worth noting that some sites provide opportunities to serve as role models during and/or after SEAP. For example, SEAP apprentices may assist with summer GEMS labs, volunteer at eCYBERMISSION's National Judging and Education Event, or judge local robotics competitions during the school year. At one site, apprentices invited their school teachers to command-level research presentations at the end of the apprenticeship and will repeat these presentations for classmates back at their high schools.

[17] Three items are not described here: "I enjoyed the hands-on/laboratory activities at SEAP", "I learned many new and interesting things during the day to day activities at SEAP," and "I think about the new STEM information I learned in SEAP when I am outside of the SEAP site." These data are summarized in Actionable Evaluation and Appendix B.

Overall, the majority of apprentices intended to pursue STEM and STEM-based activities after participating in SEAP, but also intend to (and have opportunities to) serve as STEM role models and SEAP ambassadors.

Army STEM

The Army's goal of establishing a coherent pipeline of opportunities for engaging and developing STEM talent from kindergarten to college, and then attracting that talent to Army/DoD careers, requires that each program promote its participants' awareness of both AEOP initiatives and Army/DoD STEM careers. Apprentices and mentors who are aware of the portfolio of AEOP programs can serve as stewards of AEOP in their personal and professional relationships, advancing the AEOP's mission of outreach. Mentors who are aware of and knowledgeable about the portfolio of AEOP programs can provide guidance and encouragement to apprentices regarding next steps in their AEOP pathway. Mentors who are knowledgeable about Army/DoD STEM career opportunities can inspire apprentices' interest and appreciation of them and provide guidance about educational pathways to achieve them. Apprentices that have greater awareness of and positive attitudes toward Army/DoD STEM careers are more likely to seek them out in the future.

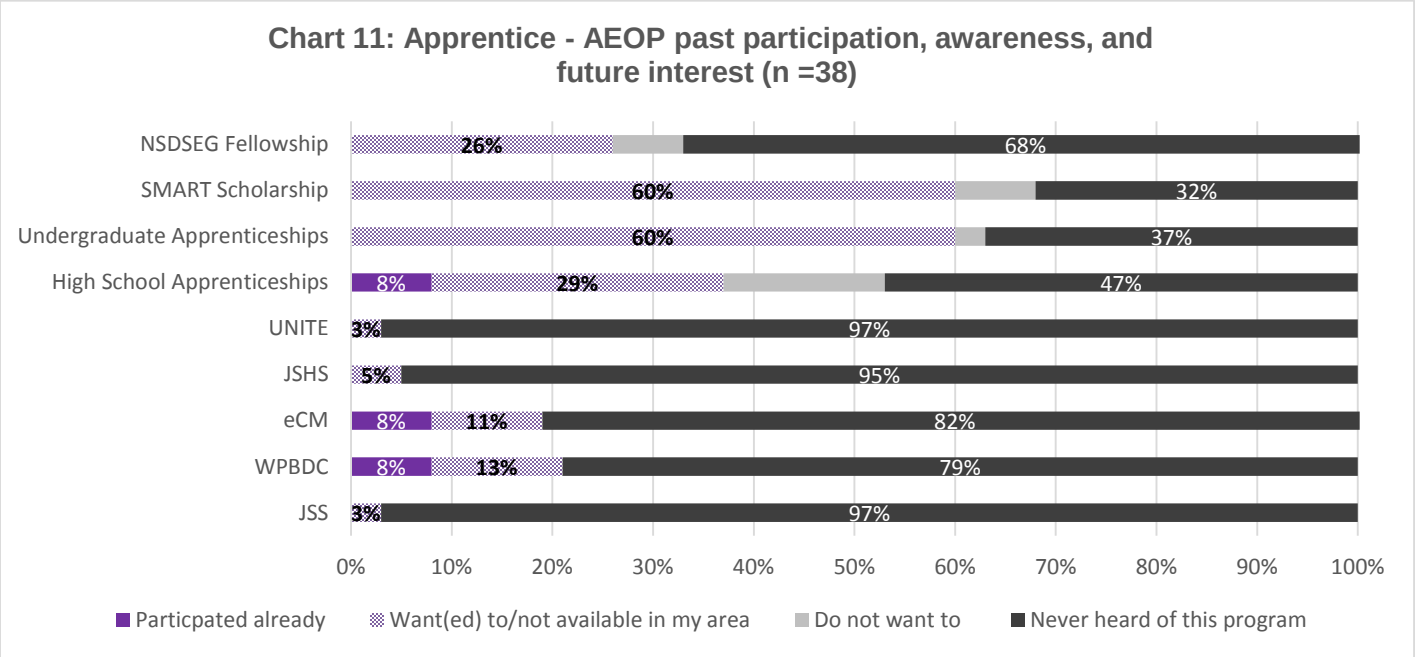
Army Educational Outreach Programs

- Junior Solar Sprint (JSS)
- Gains in Mathematics and Science Education (GEMS)
- West Point Bridge Design Competition (WPBDC)
- eCYBERMISSION (eCM)
- High School Apprenticeship Program (HSAP)
- Research and Engineering Apprenticeship Program (REAP)
- Science and Engineering Apprentices Program (SEAP)
- Undergraduate Research Apprenticeship Program (URAP)
- College Qualified Leaders (CQL)
- Science, Mathematics, & Research for Transformation (SMART) scholarship (Offered by DoD)
- National Defense Science and Engineering Graduate (NDSEG) (Offered by DoD)

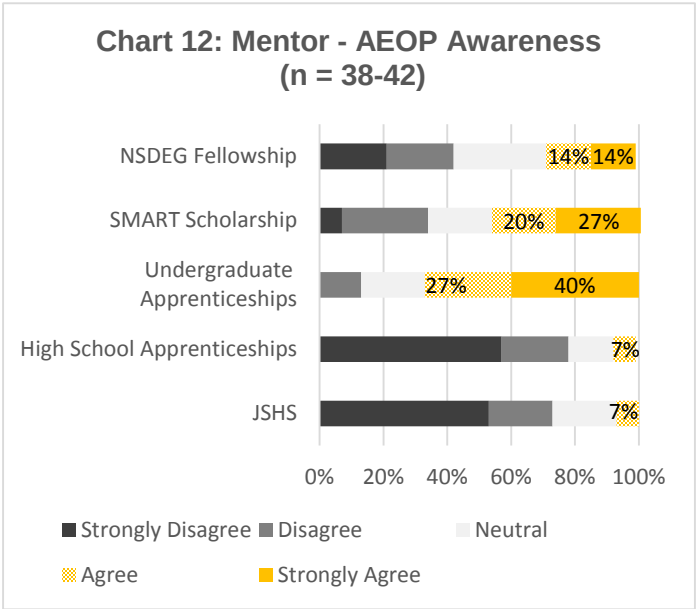
The assessments measured apprentice awareness and interest in participating in AEOP opportunities and Army/DoD STEM careers. In addition, the apprentice assessment measured apprentice attitudes toward Army/DoD STEM research and careers. Mentor assessments included corresponding items to corroborate apprentice findings and are shown here for comparison. These measures correspond to SEAP program objectives:

- Objective 3: Expose those students to DoD research and engineering activities and goals in a way that encourages a positive image and supportive attitude toward our defense community; and
- Objective 4: Establish a pool of students preparing for careers in science and engineering with a view toward potential government service.

AEOP Opportunities. Apprentice questionnaires simultaneously elicited past participation in, awareness of, and interest in other AEOP opportunities. Item choices included "Participated already," "Want to Participate," "Wanted to participate but not available in my area," "Not interested," and "Have never heard about this program". These data are reported together in Chart 11 on the next page. According to these items a very small number of apprentices had participated in West Point Bridge Design Competition (8%), eCYBERMISSION (8%), and High School Internships (8%) previously.



The most striking finding is that at the time of this questionnaire (near or after the conclusion of most SEAP apprenticeships), many apprentices (up to 96%) indicated that they have never heard about various AEOP opportunities, most notably those programs that occur outside of the SEAP site in which they worked. A considerable proportion of apprentices want to participate in other AEOPs (or would participate but perceive unavailability of the program in their area.) For example, apprentices were interested in high school STEM competitions (5% JSHS, 21% WPBDC), high school apprenticeships (29%), undergraduate apprenticeships (60%), and college scholarship programs (60%) for which they still may qualify. Only a small proportion of apprentices (3-16%) expressed awareness of but lack of interest in each of the high school and undergraduate programs.



Mentors were asked to report their level of awareness of AEOP and DoD opportunities for which their high school apprentices may still qualify. The items asked mentors to respond on a scale of 1 = “Strongly Disagree” (reflecting lack of awareness) to 6 = “Strongly Agree” (reflecting awareness).

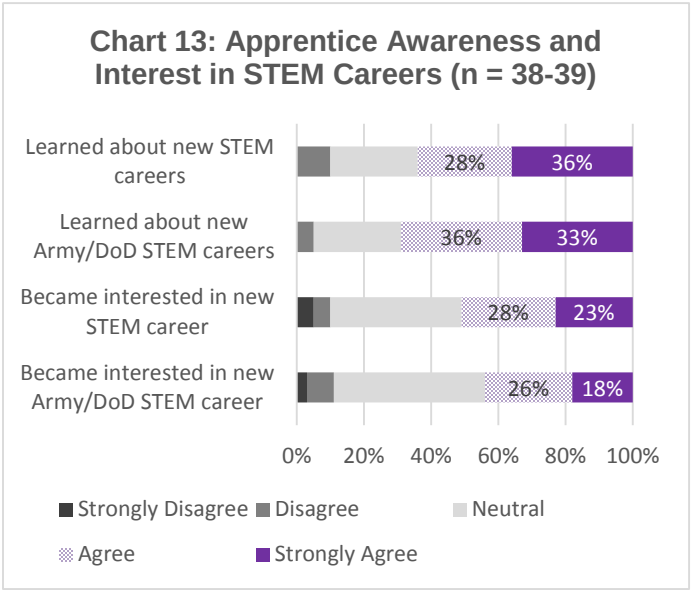
As shown in Chart 12, many mentors (13-73%) were unaware of these AEOP and DoD opportunities. The majority of mentors were aware of undergraduate apprenticeships, such as the CQL program intended as a next step for SEAP

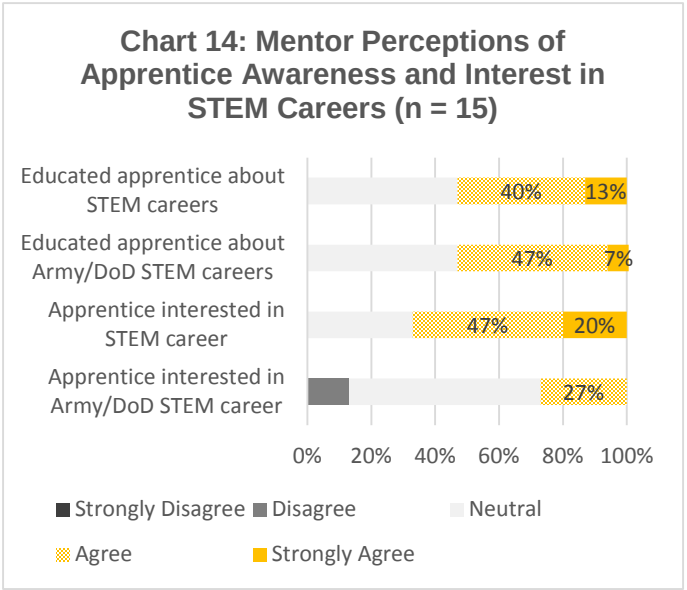
apprentices at SEAP sites. Fewer than 50% were familiar with other DoD scholarship/fellowship programs for attracting talented individuals to DoD research laboratories. When asked whether they provided information to their apprentices about AEOP and DoD educational programs, only 26% of mentors answered affirmatively with agree or strongly agree.

The apprentice questionnaire introduced JSHS as Army-sponsored regional research symposia and a national scholarship-awarding research competition. This program is a possible next step for all participants of AEOP apprenticeship programs such as SEAP. In response to a questioning asking how certain they are that they will submit their SEAP research project to JSHS, 8% (of 38) expressed interest in submitting their SEAP project to JSHS this year. This is not surprising given that only 14% of 41 mentors report encouraging their apprentices to do so. Yet, 13% of apprentices expressed interest in submitting their research to other science fairs or competitions, including sponsored fairs such as Intel International Science & Engineering Fair and Siemens Science & Engineering Fair.

In summary, these data suggest that SEAP sites and mentors have limited success educating apprentices about AEOPs, especially AEOPs outside of the SEAP site. Yet substantial apprentice interest exists that could be leveraged during targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.

Army/DoD STEM Careers. Items in the apprentice questionnaire measured the extent to which participants perceived learning about new STEM jobs and careers (herein called careers), and specifically, STEM careers within the Army/DoD. Subsequently, apprentices were asked whether they became interested in those new STEM careers. Chart 13 summarizes apprentices' perceptions of exposure to STEM and Army/DoD STEM careers during SEAP, and resulting interest. Chart 14 summarizes mentors' perceptions of efforts to educate their apprentices about careers and apprentice interest in STEM careers. All items used a response scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree".





Charts 13 and 14 illustrate that a majority of apprentices had opportunities to and perceived learning about new STEM careers during SEAP. Of 39 apprentices, 64% agreed that they learned about new STEM careers, and 53% mentors reported educating apprentices about STEM careers. Furthermore, nearly the same proportions report opportunities to learn about new STEM careers and opportunities to learn about Army/DoD STEM careers. This finding would be expected given the substantial exposure apprentices have to Army/DoD STEM research and professionals in their daily work at SEAP sites.

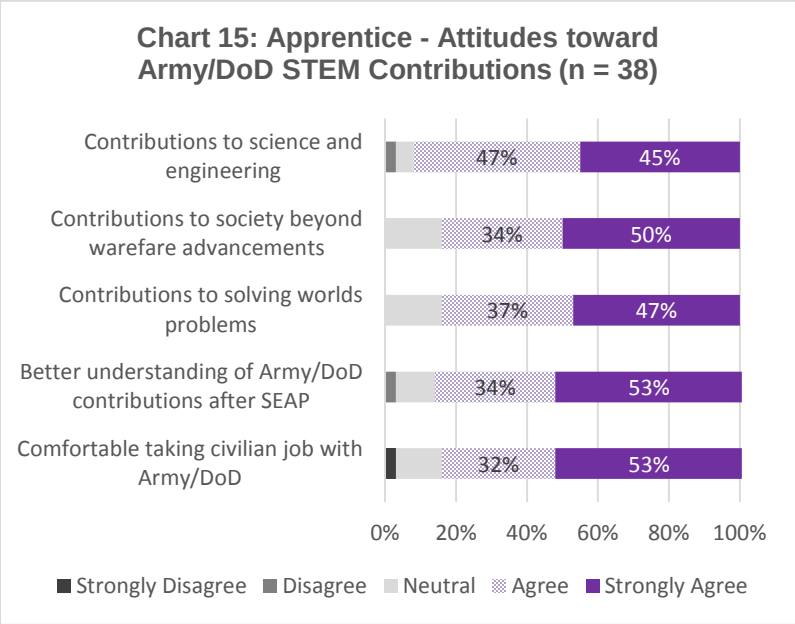
Of the apprentice respondents, 51% reported becoming interested in a new STEM career during SEAP, and 67% of mentors agreed that their apprentices expressed genuine interest in future STEM careers. Fewer SEAP apprentices (44%) reported becoming interested in Army/DoD STEM careers, though no significance difference exists when compared with interest in new STEM careers in general. A comparison of mentor the items reveals significant differences in mentors' perceptions of apprentices' expressed interest to pursue Army/DoD STEM careers as opposed to STEM careers in general. Mentors perceived much lower expressions of apprentices' interest in Army/DoD STEM careers than in STEM careers in general.[18]

When asked which three new STEM jobs they found most interesting, 25 apprentices listed 45 different jobs or careers. Of those listed, careers in engineering disciplines were most prevalent. Electrical engineering was most frequently mentioned by apprentices (24%), followed by engineering (20%). Other engineering disciplines included mechanical (16%), chemical (8%), computer (8%), environmental (8%), materials (8%), 3-D design engineer (4%), and nuclear engineering (4%). A range of STEM disciplines, career fields, and career levels were mentioned. The prevailing interest in engineering is not reflected in mentor research fields (0%).

Overall, student and mentor accounts reveal that a majority of apprentices had opportunities to learn about new STEM careers during SEAP (according to 64% apprentices, 53% mentors). Similar proportions reported opportunities to learn about Army/DoD STEM careers, which could suggest that opportunities to learn about new STEM careers consisted largely of learning about Army/DoD STEM careers.

[18] $p < .05$ with paired samples t-test (2-tailed); Mean Diff: .933, t = 3.50, $p = .004$, $d = .904$, strong effect

Attitudes toward Army/DoD STEM. Five items measured apprentices' attitudes toward Army STEM research and careers. Chart 15 summarizes apprentices' responses.



Most apprentices (84-92%) expressed agreement that Army research and researchers have made valuable contributions to science and engineering fields and to society. A majority of SEAP apprentices (87%) credited SEAP with improving their understandings of Army/DoD STEM contributions. In contrast to the 44% who became interested in a job or career with the Army/DoD during SEAP, 85% expressed they would be comfortable taking a civilian position in STEM with the Army/DoD. This difference suggests that SEAP serves to inspire new interest and sustain existing interest in Army/DoD STEM careers. Subsequently, 73% of the 15 mentor respondents agreed or strongly agreed that their apprentices expressed a positive attitude toward the Army/DoD and STEM careers it offers.

SEAP apprentice focus groups provide elaboration of these data. Nearly half of apprentice interviewees suggested they would consider STEM jobs or careers with Army or other DoD agencies. Apprentices' reasons included the value of Army/DoD research both society and more specific needs of national security, the enjoyable atmosphere within Army research labs, apprentices' willingness to consider any position that aligns with their professional interests. A small number also suggested they might later consider Army/DoD STEM positions after clarifying their educational and career goals. Less than half of apprentice interviewees declared they were not interested in Army/DoD STEM positions because they perceived their professional interests did not align with Army/DoD STEM interests, budget cuts (including furloughs) are unattractive, an academic research setting is preferred, and security and procurement procedures are cumbersome.

We can conclude from apprentice data that SEAP potentially impacted students' awareness of, attitude toward, and interest in Army STEM. SEAP served to inspire interest in new STEM careers, including 44% expressing new interest in Army/DoD STEM careers. Since 85% would consider a civilian position in STEM with the Army/DoD, SEAP likely also sustained pre-SEAP interest in Army/DoD STEM careers. Furthermore, 87% of apprentices credited SEAP with improving their understanding Army/DoD STEM contributions. Focus group data suggests that SEAP provided apprentices with realistic snapshots of work at Army research labs, including both potential benefits and challenges of the work and work environment.

What Participants are Saying

An overwhelming majority of apprentices and mentors surveyed and interviewed spoke highly of their SEAP experiences. Apprentices and mentors alike frequently encouraged expansion of SEAP to address unmet local need and suggested more and better marketing for both recruitment and greater public awareness of AEOP's role in STEM education. A unique perspective of one apprentice was to consider recruiting and selecting apprentices that are not typically considered the highest achievers or that come from non-STEM-focused high schools—to inspire and encourage interest and inclusion of underserved groups. A unique perspective of another apprentice was to keep SEAP a secret, rather than recommending his friends apply, so he could have a better chance of securing a highly valued SEAP apprenticeship next summer. The following quotations provide further illustration of overall participant satisfaction:

SEAP Apprentices would participant again, if given the chance:

- "Yes, I would. I am interested in working for the government in the future and more experience now will help me affirm that is indeed something I would like to do."
- "I would love to participate in SEAP again. The exposure to professionalism, discipline, and the STEM field itself were a great experience for an aspiring scientist."
- "I would likely participate in SEAP again if I had the option. SEAP allows for exploration of jobs in STEM-related fields that might otherwise have been unknown to me or others, and allows for learning and real experience in an area of interest before the student goes to college and begins a degree."
- "I would love to participate in SEAP again. SEAP has been an amazing experience and has helped me to choose my career."
- "Yes I would participate in SEAP again because it gives me experience in the field I want to go into in the future. It gives me a good, strong background in research and conducting my own projects and helps to prepare me for college and my career."
- "Yes because it was a great introduction to the field of science. I learned various scientific techniques that I'm excited to incorporate to my school science classes."
- "Yes, I really enjoyed my experiences. I learned that science usually doesn't work, but you just have to keep trying. Only through failure can you succeed."

SEAP Apprentices value the experience SEAP offers:

- "My SEAP mentor taught me how science really is in real life; it's not like school where everything always works."
- "Learning about the other careers, because I already knew I wanted to work for the DoD but once I saw the 3D Printing Lab I knew exactly what I wanted to study and work in."
- "I am highly satisfied with the SEAP research project. It has proven to be a challenging and entertaining learning experience, and I feel that I have grown as a student and researcher as a result of my involvement with the program. The most valuable part of the experience was, by far, the real-world research laboratory experience…"
- "I think it is a great program! It gives student an opportunity to gain hands-o n research beyond what they are provided with in the classroom."

SEAP Mentors value their apprentice's contributions:

- "[She] is an intelligent intern with a good ability to analyze experimental designs and results and how to make the experiments better. I value her input."

- "The research that [he] is doing this year is very important for the advanced development of a chemical countermeasure drug that may become part of the Army's standard of care for nerve agent exposure in the field. [He] has seen that the path of research is not always straight forward but instead obstacles often arise unexpectedly. I am happy to report that [he] has responded to the challenges we have faced during his apprenticeship and his data will help the Army make their critical decision on the use of the drug in the future."

SEAP Mentors benefit from participating in SEAP and CQL:

- "It's extremely beneficial. It kind of alleviates my guilt of always bothering my PI's the past few years. I feel like I can pay it forward… now (she) is coming to me. I always feel like I should invest in her and give her a lot of time because my PI's were always extremely busy yet gave me the time to explain things. Also, I think it's good to hear your own mantra's – like, you need to have resilience, you need to be patient, or it's going to be ok. It's reassuring to me, when my experiments aren't working for the fifth week, or I thought I had every contingency plan but there's five more… or even I just don't know the answer. I'm not here to have the answers, we're here to figure it out together. It's me kind of me retraining myself also. I look forward to every summer having a student."
- "I love it. I really enjoy doing it. (I agree with paying it forward) I remember the guy many years ago that finally saw me wandering around in the lab and took me under his wing and let me follow him for a year and taught me everything. We get busy with committees and budgets and proposals and everything and sometimes you forget how fun the science really is and why you got into it in the first place, to see the students develop and come along and learn it and take delight in that knowledge, I really enjoy it. I really do. I always have."
- "I think it's a win-win situation for everybody involved. The lab benefits and we get some really important work out of these kids, especially as they develop in maturity and their ability to work independently in the lab. They get a really important experience working in the lab, they learn a lot of good techniques, they learn what the scientific process is all about and decide early on whether it's something for them, if so… they have that experience, the contacts, the recommendations to carry them on through college and into their career. It also leaves a very good impression in their minds of the Army and what the Army is doing. Hopefully they leave here with good memories and good experiences which will impact them in the future... It's well worth it for everybody."
- "It is worthwhile for the mentors, the laboratories, and the students. A lot of these students want to go into STEM industry. These students get the experience that they need to get the jobs that they want – professional development."

Summary of Findings

The 2013 evaluation of SEAP collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 15.

Table 15. 2013 SEAP Evaluation Findings	
Participant Profiles	
Low participation of SEAP apprentices and mentors in evaluation assessments limit the reliability of findings.	• Statistical reliabilities achieved for questionnaire samples (±11.7% margin of error for apprentices, ±23.5% margin of error for mentors) suggest limited representativeness of samples. However, alternate methods for establishing representativeness suggest we may sufficiently generalize findings from the apprentice questionnaire respondents to the apprentice population.
	• Findings from mentor questionnaires should be cautiously generalized with consideration given to the calculated margins of error and with triangulation of findings with other data.
SEAP had some success in providing outreach to participants from historically underrepresented and underserved populations.	• Apprentices included female students (30%)—a population that is historically underrepresented in some STEM fields.
	• Apprentices included students who identified as Black or African American (3%) or Hispanic or Latino (3%)—these populations are among those historically considered underserved and underrepresented in STEM education.
	• While apprentices attended schools in urban (10%) and rural (13%) settings, no apprentices reported qualifying for free or reduced lunch at school, a common indicator of low-income status.
	• Mentors identified as predominantly male (67%) and White or Caucasian (67%). Less than 10% identified as Black or African American (3%) and Hispanic or Latino (3%).
SEAP apprentices intend to pursue post-secondary education in STEM.	• 97% of apprentices planned to pursue a degree in a STEM field (10% Bachelors, 31% Masters, and 56% Doctorate)
	• Large proportions of apprentices planned to pursue engineering (39%) and medicine/health-related fields (26%). Apprentices also intended to pursue math/computer science (16%), chemistry (11%), physical science (3%) and life science (3%).
Actionable Program Evaluation	
SEAP marketing and recruitment was largely a site-based endeavor.	• SEAP sites market SEAP to local schools and universities, to local educators, and to participants of their GEMS programs.
	• Apprentices most frequently reported learning about SEAP through family, family friends, or school staff with connections to the SEAP mentor and/or Army research facility. 30% of apprentices reported having a family member or family friend at the Army research facility where the SEAP apprenticeship took place.
	• Apprentices who identified as GEMS alumni reported learning about SEAP through GEMS activities and staff.
	• Many mentors reported selecting apprentices that had been "vetted" by a personal or professional connection of the mentor.

SEAP apprentices seek opportunities to clarify and advance their STEM pathways.	• Apprentices were motivated to participate in SEAP by encouragement they received from others who have connections to the SEAP program, by their own positive experiences in GEMS programs, and by opportunities SEAP could provide to clarify and advance their STEM pathways.
SEAP mentors seek opportunities to engage with STEM learners in their work.	• Mentors were motivated to participate in SEAP because of positive experiences as CQL, SEAP, or GEMS mentors, by opportunities to re-engage former apprentices in the research project, and by opportunities to have project needs met by hosting an apprentice.
SEAP mentors engaged their apprentices in STEM research and provided limited guidance about educational and career pathways during the SEAP apprenticeship.	• Apprentices and mentors reported similar types and frequencies of mentor activities related to engaging apprentices in STEM research. Most frequently they reported training the apprentice to perform laboratory tasks and procedures; providing apprentices with constructive feedback; and efforts to ground the apprentices' laboratory-based work in scientific principles (e.g., assigning readings, teaching sessions, participation in journal club).
	• A large significant difference was found in proportions of apprentices and mentors reporting mentorship around careers (apprentices = 67%, mentors = 100%). Mentor interviewee comments possibly clarify this finding, suggesting that career-related guidance is more frequently provided to CQL apprentices than to SEAP apprentices, or is provided after the apprenticeship through ongoing communication with SEAP apprentices.
SEAP mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers outside of the SEAP site.	• Most mentor interviewees had limited awareness of AEOP initiatives beyond the GEMS, SEAP, and CQL programs running at their Army research facility. Subsequently, mentors did not consistently educate their apprentices or encourage their participation in those AEOP initiatives.
	• Mentors suggested that informational resources, mentor training, and a command-level emphasis on promoting other AEOPS were necessary to accomplish this objective.
	• Mentors reported a variety of strategies for mentoring apprentices about STEM careers, with a strong emphasis on Army/DoD STEM careers.
	• Mentors perceived that furloughs, their own lack of awareness about STEM careers (beyond their own), lack of resources, and apprentice disinterest in STEM or Army STEM careers were challenges to providing career mentorship.
SEAP benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that SEAP benefits apprentices by providing authentic research opportunities not available typical school settings, opportunities to clarify or advance their STEM pathway, and opportunities to develop and expand research skills.
	• Mentors also perceived benefits of SEAP to their laboratories and to themselves. Most notably, mentors indicated that apprentices are low-cost yet highly effective members of the lab, and apprentices have made meaningful contributions to research with near-term impact on Army processes or procedures.
SEAP's administrative processes and support are a possible area for improvement.	• Apprentices and mentors alike perceived challenges with the "cumbersome" and "time-consuming" administrative tasks associated with the SEAP program, suggesting they detract from work that can be accomplished during an already short (and furlough-disrupted) summer apprenticeship. Mentors perceived low organization of and support for these tasks.

Outcomes Evaluation	
SEAP engaged apprentices in authentic STEM activities more frequently than their school environment.	• Apprentices reported that SEAP provides more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (32%-66% in SEAP, 17-39% in school) and hands-on research activities (35%-62% in SEAP, 8%-39% at school).
	• Moderate to large significant differences were found in apprentices perceptions of how frequently they did the following in SEAP as compared to school: used, cared for, and calibrated equipment; employed advanced measurement techniques; defined research questions; and worked as part of a research team.
	• Apprentice and mentor data suggested SEAP had a larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
SEAP apprentices become more confident in STEM, and mentors rate their research skills highly.	• A majority of apprentices (58%-79%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (48%-59%) rated their apprentices at near expert or expert levels of the development continuum across 6 key STEM skills and abilities: information literacy, scientific reasoning, laboratory, data collection, quantitative literacy, and teamwork and collaboration. Most mentors (57%-79%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels.
SEAP apprentices will serve as STEM role models for their peers	• 50-81% of SEAP apprentices intend to serve as a role models by sharing their SEAP experiences with friends, recommending SEAP to friends, encouraging friends to study more STEM, and mentoring younger STEM learners.
SEAP apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Many apprentices (32%-97%) and mentors (13-78%) were unaware of other AEOP initiatives, with higher proportions lacking awareness for programs occurring outside of the Army research facility.
	• SEAP apprentices are interested in participating in other AEOP opportunities: high school STEM competitions (5-21%), high school apprenticeships (36%), college apprenticeships (60%), and college scholarship programs (60%). This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
SEAP apprentices have positive attitudes toward the defense community and a view toward potential government service.	• A majority of apprentices had opportunities to learn about new STEM careers during SEAP as reported by apprentices and mentors (64% apprentices, 53% mentors). Army/DoD STEM careers received substantial attention (69% apprentices, 54% mentors).
	• SEAP served to inspire interest in new STEM careers, with 44% of apprentices expressing new interest in Army/DoD STEM careers in particular. 85% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society.
	• Most apprentices (87%) credited SEAP with improving their understanding Army/DoD STEM contributions. Most mentors (73%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Greater commitment should be made to producing more reliable and valid evaluation of SEAP activities and benefits to participants. The 2013 evaluation provides valuable information regarding how SEAP is perceived by less than half of participants, and begins to provide evidence for how the program has impacted SEAP apprentices. However, the low response rate from both SEAP apprentices and mentors poses the most significant threat to the validity of these findings. In other words, we have limited confidence that these findings of questionnaire respondents are representative of or can be generalized to the full population of participants. Mentors provide an authoritative, albeit subjective, assessment of apprentices' performance (STEM competencies) at the end of the program that is otherwise not possible; future evaluation will further rely on mentors to assess *growth* in apprentices' STEM competencies. Their participation in SEAP's evaluation is vital. Coordinated efforts should be made by the Army, ASEE managers, and site coordinators to encourage and improve apprentice and mentor participation in the SEAP evaluation efforts. Subsequently, evaluators should endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments to further maximize participation.

2. The number of applications for SEAP apprenticeships (814 applications for 101 funded apprenticeships) is indicative of unmet need. Of particular note, the rate of participation varied from 0% to 35% at SEAP sites having greater than 4 applicants. To the extent allowed by annual budget constraints, SEAP should endeavor to engage more Army S&E mentors, thereby creating more apprenticeship positions to populate. SEAP programming may benefit from a careful examination of and attention to program- and site-level structures, processes, and resources that both enable and discourage Army S&Es' participation in SEAP. Program- and site-level accommodations may be required to further improve Army S&Es' awareness of SEAP, feasibility of their participation, and overall motivation to participate in SEAP. Simultaneous with this effort, ASEE and SEAP sites should consider how to effectively recruit a more demographically diverse mentor pool to provide apprentices with greater access to same-demographic role models and mentors.

3. SEAP and AEOP objectives include expanding participation of historically underrepresented and underserved populations. While ASEE conducts targeted marketing of SEAP to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in determining SEAP apprentices. SEAP may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide, including but not limited to maximizing the recruitment and repeated engagement of female, racial/ethnic minorities, and low- income students in GEMS programming, and subsequent recruitment of those individual GEMS alumni as SEAP apprentices. Guidance may also be provided to ensure other "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and SEAP sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site).

4. Apprentice and mentor data suggested that SEAP apprentices have more opportunities to participate in the hands-on aspects of research and fewer opportunities to participate in the academic (minds-on) aspects of research, including technical writing. Site coordinators and mentors might explore strategies that appropriately and meaningfully expand apprentices' opportunities to engage in all aspects of the research under the tutelage of their mentor, including opportunities to generate research questions, design experiments, analyze and interpret data, formulate conclusions, and contribute to technical writing about the research in which they are engaged. Whether these strategies are mentors modeling such practices for apprentices, scaffolding "thought exercises" to be completed by apprentices, or coaching apprentices through making real contributions in these areas, such efforts will maximize apprentices' professional development as STEM apprentices, better mirror the day to day practices of scientists and engineers, and more closely align with current research and best practices identified for effective STEM learning.

5. ASEE, SEAP sites, and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encouraging continued participation in programs for which apprentices qualify. Evaluation data suggests that SEAP apprentices and mentors were largely unaware of other AEOP initiatives, especially those offered outside of the Army research facilities. Yet, substantial apprentice interest exists in AEOPs. This interest would benefit from more robust attention by site coordinators and mentors during SEAP program activities. Continued guidance by ASEE is needed for educating SEAP site coordinators and mentors about AEOP opportunities, especially beyond the SEAP sites. Adequate resources and guidance for using them with apprentices should be provided to all site coordinators and mentors in order that all apprentices leave SEAP with an idea of their next steps in AEOP, whether at or outside of the Army site.

6. Most apprentices had opportunities to learn about STEM research and careers during SEAP, especially Army/DoD STEM research and careers to which they are exposed daily. However, many mentors reported lack of awareness of STEM careers beyond their own, lack of informational resources, and lack of time for educating apprentices about other STEM careers. We strongly recommend a SEAP- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[19]

7. As reflected in the apprentice respondent profile Table 9 (and footnote 6), the evaluation assessments revealed that a number of college students were supported through SEAP apprenticeships, rather than through CQL apprenticeships that are expressly intended for college students. Support of college students in SEAP programming does not align with the intent or objectives of the program, and may impact other aspects of programming, including discrepancy in program budget versus expenditures due to different pay scales offered to high school and college students, as well as lack of consistency or coherence in the SEAP experiences of apprentices. During the summer 2013 evaluators communicated these findings to ASEE and to the Army, and the development of a standard operating procedure (SOP) has since been initiated. It will be important for ASEE and the Army to closely monitor and support SEAP sites for compliance of the SOP during FY14 programing and beyond.

[19] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

Appendices

Appendix A:
2013 SEAP Evaluation Plan

Key Evaluation Questions

The SEAP evaluation 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:

- 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 careers?

Methods and Instruments

The FY2013 evaluation used a mixed methods approach[1] to allow for broad generalization and for deeper focusing of the evaluation. This mixed methods approach employed quantitative measures to assess level of agreement or satisfaction, as well as qualitative measures, such as open or constructed-response items in questionnaires and focus groups that provided less structured items assessing perceived value, satisfaction, or suggestions for improvement.

The assessment strategy for SEAP included onsite focus groups with apprentices and mentors at 4 SEAP sites, a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubrics.

Data Collection and Sampling

Evaluators collected data from 2013 summer programs during a six week period from early July through mid-August, and, when possible, toward the conclusion of a site's summer activities. Focus groups were conducted at 4 SEAP sites in the Eastern, U.S. Mentor focus groups included 20 mentors for SEAP and/or CQL (10 females, 10 males), as they often worked with both programs. Apprentice focus groups included 24 apprentices (12 females, 12 males). While evaluators provided program staff with guidelines for purposive sampling—equal representation of males and females and a range of age/grade levels, race/ethnicity demographics, and STEM interests—when assembling focus groups where large numbers of students were available, convenience sampling was ultimately employed for both apprentice and mentor focus group at each site.

Evaluators administered online questionnaires to apprentice and mentor participants during a 10-day period in late July and early August (more than halfway through the apprenticeship) to accommodate a review of data in support of FY14 planning. The questionnaires continued to collect data beyond that period, in an order to allow mentors to complete rubrics for their apprentices' final project and presentation. Few mentors did so. Questionnaires also employed convenience sampling. All apprentices and mentors were invited to participate in these questionnaires, which were emailed to them by the CQL

[1] Creswell, 2003; Quinn 2001; Greene & Caracelli, 1997

program administrator and/or CQL site coordinator. Mentors were also sent links for the apprentice questionnaire to further encourage apprentice participation. Questionnaires consisted of closed or forced-response "quantitative" items as well as opened or constructed-response "qualitative" items.

Data Analyses

Quantitative and qualitative data were compiled and analyzed after all data collection concluded.

Evaluators summarized quantitative data with descriptive statistics such as numbers of respondents, frequencies and proportions of responses, average response when responses categories are assigned to a 6-point scale (e.g., 1 = "Strongly Disagree" to 6 = "Strongly Agree"), and standard deviations. All apprentice and mentor data collected from questionnaires are summarized fully in Appendices B and C.

Charts used within this report narrative provide visual representations of data in terms of proportions of responses, unless otherwise noted. This allows the reviewer to easily apply the determined margin of error for each participant groups' questionnaire responses. For visual simplicity of charts, "Somewhat Disagree" and "Somewhat Agree" (and similar categories) are aggregated as "Neutral" responses.

Evaluators conducted inferential statistics (herein called comparison or significance testing[2]) on key items to compare effect of SEAP and school experience, or to compare participant group perceptions, ultimately to identify statistically and practically significant differences in these data. Statistical significance indicates whether a result is different than chance alone. Statistical significance is determined with t-, McNemar, ANOVA, or Tukey's tests, with significance defined at $p < 0.05$. Practical significance, also known as effect size, indicates how weak or strong (also noted as small or large) an effect is and is usually studied in relation to statistical significance. Practical significance is determined with Cohen's *d* or Pearson's *r*, with *d* or *r* of .250, which is considered weak but "substantively important" at $p < 0.05$.[3] Statistically and/or practically significant findings are noted as "statistical" or "significant" in the report narrative with footnotes or tables providing details and results of statistical tests. These findings should be taken as potential indicators of effect and potentially promising activities for sites to explore in more depth; they should not be taken as a rigorous measure of the effectiveness of any one sites' structures, processes, or activities.

Evaluators analyzed qualitative data, including constructed-response questionnaire and focus group data for emergent themes. These data are then summarized by theme, by frequency of participants addressing a theme, and sample participant responses for that theme. When possible, two raters analyze each complete qualitative data set. When not possible, a portion of the data set are analyzed by both raters to determine and ensure inter-rater reliability. Thus, the summary of themes and frequency for constructed-response questionnaire items generally represent evaluators' consensus ratings.

[2] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

[3] U.S. Department of Education, What Work's Clearinghouse Procedures and Standards Handbook, accessed June 30 http://ies.ed.gov/ncee/wwc/pdf/reference_resources/wwc_procedures_v3_0_draft_standards_handbook.pdf

Appendix A:
2013 SEAP Evaluation Plan

To the extent possible, findings were triangulated across data sources (apprentices, mentors), data types (quantitative questionnaire data and qualitative data from questionnaires and focus groups), and different evaluators conducting the analyses and reporting. This triangulation enhances the credibility of findings synthesized from single data sources or data types. For example, evaluators identify trends from the qualitative data—emergent themes with high frequencies in respondents addressing them—to provide additional evidence of, explanation for, or illustrations of quantitative data. We have posed plausible explanations when divergence between data sources or data types is evident; any such explanations are worthy of further exploration in the full study and, potentially, in future evaluation efforts. Periodically, less unique perspectives are reported and identified as such when they provide illustration that captures the spirit of SEAP or AEOP objectives.

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Thank you for your participation in this study about the 2013 Science and Engineering Apprenticeship Program (SEAP). The following survey will collect information about you, your experiences in school, and your experiences in SEAP. The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support SEAP.

About this survey:

- This survey is CONFIDENTIAL; no one will be able to tell who said what so your comments cannot be held against you.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time. If you provide your email address, the AEOP may contact you in the future to ask about your academic and career success.
- We do hope that you will finish the survey because your responses will give SEAP valuable information for improvement.

By completing this survey, you are providing your assent to participate in the research/evaluation study

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Tim Donovan, American Society for Engineering Education
Project Assistant, SEAP
(202) 649-3833, T.Donovan@asee.org

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Provide your personal information below (optional):

First Name: _____
Last Name: _____
Email Address: _____

What is your age (in years)?

- ❍ 14 years
- ❍ 15 years
- ❍ 16 years
- ❍ 17 years
- ❍ 18 years
- ❍ Other (specify): _____

What grade/class rank will you start this fall?

- ❍ 9th grade
- ❍ 10th grade
- ❍ 11th grade
- ❍ 12th grade
- ❍ College freshman
- ❍ Other _____

Who is your SEAP mentor?

Your mentor's first name: _____
Your mentor's last name: _____

Did you participate in GEMS as a student?

- ❍ No
- ❍ Yes: How many times? _____

Have you ever worked as a SEAP apprentice before?

- ❍ No
- ❍ Yes: How many times? _____

As part of your CURRENT SEAP experience, are you serving as a "near-peer" mentor for GEMS?

- ❍ No
- ❍ Yes

Have you worked as a "near-peer" mentor before?

- ❍ No
- ❍ Yes: How many times? _____

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

In which laboratory are you currently working? (select from the list)

- ❍ AMRDEC; Redstone Arsenal, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ECBC; Edgewood, MD
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ NATICK; Natick, MA
- ❍ USACEHR; Fort Detrick, MD
- ❍ USACIL; Fort Gillem, GA
- ❍ USAMRICD; Aberdeen, MD
- ❍ USAMRIID; Fort Detrick, MD
- ❍ Walter Reed (WRAIR); Silver Spring, MD
- ❍ Other (specify): _____

Prior to becoming a SEAP apprentice, did you already know someone who works at your laboratory site?

- ❍ Yes - a family member that works at this lab site
- ❍ Yes - a family friend that works at this lab site
- ❍ No - I did not know anyone that works at this lab site

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your ethnicity/race?

- ❍ American Indian or Alaska Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White or Caucasian
- ❍ Some other ethnicity/race: _____
- ❍ Choose not to report

What kind of school do you attend?

- ❍ Public
- ❍ Private
- ❍ Home School
- ❍ Other (Please Specify) _____

Which of the following best describes your REGULAR SCHOOL?

- ❍ It is in a RURAL setting
- ❍ It is in a SUBURBAN setting
- ❍ It is in an URBAN setting
- ❍ Other (Please Specify) _____

Do you qualify for free / reduced lunch at school?

- ❍ Yes
- ❍ No
- ❍ I don't know / choose not to answer

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Take a moment to think about the Science, Technology, Engineering, and Math (STEM) activities during your SEAP experience. Then, use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I want to study more Science, Technology, Engineering, or Math (STEM) after participating in SEAP	❍	❍	❍	❍	❍	❍
I enjoyed the hands-on / laboratory activities at SEAP	❍	❍	❍	❍	❍	❍
After my SEAP experience, I think I would like to join a STEM-based club	❍	❍	❍	❍	❍	❍
I learned many new and interesting things during the day-to-day activities at SEAP	❍	❍	❍	❍	❍	❍
I like to share the information that I learned in SEAP with my friends and family	❍	❍	❍	❍	❍	❍
I think about the new STEM information I learned in SEAP when I am outside of the SEAP site	❍	❍	❍	❍	❍	❍
After SEAP, I am interested in joining a STEM-related professional organization	❍	❍	❍	❍	❍	❍
I want learn more about the STEM topics that I was exposed to during SEAP	❍	❍	❍	❍	❍	❍
After SEAP, I will encourage my friends to study more STEM courses	❍	❍	❍	❍	❍	❍
I will recommend SEAP to my friends	❍	❍	❍	❍	❍	❍
After SEAP, I want to mentor younger students in learning about STEM	❍	❍	❍	❍	❍	❍

Please take a moment to think about your SEAP mentor. Use the scale provided to tell us how much you agree or disagree with the following statements:

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
My SEAP mentor frequently worked with me in the laboratory	❍	❍	❍	❍	❍	❍
I learned a lot from my SEAP mentor about performing STEM research	❍	❍	❍	❍	❍	❍
My SEAP mentor encouraged me to perform a variety of tasks in the laboratory	❍	❍	❍	❍	❍	❍
My SEAP mentor helped me to formulate my educational goals	❍	❍	❍	❍	❍	❍
My SEAP mentor taught me how to work more effectively in a laboratory	❍	❍	❍	❍	❍	❍
MY SEAP mentor spoke with me about my career interests	❍	❍	❍	❍	❍	❍
My SEAP mentor helped me become a better writer of scientific research	❍	❍	❍	❍	❍	❍
I would like to work with my SEAP mentor again	❍	❍	❍	❍	❍	❍

Please take a moment to consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In school, I had to define a research question or thesis and determine its critical concepts	❍	❍	❍	❍	❍	❍
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	❍	❍	❍	❍	❍	❍
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	❍	❍	❍	❍	❍	❍
In school, I had to organize and synthesize information across academic sources	❍	❍	❍	❍	❍	❍
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	❍	❍	❍	❍	❍	❍
In school, I had to work as part of a team on research projects	❍	❍	❍	❍	❍	❍

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your SEAP research experiences. Use the scale provided to indicate how often you performed each of the following activities IN SEAP:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In SEAP, I had to define a research question or thesis and determine its critical concepts	❍	❍	❍	❍	❍	❍
In SEAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	❍	❍	❍	❍	❍	❍
In SEAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	❍	❍	❍	❍	❍	❍
In SEAP, I had to organize and synthesize information across academic sources	❍	❍	❍	❍	❍	❍
In SEAP, I had to determine appropriate ethical and legal uses of published academic research for my own work	❍	❍	❍	❍	❍	❍
In SEAP, I had to work as part of a team on research projects	❍	❍	❍	❍	❍	❍

Please take a moment to consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In school, I used advanced science or engineering equipment	❍	❍	❍	❍	❍	❍
In school, I cleaned and cared for the equipment in a science or engineering laboratory	❍	❍	❍	❍	❍	❍
In school, I calibrated laboratory equipment for experimentation	❍	❍	❍	❍	❍	❍
In school, I created solutions from reagents in preparation for experimental procedures	❍	❍	❍	❍	❍	❍
In school, I used proper safety procedures when handling equipment and material in the lab	❍	❍	❍	❍	❍	❍
In school, I employed advanced measurement techniques in science or engineering procedures	❍	❍	❍	❍	❍	❍

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your SEAP research experiences. Use the scale provided to indicate how often you performed each of the following activities IN SEAP:

	Never	Once per week	2 or 3 times per week	4 or 5 times per week	Every day	Multiple times per day
In SEAP, I used advanced science or engineering equipment	❍	❍	❍	❍	❍	❍
In SEAP, I cleaned and cared for the equipment in a science or engineering laboratory	❍	❍	❍	❍	❍	❍
In SEAP, I calibrated laboratory equipment for experimentation	❍	❍	❍	❍	❍	❍
In SEAP, I created solutions from reagents in preparation for experimental procedures	❍	❍	❍	❍	❍	❍
In SEAP, I used proper safety procedures when handling equipment and material in the lab	❍	❍	❍	❍	❍	❍
In SEAP, I employed advanced measurement techniques in science or engineering procedures	❍	❍	❍	❍	❍	❍

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how accurately each statement describes you AFTER SEAP:

	Not at all like me	Not like me	Not much like me	Somewhat like me	Like me	Just like me
After SEAP, I am more confident in my ability to formulate hypotheses and design experiments to test them	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident that I can analyze data and understand the results of an experiment	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident in my ability to complete academic literature reviews for my own research projects	❍	❍	❍	❍	❍	❍
After SEAP, I am more confident that I can make significant research contributions as an effective part of a research team	❍	❍	❍	❍	❍	❍

Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?

❍ I do not plan to attend college
❍ 2-year/Associate's degree in a science, technology, engineering, and/or mathematics (STEM) related field.
❍ 2-year/Associate's degree in something other than a STEM-related field.
❍ Bachelor's degree in a science, technology, engineering, and/or mathematics (STEM) related field.
❍ Bachelor's degree in something other than a STEM-related field.
❍ Master's degree in a STEM-related field.
❍ Master's degree in something other than a STEM-related field.
❍ Doctoral degree in a STEM-related field.
❍ Doctoral degree in something other than a STEM-related field.

Consider the highest level of education that you plan to pursue (your response to the question above). Use the scale below to tell us how certain you are that you will be able to do each of the following:

	Not at all Certain	Uncertain	Relatively Uncertain	Relatively Certain	Certain	Very Certain
I will be admitted into my program of choice	❍	❍	❍	❍	❍	❍
I will attend college to pursue this educational degree	❍	❍	❍	❍	❍	❍
I will get good grades in my classes	❍	❍	❍	❍	❍	❍
I will be able to overcome any obstacle between me and this educational degree	❍	❍	❍	❍	❍	❍
I will finish this degree	❍	❍	❍	❍	❍	❍

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Which of the following categories best describes the STEM field you want to pursue?

- ❍ Engineering (e.g., technology, robotics, computers, etc.)
- ❍ Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)
- ❍ Physical Science (e.g., physics, astronomy, etc.)
- ❍ Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)
- ❍ Life Science (e.g., biology, animal science, ecology, etc.)
- ❍ Medicine / Health (e.g., behavioral science, medicine, public health, etc.)
- ❍ Mathematics / Computer Science
- ❍ Social Science (e.g., sociology, psychology, economics, etc.)
- ❍ Other STEM field
- ❍ A field unrelated to STEM

Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
In SEAP, I learned about new STEM-related jobs/careers.	❍	❍	❍	❍	❍	❍
In SEAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
In SEAP, I became interested in a STEM job/career I did not know about before.	❍	❍	❍	❍	❍	❍
In SEAP, I became interested in a new STEM-related job/career with the Army/DoD	❍	❍	❍	❍	❍	❍

Of the new STEM jobs/careers that you learned about, which three did you find MOST INTERESTING? (Please list them):

Job #1:

Job #2:

Job #3:

Use the scale provided to tell us how much you agree or disagree with the following statements about the Department of Defense (DoD):

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
The Army/DoD has made many important contributions to science and engineering with applied research	❍	❍	❍	❍	❍	❍
Army/DoD researchers contribute much more to society than just "warfare" advancements	❍	❍	❍	❍	❍	❍
Army/DoD researchers use cutting-edge technology to solve the world's problems	❍	❍	❍	❍	❍	❍
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	❍	❍	❍	❍	❍	❍
After SEAP, I have a better understanding of the important contributions that Army/DoD researchers have made every day civilian life	❍	❍	❍	❍	❍	❍

Have you ever participated in/heard about any of the following programs?

	Yes, I participated	I would have participated but it was not available in my area	I have never heard about this program
Junior Solar Sprint (JSS): A solar-car building and race for 6th – 8th grade	❍	❍	❍
Junior Science and Humanities Symposium (JSHS): A high school STEM research competition	❍	❍	❍
UNITE: An engineering summer program for high school students from underserved groups	❍	❍	❍
West Point Bridge Contest: A computer-based engineering design competition for 6th-12th grade	❍	❍	❍
eCYBERMISSION: A web-based science, technology, engineering, and mathematics (STEM) competition for 6th-9th grade	❍	❍	❍

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Have you been provided with information about the following programs that are sponsored by the U.S. Army? Do you want to participate?

	I already participated in this program	Yes - I want to participate	Yes - I would participate but it is not available in my area	Yes - but I do not want to participate	I have never heard about this program
High School Internships: Internships in laboratories and colleges throughout the country (REAP and HSAP)	❍	❍	❍	❍	❍
College Internships : Internships in Army laboratories through College Qualified Leaders (CQL) and in laboratories at colleges throughout the country (URAP)	❍	❍	❍	❍	❍
The Science, Mathematics And Research for Transformation (SMART) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	❍	❍	❍	❍	❍
The National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	❍	❍	❍	❍	❍

The Junior Science and Humanities Symposium (JSHS) provides support to high school students who compete in regional and national symposia where they present their STEM research investigations before a panel of STEM experts. Scholarships and other awards are presented to students who compete in oral research presentations. Using the scale provided, please tell us how certain you are that you will do the following:

	Not at all Certain	Uncertain	Relatively Uncertain	Relatively Certain	Certain	Very Certain
I will submit my research project/final presentation to JSHS during the 2013-2014 school year	❍	❍	❍	❍	❍	❍

Do you intend to submit your SEAP research project/final presentation to any other science fairs or competitions?

❍ No

❍ Yes, which one(s)? _____

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Given the opportunity, would you participate in SEAP again? Why or Why not?

Do you have any other comments or input to provide us regarding your SEAP mentor?

In a couple of sentences, tell us about your overall satisfaction with the SEAP research project/final presentation: What was the most valuable part of that experience?

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:

Rebecca Kruse – rkruse75@vt.edu or Tanner Bateman – tbateman@vt.edu

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

What is your age?		
	Freq.	**%**
16 years	13	31%
17 years	18	43%
18 years	8	19%
19 years	0	0%
20 years	1	2%
21 years	2	5%
Total	**42**	**100%**

Note. Average age = 17.1 years

What grade/class rank will you start this fall?		
	Freq.	**%**
10th grade	1	2%
11th grade	2	5%
12th grade	25	60%
College freshman	11	26%
College sophomore	0	0%
College junior	2	5%
College senior	1	2%
Total	**42**	**100%**

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Did you participate in GEMS as a student?		
	Freq.	**%**
No	31	76%
Yes – one time before	2	5%
Yes – two times before	1	2%
Yes – three times before	5	12%
Yes – four times before	2	5%
Total	**41**	**100%**

Have you ever worked as a SEAP before?		
	Freq.	**%**
No	32	78%
Yes – one time before	7	17%
Yes – two times before	1	2%
Yes – three times before	1	2%
Total	**41**	**100%**

As part of your CURRENT SEAP experience, are you serving as a "near-peer" mentor for GEMS?		
	Freq.	**%**
No	36	90%
Yes	4	10%
Total	**40**	**100%**

Have you ever worked as a “near-peer” mentor before?		
	Freq.	**%**
No	37	93%
Yes – one time before	2	5%
Yes – two times before	1	2%
Total	**40**	**100%**

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

At which laboratory are you currently working (select from the list)?						
SEAP Site	**Freq.**	**%**		**SEAP Site**	**Freq.**	**%**
AMRDEC; Redstone Arsenal, AL	2	5%		**USACEHR; Fort Detrick, MD**	2	5%
ARL-A; Adelphi, MD	8	20%		**USACIL; Fort Gillem, GA**	0	0%
ARL-APG; Aberdeen, MD	14	35%		**USAMRICD; Aberdeen, MD**	8	20%
ECBC; Edgewood, MD	0	0%		**USAMRIID; Fort Detrick, MD**	1	3%
ERDC-CERL; Champaign, IL	3	8%		**Walter Reed (WRAIR); Silver Spring, MD**	0	0%
ERDC-MS; Vicksburg, MS	0	0%		**Other (specify):**	2	5%
NATICK; Natick, MA	0	0%				
				Total	**40**	**100%**

Note. Other = "ERDC-TEC", & "Georgetown University"

Prior to becoming a SEAP apprentice, did you already know someone who works at your laboratory site?		
	Freq.	**%**
Yes - a family member that works at this lab site	7	18%
Yes - a family friend that works at this lab site	5	13%
No - I did not know anyone that works at this lab site	28	70%
Total	**40**	**100%**

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Which of the following best describes you?		
	Freq.	**%**
Male	28	70%
Female	12	30%
Choose not to report	0	0%
Total	**40**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	14	35%
Black or African American	1	3%
Hispanic or Latino	1	3%
White/Caucasian	21	53%
Other	1	3%
Choose not to report	2	5%
Total	**40**	**100%**

Note. Other = "Indian"

What kind of school do you attend?		
	Freq.	**%**
Public	32	80%
Private	6	15%
Home School	0	0%
Other	2	5%
Total	**40**	**100%**

Which of the following best describes your regular school?		
	Freq.	**%**
It is in a RURAL setting	5	13%
It is in a SUBURBAN setting	31	78%
It is in an URBAN setting	4	10%
Other	0	0%
Total	**40**	**100%**

Do you qualify for free / reduced lunch at school?		
	Freq.	**%**
Yes	0	0%
No	36	90%
I don't know / choose not to answer	4	10%
Total	**40**	**100%**

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to think about the Science, Technology, Engineering, and Math (STEM) activities that you have participated in during your SEAP experience. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	1	2	3	4	5	6	n	Avg.	SD
I want to study more Science, Technology, Engineering, or Math (STEM) after participating in SEAP	1 (3%)	1 (3%)	0 (0%)	3 (8%)	14 (35%)	21 (53%)	40	**5.28**	1.09
I enjoyed the hands-on / laboratory activities at SEAP	1 (3%)	0 (0%)	2 (5%)	3 (8%)	13 (33%)	21 (53%)	40	**5.25**	1.08
After my SEAP experience, I think I would like to join a STEM-based club	2 (5%)	0 (0%)	5 (13%)	13 (33%)	13 (33%)	7 (18%)	40	**4.40**	1.22
I learned many new and interesting things during the day-to-day activities at SEAP	1 (3%)	0 (0%)	1 (3%)	4 (10%)	15 (38%)	19 (48%)	40	**5.23**	1.03
I like to share the information that I learned in SEAP with my friends and family	0 (0%)	2 (5%)	2 (5%)	6 (15%)	18 (46%)	11 (28%)	39	**4.87**	1.06
I think about the new STEM information I learned in SEAP when I am outside of the SEAP site	1 (3%)	1 (3%)	3 (8%)	8 (20%)	17 (43%)	10 (25%)	40	**4.73**	1.15
After SEAP, I am interested in joining a STEM-related professional organization	1 (3%)	0 (0%)	2 (5%)	8 (20%)	20 (50%)	9 (23%)	40	**4.83**	1.01
I want learn more about the STEM topics that I was exposed to during SEAP	1 (3%)	1 (3%)	3 (8%)	6 (15%)	13 (33%)	16 (40%)	40	**4.93**	1.23
After SEAP, I will encourage my friends to study more STEM courses	1 (3%)	0 (0%)	5 (13%)	12 (30%)	14 (35%)	8 (20%)	40	**4.55**	1.11
I will recommend SEAP to my friends	1 (3%)	2 (5%)	1 (3%)	4 (10%)	17 (43%)	15 (38%)	40	**4.98**	1.21
After SEAP, I want to mentor younger students in learning about STEM	0 (0%)	4 (10%)	8 (20%)	8 (20%)	12 (30%)	8 (20%)	40	**4.30**	1.29

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to think about your SEAP mentor. Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
My SEAP mentor frequently worked with me in the laboratory	2 (5%)	2 (5%)	3 (8%)	10 (26%)	12 (31%)	10 (26%)	39	**4.49**	1.37
I learned a lot from my SEAP mentor about performing STEM research	1 (3%)	1 (3%)	1 (3%)	4 (10%)	17 (44%)	15 (38%)	39	**5.05**	1.12
My SEAP mentor encouraged me to perform a variety of tasks in the laboratory	1 (3%)	0 (0%)	1 (3%)	9 (24%)	12 (32%)	15 (39%)	38	**5.00**	1.09
My SEAP mentor helped me to formulate my educational goals	1 (3%)	0 (0%)	3 (8%)	13 (33%)	12 (31%)	10 (26%)	39	**4.67**	1.11
My SEAP mentor taught me how to work more effectively in a laboratory	2 (5%)	0 (0%)	2 (5%)	10 (26%)	11 (28%)	14 (36%)	39	**4.79**	1.28
MY SEAP mentor spoke with me about my career interests	1 (3%)	1 (3%)	4 (10%)	7 (18%)	16 (41%)	10 (26%)	39	**4.69**	1.20
My SEAP mentor helped me become a better writer of scientific research	1 (3%)	1 (3%)	3 (8%)	10 (26%)	12 (31%)	12 (31%)	39	**4.72**	1.21
I would like to work with my SEAP mentor again	1 (3%)	1 (3%)	0 (0%)	6 (15%)	9 (23%)	22 (56%)	39	**5.23**	1.16

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = "*Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In school, I had to define a research question or thesis and determine its critical concepts	13 (33%)	15 (38%)	6 (15%)	1 (3%)	1 (3%)	3 (8%)	39	**2.26**	1.43
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	9 (23%)	14 (36%)	10 (26%)	2 (5%)	1 (3%)	3 (8%)	39	**2.51**	1.39
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	5 (13%)	16 (41%)	3 (8%)	7 (18%)	3 (8%)	5 (13%)	39	**3.05**	1.62
In school, I had to organize and synthesize information across academic sources	3 (8%)	12 (31%)	11 (28%)	6 (15%)	1 (3%)	6 (15%)	39	**3.21**	1.51
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	8 (21%)	14 (36%)	8 (21%)	3 (8%)	3 (8%)	3 (8%)	39	**2.69**	1.49
In school, I had to work as part of a team on research projects	5 (13%)	17 (44%)	9 (23%)	2 (5%)	4 (10%)	2 (5%)	39	**2.72**	1.36

Please take a moment to consider your SEAP research experiences. Use the scale provided to indicate how often you performed each of the following activities IN SEAP:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In SEAP, I had to define a research question or thesis and determine its critical concepts	4 (11%)	10 (26%)	11 (29%)	6 (16%)	3 (8%)	4 (11%)	38	**3.16**	1.46
In SEAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	10 (26%)	6 (16%)	6 (16%)	8 (21%)	4 (11%)	4 (11%)	38	**3.05**	1.69
In SEAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	7 (18%)	5 (13%)	12 (32%)	4 (11%)	5 (13%)	5 (13%)	38	**3.26**	1.64
In SEAP, I had to organize and synthesize information across academic sources	7 (18%)	6 (16%)	9 (24%)	7 (18%)	5 (13%)	4 (11%)	38	**3.24**	1.60
In SEAP, I had to determine appropriate ethical and legal uses of published academic research for my own work	8 (21%)	10 (26%)	8 (21%)	3 (8%)	5 (13%)	4 (11%)	38	**2.97**	1.65
In SEAP, I had to work as part of a team on research projects	5 (13%)	5 (13%)	3 (8%)	6 (16%)	9 (24%)	10 (26%)	38	**4.03**	1.78

Note. Response scale: **1** = "*Never*," **2** = "*Once per week*," **3** = *"2 or 3 times per week*," **4** = "4 or 5 *times per week*," **5** = "*Every day*," **6** = "*Multiple times per day*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:

	1	2	3	4	5	6	n	Avg	SD
In school, I used advanced science or engineering equipment	13 (33%)	14 (36%)	8 (21%)	0 (0%)	2 (5%)	2 (5%)	39	**2.23**	1.35
In school, I cleaned and cared for the equipment in a science or engineering laboratory	11 (28%)	12 (31%)	9 (23%)	0 (0%)	5 (13%)	2 (5%)	39	**2.54**	1.50
In school, I calibrated laboratory equipment for experimentation	24 (62%)	8 (21%)	3 (8%)	0 (0%)	2 (5%)	2 (5%)	39	**1.82**	1.41
In school, I created solutions from reagents in preparation for experimental procedures	12 (32%)	17 (45%)	6 (16%)	0 (0%)	1 (3%)	2 (5%)	38	**2.13**	1.26
In school, I used proper safety procedures when handling equipment and material in the lab	2 (5%)	14 (36%)	8 (21%)	1 (3%)	8 (21%)	6 (15%)	39	**3.44**	1.64
In school, I employed advanced measurement techniques in science or engineering procedures	11 (28%)	13 (33%)	9 (23%)	1 (3%)	3 (8%)	2 (5%)	39	**2.44**	1.41

Please take a moment to consider your SEAP research experiences. Use the scale provided to indicate how often you performed each of the following activities in SEAP:

	1	2	3	4	5	6	n	Avg	SD
In SEAP, I used advanced science or engineering equipment	6 (16%)	2 (5%)	8 (21%)	1 (3%)	8 (21%)	13 (34%)	38	**4.11**	1.87
In SEAP, I cleaned and cared for the equipment in a science or engineering laboratory	10 (26%)	6 (16%)	1 (3%)	3 (8%)	8 (21%)	10 (26%)	38	**3.61**	2.06
In SEAP, I calibrated laboratory equipment for experimentation	13 (34%)	4 (11%)	7 (18%)	2 (5%)	5 (13%)	7 (18%)	38	**3.08**	1.95
In SEAP, I created solutions from reagents in preparation for experimental procedures	18 (47%)	3 (8%)	4 (11%)	1 (3%)	6 (16%)	6 (16%)	38	**2.79**	2.03
In SEAP, I used proper safety procedures when handling equipment and material in the lab	7 (18%)	3 (8%)	4 (11%)	2 (5%)	7 (18%)	15 (39%)	38	**4.16**	1.98
In SEAP, I employed advanced measurement techniques in science or engineering procedures	6 (16%)	3 (8%)	7 (18%)	3 (8%)	7 (18%)	12 (32%)	38	**4.00**	1.86

Note. Response scale: **1** = "*Never,*" **2** = "*Once per week,*" **3** = *"2 or 3 times per week,*" **4** = "4 or 5 *times per week,*" **5** = "*Every day*," **6** = "*Multiple times per day*".

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Use the scale provided to tell us how accurately each statement describes you AFTER SEAP:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
After SEAP, I am more confident in my ability to formulate hypotheses and design experiments to test them	1 (3%)	3 (8%)	2 (5%)	10 (26%)	10 (26%)	12 (32%)	38	**4.61**	1.35
After SEAP, I am more confident that I can analyze data and understand the results of an experiment	0 (0%)	3 (8%)	1 (3%)	4 (11%)	16 (42%)	14 (37%)	38	**4.97**	1.15
After SEAP, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	1 (3%)	3 (8%)	2 (5%)	3 (8%)	14 (38%)	14 (38%)	37	**4.84**	1.36
After SEAP, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	0 (0%)	0 (0%)	2 (5%)	7 (18%)	16 (42%)	13 (34%)	38	**5.05**	0.87
After SEAP, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	1 (3%)	5 (13%)	0 (0%)	8 (21%)	12 (32%)	12 (32%)	38	**4.61**	1.42
After SEAP, I am more confident in my ability to complete academic literature reviews for my own research projects	0 (0%)	4 (11%)	3 (8%)	6 (16%)	10 (26%)	15 (39%)	38	**4.76**	1.34
After SEAP, I am more confident that I can make significant research contributions as an effective part of a research team	0 (0%)	1 (3%)	0 (0%)	8 (21%)	10 (26%)	19 (50%)	38	**5.21**	0.96

Note. Response scale: **1** = "*Not at all like me,*" **2** = "*Not like me,*" **3** = *"Not much like me,*" **4** = "*Somewhat* like *me*," **5** = "*Like me*," **6** = "*Just like me*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?		
	Freq.	**%**
I do not plan to attend college	0	0%
2-year/Associate's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	0	0%
2-year/Associate's degree in something other than a STEM-related field.	0	0%
Bachelor's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	4	10%
Bachelor's degree in something other than a STEM-related field.	0	0%
Master's degree in a STEM-related field.	12	31%
Master's degree in something other than a STEM-related field.	0	0%
Doctoral degree in a STEM-related field.	22	56%
Doctoral degree in something other than a STEM-related field.	1	3%
Total	**39**	**100%**

Thinking about your educational goals, use the scale provided to tell us how certain you are that you will be able to do each of the following:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I will be admitted into my program of choice	1 (3%)	2 (5%)	1 (3%)	15 (38%)	10 (26%)	10 (26%)	39	**4.56**	1.21
I will attend college to pursue this educational degree	0 (0%)	0 (0%)	0 (0%)	5 (13%)	7 (18%)	27 (69%)	39	**5.56**	0.72
I will get good grades in my classes	0 (0%)	0 (0%)	0 (0%)	8 (21%)	17 (44%)	14 (36%)	39	**5.15**	0.74
I will be able to overcome any obstacle between me and this educational degree	0 (0%)	0 (0%)	0 (0%)	10 (26%)	14 (36%)	15 (38%)	39	**5.13**	0.80
I will finish this degree	0 (0%)	0 (0%)	0 (0%)	5 (13%)	11 (28%)	23 (59%)	39	**5.46**	0.72

Note. Response scale: **1** = "*Not at all certain,*" **2** = "*Uncertain,*" **3** = *"Relatively uncertain,*" **4** = "*Relatively Certain,*" **5** = "*Certain*," **6** = "*Very Certain*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Which of the following categories best describes the STEM field you want to pursue?		
	Freq.	**%**
Engineering	15	39%
Environmental Science	0	0%
Physical Science	1	3%
Chemistry	4	11%
Life Science	1	3%
Medicine / Health	10	26%
Mathematics / Computer Science	6	16%
Social Science	0	0%
Other STEM Field	1	3%
A field unrelated to STEM	0	0%
Total	**38**	**100%**

Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
In SEAP, I learned about new STEM-related jobs/careers.	0 (0%)	4 (10%)	1 (3%)	9 (23%)	11 (28%)	14 (36%)	39	**4.77**	1.27
In SEAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	0 (0%)	2 (5%)	3 (8%)	7 (18%)	14 (36%)	13 (33%)	39	**4.85**	1.14
In SEAP, I became interested in a STEM job/career I did not know about before.	2 (5%)	2 (5%)	6 (15%)	9 (23%)	11 (28%)	9 (23%)	39	**4.33**	1.40
In SEAP, I became interested in a new STEM-related job/career with the Army/DoD	1 (3%)	3 (8%)	5 (13%)	12 (32%)	10 (26%)	7 (18%)	38	**4.26**	1.29

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = *"Somewhat Disagree,"* **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

Of the new STEM jobs/careers that you learned about, which THREE did you find most interesting? (n = 25)						
Job	**Freq.**	**%**		**Job**	**Freq.**	**%**
Electrical Engineering	6	9%		**Dietetics**	1	2%
Engineering	5	8%		**Electron Microscopy Analyst**	1	2%
Mechanical Engineering	4	6%		**Electro-optic physicist**	1	2%
Research Scientists	4	6%		**Interdisciplinary biology and mechanical engineering program director**	1	2%
Brain Surgery	2	3%		**Laser Physicist**	1	2%
Chemical Engineering	2	3%		**Microelectromechanical Systems**	1	2%
Computer Engineering	2	3%		**Nanoparticle Scientist**	1	2%
Environmental Engineering	2	3%		**Nanotechnology**	1	2%
Materials Engineer	2	3%		**Network Mathematician**	1	2%
Optics	2	3%		**Nuclear Engineering**	1	2%
3D Design Engineer	1	2%		**Physician**	1	2%
3D Printing Lab Technician	1	2%		**Physician's assistant**	1	2%
Adhesives	1	2%		**Physicist**	1	2%
Analyze the EEG & Slider	1	2%		**Post-Doctorate Positions**	1	2%
Animal Behavior analyst	1	2%		**Programmer**	1	2%
Applied epidemiology	1	2%		**Quantum networking researcher**	1	2%
Army doctor	1	2%		**Robotics**	1	2%
Biologist	1	2%		**Signal Processing**	1	2%
Chemist	1	2%		**Stem Cell Researcher**	1	2%
Composites	1	2%		**Systems Engineering**	1	2%
Computational Chemistry	1	2%		**Technician**	1	2%
Computer Science	1	2%		**Theoretical Chemist**	1	2%
Computer Security	1	2%				
				Total	**66**	**100%**

Appendix B:
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Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
The Army/DoD has made many important contributions to science and engineering with applied research	0 (0%)	1 (3%)	0 (0%)	2 (5%)	18 (47%)	17 (45%)	38	**5.32**	0.81
Army/DoD researchers contribute much more to society than just "warfare" advancements	0 (0%)	0 (0%)	1 (3%)	5 (13%)	13 (34%)	19 (50%)	38	**5.32**	0.81
Army/DoD researchers use cutting-edge technology to solve the world's problems	0 (0%)	0 (0%)	0 (0%)	6 (16%)	14 (37%)	18 (47%)	38	**5.32**	0.74
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	1 (3%)	0 (0%)	0 (0%)	5 (13%)	12 (32%)	20 (53%)	38	**5.29**	1.01
After SEAP, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life	0 (0%)	1 (3%)	0 (0%)	4 (11%)	13 (34%)	20 (53%)	38	**5.34**	0.88

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = "*Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

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Have you ever participated in or heard about any of the following programs?			
	Yes, I participated	I would have participated but it was not available in my area / I did not qualify for this program	I have never heard about this program
Junior Solar Sprint (JSS):	0 (0%)	1 (3%)	37 (97%)
Junior Science and Humanities Symposium (JSHS):	0 (0%)	2 (5%)	36 (95%)
UNITE:	0 (0%)	1 (3%)	37 (97%)
West Point Bridge Contest:	3 (8%)	5 (13%)	30 (79%)
eCYBERMISSION:	3 (8%)	4 (11%)	31 (82%)

Have you been provided with information about the following programs that are sponsored by the U.S. Army? Do you want to participate?					
	I already participated in this program	Yes - I want to participate	Yes - I would participate but it is not available in my area	Yes - but I do not want to participate	I have never heard about this program
High School Internships:	3 (8%)	10 (26%)	1 (3%)	6 (16%)	18 (47%)
College Internships: (URAP)	0 (0%)	21 (55%)	2 (5%)	1 (3%)	14 (37%)
The Science, Mathematics And Research for Transformation (SMART) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	0 (0%)	21 (55%)	2 (5%)	3 (8%)	12 (32%)
The National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	0 (0%)	8 (21%)	2 (5%)	2 (5%)	26 (68%)

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The Junior Science and Humanities Symposium (JSHS) provides support to high school students who compete in regional and national symposia where they present their STEM research investigations before a panel of STEM experts. Scholarships and other awards are presented to students who compete in oral research presentations. Using the scale provided, please tell us how certain you are that you will do the following:

	1	2	3	4	5	6	n	Avg.	SD
I will submit my research project/final presentation to JSHS during the 2013-2014 school year	11 (29%)	10 (26%)	11 (29%)	3 (8%)	2 (5%)	1 (3%)	38	**2.42**	1.29

Note. Response scale: **1** = "*Not at all certain,*" **2** = "*Uncertain,*" **3** = *"Relatively uncertain,*" **4** = "*Relatively Certain,*" **5** = "*Certain*," **6** = "*Very Certain*".

Do you intend to submit your SEAP research project/final presentation to any other science fairs or competition

	Freq.	%
No	33	87%
Yes, which one(s)?	5	13%
Total	**38**	**100%**

Do you intend to submit your SEAP research project/final presentation to any other science fairs or competition (n = 5 written responses)

Which one(s)?	Freq.	%		Which one(s)?	Freq.	%
Intel International Science and Engineering Fair	2	40%		**Calvert Hall College McMullen Scholar Senior Independent Project**	1	20%
Siemens: Science and Engineering Fair	1	20%		**College**	1	20%
SEAP student symposium	1	20%				

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Given the opportunity, would you participate in SEAP again? Why or Why not? (n = 32)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Yes		**26**	
Academic Research Activities		**11**	
	It was a positive learning experience	10	• "I learned a lot about materials engineering and would like to continue learning." • "It was a very good learning experience in another field of science."
	Networking with others	1	• "[One could] make amazing connections at many locations."
General Satisfaction		**10**	
	Great experience	7	• "SEAP has been an amazing experience." • "[SEAP is] a great experience for an aspiring scientist."
	Generally satisfied with experience	2	• "I enjoyed the experience."
	Interesting / Inspiring experience	1	• "It was an interesting, inspiring experience."
Hands-On Research Activities		**8**	
	Getting hands-on experience in the lab	7	• "There are some many cool gadgets to experiment with." • "Internships are great for just the experience in workplace and laboratory environment."
	Working in a world-renowned laboratory	1	• "[I] get to work in a world-class laboratory."
STEM Pathway		**7**	
	Helps select/solidify career choice	4	• "[SEAP] has helped me to choose my career." • "I am interested in working for the government in the future and more experience now will help me affirm that is indeed something I would like to do."
	Exploration of careers	2	• "SEAP allows for exploration of jobs in STEM-related fields that might otherwise have been unknown to me or others."
	Provides an advantage over others	1	• "The advantages this program provides over competing students in my field is worth the time and work."
Other		**6**	
	Positive environment	3	• "I really enjoyed having the opportunity to be thrown into a new setting and have a bunch of new information around me. Everyone was very helpful and I felt that I could ask any question I had."
	Getting paid	3	• "There's always the monetary incentive of a 2000 dollar paycheck."

CONTINUED - Given the opportunity, would you participate in SEAP again? Why or Why not? (n = 32)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
No		**5**	
	Not interested in the materials presented	3	• "I would like to intern in something closer to the field I want to study."
	Would prefer to participate in other AEOP Program	2	• "No, because I am moving into CQL, so I am still staying with this branch of internships" • "No but I do hope to participate as a CQL."

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Do you have any other comments or input to provide us regarding your SEAP mentor? (n = 25)			
Broad Theme	Narrow Theme(s)	**Freq.**	**Example Response(s)**
Satisfaction with Program			
	Overall satisfaction with mentor	12	• Apprentice commented that (his) mentor helped him tremendously throughout the summer and that he has plans to come back next summer as well. • Apprentice stated that their mentor was very helpful, and hopes that more students would be sent that way so that they can become accustomed to mentoring.
	Works with more than one mentor	2	• Two apprentices mentioned that they work with more than one mentor on a day to day basis.
	Worked primarily with co-mentor	2	• Two apprentices noted that they did not work primarily with 'main' mentor. Main mentor made sure that apprentice was working with a co-mentor, who was an undergraduate student.
	Mentor absent for significant periods of time	1	• Apprentice specifically stated that mentor was occasionally absent for significant amounts of time, but did prepare them for his absence. *Apprentice further noted that it appeared that the mentor was not given complete information regarding the SEAP program.*
	Logistics provided significant barrier	1	• Apprentice noted significant barriers to program, including government regulations and procedures (security clearance, computer access) as well as safety procedures (having to do with 'Class 4 lasers') which caused significant delays to the work. Apprentice was unable to work directly with mentor as a result, but was able to do some work with mentor's colleague.
STEM Pathway			
	Mentor spoke to apprentices about future education and career goals	2	• Apprentice mentioned that mentor got him started in programming, reaffirming that Computer Engineering was something he would enjoy. • Apprentice noted the usefulness of hearing about the pros and cons of pursuing a Doctoral degree.
Effective Mentorship			
	Regular check-ins with apprentice(s)	2	• Apprentice mentioned that mentor was always willing to listen and give advice and wants to help students toward their goals. • Apprentice noted that their mentor was very willing to help, and checks on them 2-3 times per day.
	Apprentices wanted more mentor involvement	2	• Apprentice stated that mentor could have been a bit more organized and clear on what they were going to be doing that day. • Apprentice noted that mentor wasn't too involved in their research project, and that they would've enjoyed

			the program more if experience was a little more structured.
Hands-On / Laboratory Research Activities in SEAP			
	Apprentice enjoyed hands-on research activities	1	• Apprentice noted that his mentor taught him how science really is in real life – not like school everything always works.
	Apprenticewanted more hands-on activities	1	• Apprentice noted that they would have liked for the work or subject to be a little more interesting or hands-on.
Academic Research Activities in SEAP			
		1	• Apprentice learned a lot about computer science from guidance provided in SEAP.

Appendix B:
2013 SEAP Apprentice Questionnaire and Data Summary

In a couple of sentences, tell us about your overall satisfaction with the SEAP research project/final presentation: What was the most valuable part of that experience? (n = 28)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Academic Research Activities		**13**	
	Learning about new topics	4	• "The most valuable part of the SEAP research project was discovering new areas of study."
	Growth as a scientist	4	• "I feel that I have grown as a student and researcher as a result of my involvement with the program." • "The most valuable part was creating the experiment and carrying it out."
	Developing presentation skills	3	• "…giving a formal presentation is very valuable. Being a professional in a math or science field requires numerous papers to be written and presentations to be given."
	Academic writing skills	2	• "My understanding of what my project was really only came to me as I created my final paper."
Hands-on / Laboratory Research Activities		**12**	
	Working in a real-world research environment	8	• "I also learned a lot about working in a scientific, research environment, which I greatly appreciated." • "It gives student an opportunity to gain hands-on research beyond what they are provided with in the classroom."
	Learning a specific skill	4	• "The most valuable part of the research project to me was learning how to program."
Satisfaction with program		**11**	
	SEAP is a valuable experience	5	• "I enjoyed my SEAP experience." • "I think it is a great program!"
	Satisfied with research project	4	• "I am highly satisfied with the SEAP research project." • "I enjoyed having the opportunity to look back and reflect on everything I did."
	Dissatisfied with SEAP	2	• "Sometimes, I felt like I didn't have much to do." • "The best part was that I got to work with great people and got to obtain a basis in programming, but other than that was very disappointed."
STEM Pathway		**4**	
	Helped clarify education and career goals	3	• "Learning about the other careers, because I already knew I wanted to work for the DoD but once I saw the 3D Printing Lab I knew exactly what I wanted to study and work in."
	Networking	1	• "I believe that the most valuable part of my SEAP experience was the connections I achieved with professionals. These connections aid in my networking,

			and these people will be able to serve as references for my future endeavors."
Other		**2**	
	Learning from peers	2	• "I thought that just working with others that were my peers helped inspire me a lot. Most of these people were already in college, but I was able to learn so much from them."
STEM Ambassadorship		**1**	
	Showcasing work to others	1	• "These two key parts of SEAP will also be essential to show family and friends what I completed during the summer!"

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Thank you for your participation in this study about the 2013 Science and Engineering Apprenticeship Program (SEAP). The following assessment will collect information about you and your SEAP apprentice(s). The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support SEAP.

About this survey:

- This research protocol has been approved for use with human subjects by the Virginia Tech IRB office. Although this assessment is not anonymous, it is CONFIDENTIAL; prior to analysis and reporting, responses will be de-identified and no one will be able to connect your responses to you or your apprentice's name.
- Additionally, only AEOP evaluation personnel will have access to completed assessments and personal information will be stored securely.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time.
- If you provide your email address, the AEOP may contact you in the future to ask about you or your SEAP apprentice(s).
- We do hope that you will finish the survey because your responses will give SEAP valuable information for improvement and for generating reports for our supporting organizations

By choosing to complete this assessment, you are providing your consent to participate in the SEAP research/evaluation study

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Tim Donovan, American Society for Engineering Education
Project Assistant, SEAP
(202) 649-3833, T.Donovan@asee.org

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Provide your personal information below (optional):

First Name: _____
Last Name: _____
Email Address: _____

In total, how many SEAP apprentices have you mentored through the years?

Total # of apprentices mentored: _____, apprentices.

In the past, have you ever worked as a SEAP apprentice?

- ❍ No
- ❍ Yes - for how many years? _____

Do you serve as a mentor for apprentices or students in programs other than SEAP?

- ❍ No
- ❍ Yes - which program(s)? _____

In which laboratory are you working? (select from the list)

- ❍ AMRDEC; Redstone Arsenal, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ECBC; Edgewood, MD
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ NATICK; Natick, MA
- ❍ USACEHR; Fort Detrick, MD
- ❍ USACIL; Fort Gillem, GA
- ❍ USAMRICD; Aberdeen, MD
- ❍ USAMRIID; Fort Detrick, MD
- ❍ Walter Reed (WRAIR); Silver Spring, MD
- ❍ Other (specify): _____

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your ethnicity/race?

- ❍ American Indian or Alaska Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White or Caucasian
- ❍ Some other ethnicity/race: _____
- ❍ Choose not to report

Which of the following categories best describes your research field?

- ❍ Engineering (e.g., technology, robotics, computers, etc.)
- ❍ Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)
- ❍ Physical Science (e.g., physics, astronomy, etc.)
- ❍ Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)
- ❍ Life Science (e.g., biology, animal science, ecology, etc.)
- ❍ Medicine / Health (e.g., behavioral science, medicine, public health, etc.)
- ❍ Mathematics / Computer Science
- ❍ Social Science (e.g., sociology, psychology, economics, etc.)
- ❍ Other STEM field: _____

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Please take a moment to think about your SEAP mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I frequently worked with my SEAP apprentice(s) in the laboratory	❍	❍	❍	❍	❍	❍
I taught my SEAP apprentice(s) about performing STEM research	❍	❍	❍	❍	❍	❍
I encouraged my SEAP apprentice(s) to perform a variety of tasks in the laboratory	❍	❍	❍	❍	❍	❍
I helped my SEAP apprentice(s) formulate their educational goals	❍	❍	❍	❍	❍	❍
I taught my SEAP apprentice(s) how to work more effectively in a laboratory	❍	❍	❍	❍	❍	❍
I spoke with my SEAP apprentice(s) about their career interests	❍	❍	❍	❍	❍	❍
I helped my SEAP apprentice(s) be better writers of scientific research	❍	❍	❍	❍	❍	❍
I would like to work with my SEAP apprentice(s) again	❍	❍	❍	❍	❍	❍

Use the scale provided to tell us how much you agree or disagree with each of the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I helped my SEAP apprentice(s) clarify their educational goals and pathways	❍	❍	❍	❍	❍	❍
I provided guidance to my SEAP apprentice(s) about the steps they will need to achieve their professional and educational goals	❍	❍	❍	❍	❍	❍
I helped my SEAP apprentice(s) draft their CV/Résumé	❍	❍	❍	❍	❍	❍
I will write or help my SEAP apprentice(s) obtain letters of reference	❍	❍	❍	❍	❍	❍
I introduced my SEAP apprentice(s) to professional and educational networks that will help them in the future	❍	❍	❍	❍	❍	❍
I exposed my SEAP apprentice(s) to professional organizations that can help them pursue their career/educational goals	❍	❍	❍	❍	❍	❍
My SEAP apprentice(s) were interested in pursuing AEOP programs in the future	❍	❍	❍	❍	❍	❍
I am interested in mentoring more SEAP apprentices in the future	❍	❍	❍	❍	❍	❍
I would recommend my SEAP apprentice(s) for future Army internships	❍	❍	❍	❍	❍	❍

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any SEAP mentor activities related to educating your apprentice(s) about STEM-related careers. Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I educated my SEAP apprentice(s) about a wide variety of STEM jobs/careers.	❍	❍	❍	❍	❍	❍
I educated my SEAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
During SEAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	❍	❍	❍	❍	❍	❍
My SEAP apprentice(s) expressed a lot of interest about pursuing a STEM career	❍	❍	❍	❍	❍	❍
My SEAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	❍	❍	❍	❍	❍	❍
My SEAP apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	❍	❍	❍	❍	❍	❍

Please describe the ways in which you educated your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Please describe any challenges you faced when educating your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Please describe how SEAP could better support you in your efforts to educate your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD.

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any SEAP mentor activities related to educating your apprentice(s) about programs offered by the Army Education Outreach Program (AEOP). Use the scale provided to tell us how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I know about the Junior Science & Humanities Symposium (JSHS): the national science competition offered by the AEOP	❍	❍	❍	❍	❍	❍
I encouraged my apprentice(s) to submit his/her research project/final report to JSHS	❍	❍	❍	❍	❍	❍
My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS	❍	❍	❍	❍	❍	❍
I know about the other High School Internship programs offered by the AEOP: The Research in Engineering Apprenticeship Program (REAP) & the High School Apprenticeship Program (HSAP)	❍	❍	❍	❍	❍	❍
I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL) & the Undergraduate Research Apprenticeship Program (URAP)	❍	❍	❍	❍	❍	❍
I provided information to my apprentice(s) about one or more AEOP program(s)	❍	❍	❍	❍	❍	❍
My apprentice(s) expressed interest in pursuing AEOP programs in the future	❍	❍	❍	❍	❍	❍
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	❍	❍	❍	❍	❍	❍
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	❍	❍	❍	❍	❍	❍

Please describe the ways in which you educated your SEAP apprentice(s) about AEOP programs:

Please describe any challenges you faced when educating your SEAP apprentice(s) about AEOP programs.

Please describe how SEAP could better support you in your efforts to educate your SEAP apprentice(s) about AEOP programs.

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Rubrics for Rating Apprentices' Skills, Abilities, and Final Project(s) Instructions:

- **Please make sure that you complete a set of the following rubrics for each apprentice that you worked with this summer. If you worked with more than one apprentice, you will be prompted to enter their name and rate them later in the survey.**
- **We have already collected your name but we also need the name of your apprentice(s) to connect their questionnaire to yours. However, reports will never contain any personally identifiable information and results are only reported in the aggregate.**
- **When filling out the assessment tool below, please ensure that you are basing your responses on behavior or work that you have personally witnessed or reviewed.**

What is your apprentice's name?

First Name: _____

Last Name: _____

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "No Experience" and 6 = "Expert". Please rate [Apprentice's name]'s laboratory skill level.

- (1): Student is confused about the lab equipment and cannot use it effectively or safely.
- (2): Can identify the equipment and components. Knows about equipment care and safety but cannot consistently perform operations
- (3): Can perform rudimentary operations with equipment under supervision. Periodically violates proper safety and equipment care protocols
- (4): Can execute basic operations independently. Still needs periodic supervision for safety and equipment care
- (5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision
- (6): Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed

In the rubric below 1 = "No Experience" and 6 = "Expert". Please rate [Apprentice's name]'s level of skill with the Data Collection Techniques (e.g., Lab, Research, and/or Measurement Techniques) that are used in your laboratory.

- (1): Student is confused about techniques, how to perform them, and their importance. Training from a supervisor is needed regularly
- (2): Is beginning to understand techniques and their importance with supervision. Results are not useful at this point
- (3): Understands techniques and their importance but supervision is needed to perform them. Results are only useful when operations have been supervised heavily
- (4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor
- (5): Understands and uses techniques competently without supervision. Yielded results are useful
- (6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s scientific teamwork/collaboration abilities in your laboratory?

- (1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions
- (2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates
- (3): Attempts but rarely offers unique ideas to the team or manages to retain information from teammates. Occasionally late with task completion. Congenial but sometimes indifferent toward teammates
- (4): Occasionally articulates alternative ideas to the team but struggles to synthesize multiple points of view. Is usually on time with task completion. Is polite and positive with teammates
- (5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates
- (6): Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s scientific reasoning skills/abilities?

- (1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles
- (2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles
- (3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles
- (4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles
- (5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research
- (6): Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s information literacy skills/abilities?

- (1): Information searches are not connected to research needs and search is done entirely via web search engines. No information from sources is included nor consideration for sources
- (2): Information searches are vaguely tied to research needs and search is not systematic in nature. Sources are often not credible, plagiarism is evident, and ethical uses are not considered
- (3): Sometimes does not discern needed information and how or where to search for it. Sources are sometimes not credible and ethical uses of information are compromised occasionally
- (4): Has a rudimentary understanding of needed information and how or where to search for it. Finds mostly credible sources and understands that plagiarism is unacceptable
- (5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses
- (6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner

In the rubric below 1 = "No Experience" and 6 = "Expert". Which of the following categories most accurately describes [Apprentice's name]'s quantitative literacy skills/abilities?

- (1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation
- (2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation
- (3): Sometimes misunderstands quantitative information which results in inaccurate sets of findings. Judgments are occasionally not based on results and may not consider some limitations
- (4): Converts quantitative information into results but they are occasionally inaccurate. Judgments and conclusions are based on results but sometimes incomplete while consideration for limitations may also be incomplete during derivation
- (5): Adequately converts and interprets quantitative information into an accurate set of results. Applies the results of analysis to judgments and conclusions while considering assumptions and limitations in their derivation
- (6): Expertly converts and interprets quantitative information into a comprehensive set of accurate results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Final Project Rubric

- **If [Apprentice's name] has completed their final research project -- please use the following rubrics to rate the quality of [Apprentice's name]'s work on their project (i.e., their research report or research presentation)**
- **If [Apprentice's name] has not completed their final research project -- please do not use the following rubrics.**

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Introduction/Purpose?

- ❍ (1): The student provides no real purpose and makes little to no connection with existing research
- ❍ (2): The purpose of the research evades the student. Connections with existing research are often inaccurate or misinterpreted
- ❍ (3): Only partially understands the purpose of the research. Connections with existing research are sometimes inaccurate
- ❍ (4): The purpose of the research is accurate but sometimes unclear. Connections with existing research are incomplete
- ❍ (5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague
- ❍ (6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Methods (e.g., description of equipment & procedures)?

- ❍ (1): The student provides no list or description of the equipment or procedures for this study
- ❍ (2): Equipment and procedures are inaccurately listed and described. Replication would be impossible
- ❍ (3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult
- ❍ (4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information
- ❍ (5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification
- ❍ (6): Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Results (e.g., data analysis, interpretation & findings)

- ❍ (1): Does not report or analyze data. Interpretation of findings is non-existent or not based on the provided evidence
- ❍ (2): Analyzes data incorrectly. Interpretation of results is inaccurate.
- ❍ (3): Misunderstands some data analyses and makes several mistakes. Makes some errors interpreting results. No synthesis of findings
- ❍ (4): Understands data analysis but makes one or two mistakes. Only rudimentary interpretation of results. Synthesis of findings is incomplete
- ❍ (5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear
- ❍ (6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Conclusions

- ❍ (1): No conclusions, limitations, or future directions are offered
- ❍ (2): Discussion of findings is unstructured and does not tie back to the research question very well. Barely touches on limitations
- ❍ (3): Vaguely ties the findings back to the research questions. Limitations are only touched on. No future directions are offered
- ❍ (4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed
- ❍ (5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus
- ❍ (6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Structure?

- ❍ (1): Does not include or distinguish between an abstract, body, appendix, or bibliography
- ❍ (2): Missing two or more components (abstract, body, appendix, or bibliography). Ordering, labeling, and grammar are not acceptable
- ❍ (3): Missing one component (abstract, body, appendix, or bibliography). Order of sections is disjointed or mislabeled. Grammar is minimally acceptable
- ❍ (4): Abstract, body, appendices, citations, and bibliography are included with mistakes. Order and labeling of sections is present but not always clear. Grammar is adequate
- ❍ (5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality
- ❍ (6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable

In the rubric below 1 = "Unsatisfactory" and 6 = "Exemplary". Which of the following categories best describes [Apprentice's name]'s Oral Communication?

- ❍ (1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)
- ❍ (2): Fails to present one intro, purpose, an/or conclusion. Very few and non-credible supporting materials are used
- ❍ (3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best
- ❍ (4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question
- ❍ (5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility
- ❍ (6): Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility

Do you have any other comments or input to provide us regarding [Apprentice's name]'s final project?

Do you have any other comments or input to provide us regarding your SEAP apprentice?

[Respondents who report mentoring more than one apprentice are prompted to provide rubric ratings and information for up to 10 apprentices. Otherwise, they are directed immediately to the final question below.]

Please take a moment to tell us about any successes and/or challenges that you or your apprentice(s) experienced during SEAP this year:

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:

Rebecca Kruse – rkruse75@vt.edu or Tanner Bateman – tbateman@vt.edu

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

In total, how many SEAP apprentices have you mentored through the years? (Avg. = 5.13 apprentices, SD = 6.00)						
# of apprentices	**Freq.**	**%**		**# of apprentices**	**Freq.**	**%**
20	1	7%		9	-	-
19	-	-		8	1	7%
18	-	-		7	-	-
17	-	-		6	-	-
16	1	7%		5	2	13%
15	-	-		4	1	7%
14	-	-		3	-	-
13	-	-		2	2	13%
12	-	-		1	5	33%
11	-	-		0	1	7%
10	1	7%				
				Total	**15**	**100%**

In the past, have you ever worked as a SEAP apprentice?		
	Freq.	**%**
No	12	80%
Yes - for three years	2	13%
Yes – other	1	7%
Total	**15**	**100%**

Note. Other responses include "multiple years"

Do you serve as a mentor for apprentices or students in programs other than SEAP?		
	Freq.	**%**
No	4	27%
Yes	11	73%
Total	**15**	**100%**

Do you serve as a mentor for apprentices or students in programs other than SEAP? (n = 11 responding mentors)						
Program	**Freq.**	**%**		**Program**	**Freq.**	**%**
ORISE	4	36%		SCEP	1	9%
CQL	2	18%		Pathways	1	9%
STEP	2	18%		SIP (NIH internship program)	1	9%
High School Capstone Projects	2	18%		Summer School at University of Rochester (NY)	1	9%
GEMS	1	9%				
				Total # of programs listed	**9**	

Note. % = percentage of responding mentors who mentioned each program.

Appendix C:
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In which laboratory are you working?						
SEAP Site	**Freq.**	**%**		**SEAP Site**	**Freq.**	**%**
AMRDEC; Redstone Arsenal, AL	-	-		**USACEHR; Fort Detrick, MD**	3	20%
ARL-A; Adelphi, MD	-	-		**USACIL; Fort Gillem, GA**	-	-
ARL-APG; Aberdeen, MD	2	13%		**USAMRICD; Aberdeen, MD**	6	40%
ECBC; Edgewood, MD	-	-		**USAMRIID; Fort Detrick, MD**	2	13%
ERDC-CERL; Champaign, IL	1	7%		**Walter Reed (WRAIR); Silver Spring, MD**	-	-
ERDC-MS; Vicksburg, MS	1	7%		**Other (specify):**	-	-
NATICK; Natick, MA	-	-				
				Total	**15**	**100%**

Which of the following best describes you?		
	Freq.	**%**
Male	10	67%
Female	5	33%
Choose not to report	0	0%
Total	**15**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	2	13%
Black or African American	1	7%
Hispanic or Latino	1	7%
White/Caucasian	10	67%
Some other ethnicity/race:	0	0%
Choose not to report	1	7%
Total	**15**	**100%**

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Which of the following categories best describes your research field?		
	Freq.	**%**
Engineering	0	0%
Environmental Science	0	0%
Physical Science	1	7%
Chemistry	3	20%
Life Science	8	53%
Medicine / Health	3	20%
Mathematics / Computer Science	0	0%
Social Science	0	0%
Other STEM Field	0	0%
A field unrelated to STEM	0	0%
Total	**15**	**100%**

Please take a moment to think about your SEAP mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I frequently worked with my SEAP apprentice(s) in the laboratory	0 (0%)	0 (0%)	1 (7%)	3 (20%)	8 (53%)	3 (20%)	15	**4.87**	0.83
I taught my SEAP apprentice(s) about performing STEM research	0 (0%)	0 (0%)	0 (0%)	2 (13%)	6 (40%)	7 (47%)	15	**5.33**	0.72
I encouraged my SEAP apprentice(s) to perform a variety of tasks in the laboratory	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (20%)	12 (80%)	15	**5.80**	0.41
I helped my SEAP apprentice(s) formulate their educational goals	0 (0%)	0 (0%)	1 (7%)	3 (20%)	8 (53%)	3 (20%)	15	**4.87**	0.83
I taught my SEAP apprentice(s) how to work more effectively in a laboratory	0 (0%)	0 (0%)	0 (0%)	1 (7%)	7 (50%)	6 (43%)	14	**5.36**	0.63
I spoke with my SEAP apprentice(s) about their career interests	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8 (53%)	7 (47%)	15	**5.47**	0.52
I helped my SEAP apprentice(s) be better writers of scientific research	0 (0%)	1 (7%)	1 (7%)	4 (27%)	7 (47%)	2 (13%)	15	**4.53**	1.06
I would like to work with my SEAP apprentice(s) again	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (33%)	10 (67%)	15	**5.67**	0.49

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
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Use the scale provided to tell us how much you agree or disagree with each of the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I helped my SEAP apprentice(s) clarify their educational goals and pathways	0 (0%)	0 (0%)	1 (7%)	4 (27%)	10 (67%)	0 (0%)	15	**4.60**	0.63
I provided guidance to my SEAP apprentice(s) about the steps they will need to achieve their professional and educational goals	0 (0%)	0 (0%)	1 (7%)	1 (7%)	12 (80%)	1 (7%)	15	**4.87**	0.64
I helped my SEAP apprentice(s) draft their CV/Résumé	3 (20%)	4 (27%)	2 (13%)	5 (33%)	1 (7%)	0 (0%)	15	**2.80**	1.32
I will write or help my SEAP apprentice(s) obtain letters of reference	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (33%)	10 (67%)	15	**5.67**	0.49
I introduced my SEAP apprentice(s) to professional and educational networks that will help them in the future	0 (0%)	2 (13%)	0 (0%)	2 (13%)	8 (53%)	3 (20%)	15	**4.67**	1.23
I exposed my SEAP apprentice(s) to professional organizations that can help them pursue their career/educational goals	1 (7%)	2 (13%)	3 (20%)	1 (7%)	8 (53%)	0 (0%)	15	**3.87**	1.41
My SEAP apprentice(s) were interested in pursuing AEOP programs in the future	0 (0%)	0 (0%)	0 (0%)	6 (43%)	4 (29%)	4 (29%)	14	**4.86**	0.86
I am interested in mentoring more SEAP apprentices in the future	0 (0%)	1 (7%)	0 (0%)	1 (7%)	4 (27%)	9 (60%)	15	**5.33**	1.11
I would recommend my SEAP apprentice(s) for future Army internships	0 (0%)	0 (0%)	0 (0%)	1 (7%)	6 (40%)	8 (53%)	15	**5.47**	0.64

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Take a moment to reflect on any SEAP mentor activities related to educating your apprentice(s) about STEM-related careers. Use the scale provided to tell us how much you agree or disagree with the following statements									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I educated my SEAP apprentice(s) about a wide variety of STEM jobs/careers.	0 (0%)	0 (0%)	3 (20%)	4 (27%)	6 (40%)	2 (13%)	15	**4.47**	0.99
I educated my SEAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	0 (0%)	0 (0%)	4 (27%)	3 (20%)	7 (47%)	1 (7%)	15	**4.33**	0.98
During SEAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	0 (0%)	0 (0%)	2 (13%)	3 (20%)	9 (60%)	1 (7%)	15	**4.60**	0.83
My SEAP apprentice(s) expressed a lot of interest about pursuing a STEM career	0 (0%)	0 (0%)	0 (0%)	5 (33%)	7 (47%)	3 (20%)	15	**4.87**	0.74
My SEAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	0 (0%)	2 (13%)	1 (7%)	8 (53%)	4 (27%)	0 (0%)	15	**3.93**	0.96
My SEAP apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	0 (0%)	0 (0%)	0 (0%)	4 (27%)	6 (40%)	5 (33%)	15	**5.07**	0.80

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix C:
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Please describe the ways in which you educated your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD. (n = 7)

List	Freq.	Example Response(s)
Spoke with apprentice about DoD jobs /careers	4	• "I spoke to my SEAP apprentices about my collaborators and about the various institutions within the DoD that use STEM-based approaches to solve problems."
Spoke with apprentice about future education	2	• "Talked about both Grad school…"
Spoke with apprentice about general careers	1	• "We discussed college, majors and employment opportunities for those majors."
Spoke with apprentice about the purpose of their research	1	• "Make sure that they have a clear understanding of what they are doing, why they are doing it and how it relates to the Army/DoD."
Engaged apprentices with other working DoD scientists	1	• "Brown Bag lunch seminars with DoD researchers, informal conversations, collaborations with other laboratories."

Please describe any challenges you faced when educating your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD. (n = 5)

List	Freq.	Example Response(s)
SEAP site issues	2	• "Steep learning curve for computer programming. Restrictive Army computer system not ideal." • "Not enough time in the day, furloughs."
High School apprentices are not ready for career advice	1	• "Most of the SEAP apprentices are very young and know very little about STEM-related careers. For example, hey have an idea what a mechanical engineer can do but have little knowledge that mechanical engineers also need to know something about materials and possibly chemistry."
Apprentices are not interested in working for the DoD	1	• "Even with the positive experience within a DoD laboratory, the majority of SEAP students do not express interest or have aspirations to have a STEM career within the DoD."
Apprentices want to pursue academics first	1	• "Most of them want to pursue an academic route for STEM careers."
Apprentices do not engage career conversations	1	• "My apprentice was very introverted and required prodding to ask or answer questions."

Please describe how SEAP could better support you in your efforts to educate your SEAP apprentice(s) about STEM-related careers, especially those within the Army/DoD. (n = 3)

List	Freq.	Example Response(s)
Provide mentors with more informative to give apprentices	2	• "Provide slides for a presentation to introduce/help encourage these students to go into DoD STEM careers."
SEAP program logistics	1	• "Explain to the local program manager that there is no requirement to have a name associated with the funding when sending a MIPR to ARO."

Appendix C:
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Take a moment to reflect on any SEAP mentor activities related to educating your apprentice(s) about programs offered by the Army Education Outreach Program (AEOP). Use the scale provided to tell us how much you agree or disagree with the following statements:

	1	2	3	4	5	6	n	Avg.	SD
I know about the Junior Science & Humanities Symposium (JSHS): the national science competition offered by the AEOP	8 (53%)	3 (20%)	0 (0%)	3 (20%)	1 (7%)	0 (0%)	15	**2.07**	1.44
I encouraged my apprentice(s) to submit his/her research project/final report to JSHS	7 (47%)	4 (27%)	0 (0%)	4 (27%)	0 (0%)	0 (0%)	15	**2.07**	1.28
My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS	7 (47%)	4 (27%)	3 (20%)	1 (7%)	0 (0%)	0 (0%)	15	**1.87**	0.99
I know about the other High School Internship programs offered by the AEOP: The Research in Engineering Apprenticeship Program (REAP) & the High School Apprenticeship Program (HSAP)	8 (57%)	3 (21%)	1 (7%)	1 (7%)	1 (7%)	0 (0%)	14	**1.86**	1.29
I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL) & the Undergraduate Research Apprenticeship Program (URAP)	0 (0%)	2 (13%)	1 (7%)	2 (13%)	4 (27%)	6 (40%)	15	**4.73**	1.44
I provided information to my apprentice(s) about one or more AEOP program(s)	2 (13%)	3 (20%)	2 (13%)	4 (27%)	2 (13%)	2 (13%)	15	**3.47**	1.64
My apprentice(s) expressed interest in pursuing AEOP programs in the future	1 (7%)	3 (21%)	1 (7%)	5 (36%)	2 (14%)	2 (14%)	14	**3.71**	1.54
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	3 (21%)	3 (21%)	0 (0%)	4 (29%)	2 (14%)	2 (14%)	14	**3.36**	1.82
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	1 (7%)	4 (27%)	0 (0%)	3 (20%)	3 (20%)	4 (27%)	15	**4.00**	1.77

Note. Response scale: **1** = "*Strongly Disagree*," **2** = "*Disagree*," **3** = "*Somewhat Disagree*," **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

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Please describe the ways in which you educated your SEAP apprentice(s) about AEOP programs. (n = 5)		
List	**Freq.**	**Example Response(s)**
Spoke to apprentices about the AEOP programs	2	• "I have mentioned them and showed them the websites."
Apprentices participated in other AEOPs	1	• "Had two SEAP apprentices that became full-time govt. employees and successfully applied to the SMART graduate program and are now PhD students - I am in-lab mentor of both."
Apprentices attended other AEOP event	1	• "Our students attended the eCYBERMISSION event and learnt about AEOP programs."
Did not educate apprentice about AEOP programs	1	• "Other than talking to my apprentice about the SEAP program, I did not know about or talk about other AEOP programs."

Please describe any challenges you faced when educating your SEAP apprentice(s) about AEOP programs. (n = 3)		
List	**Freq.**	**Example Response(s)**
SEAP site issues	1	• "Lack of interest at command level."
Mentor does not know about AEOP programs	1	• "I don't know anything about the other AEOP programs, aside from hearing about the CQL program."
No challenges	1	• "None"

Please describe how SEAP could better support you in your efforts to educate your SEAP apprentice(s) about AEOP programs. (n = 4)		
List	**Freq.**	**Example Response(s)**
Increase mentor awareness of AEOP programs	3	• "By making mentors more aware of such programs. It may be worthwhile to give a presentation to mentors-to-be about these programs so that we can educate our interns." • "Have a short on-site training for all past and present mentors about all of the other programs." • "Educate mentors on the programs AEOP offers."
Increase emphasis from organizations	1	• "Stronger emphasis at command levels for all levels of programs from GEMS up."

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Please rate [your apprentice]'s laboratory skill level. (Avg. = 4.71, SD = 0.77)		
	Freq.	**%**
(1): Student is confused about the lab equipment and cannot use it effectively or safely.	0	0%
(2): Can identify the equipment and components. Knows about equipment care and safety but cannot consistently perform operations	0	0%
(3): Can perform rudimentary operations with equipment under supervision. Periodically violates proper safety and equipment care protocols	0	0%
(4): Can execute basic operations independently. Still needs periodic supervision for safety and equipment care	8	47%
(5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision	6	35%
(6): Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed	3	18%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **9 (53%)**; 1&2 = **0 (0%).**

Please rate your apprentice's level of skill with the Data Collection Techniques (e.g., Lab, Research, and/or Measurement Techniques) that are used in your laboratory. (Avg. = 4.47, SD = 1.18)		
	Freq.	**%**
(1): Student is confused about techniques, how to perform them, and their importance. Training from a supervisor is needed regularly	0	0%
(2): Is beginning to understand techniques and their importance with supervision. Results are not useful at this point	1	6%
(3): Understands techniques and their importance but supervision is needed to perform them. Results are only useful when operations have been supervised heavily	2	12%
(4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor	6	35%
(5): Understands and uses techniques competently without supervision. Yielded results are useful	4	24%
(6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques	4	24%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **8 (47%)**; 1&2 = **1 (6%).**

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Which of the following categories most accurately describes your apprentice's scientific teamwork/collaboration abilities in your laboratory? (Avg. = 4.71, SD = 0.85)		
	Freq.	**%**
(1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions	0	0%
(2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates	0	0%
(3): Attempts but rarely offers unique ideas to the team or manages to retain information from teammates. Occasionally late with task completion. Congenial but sometimes indifferent toward teammates	1	6%
(4): Occasionally articulates alternative ideas to the team but struggles to synthesize multiple points of view. Is usually on time with task completion. Is polite and positive with teammates	6	35%
(5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates	7	41%
(6): Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole	3	18%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **10 (59%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's scientific reasoning skills/abilities? (Avg. = 4.47, SD = 1.01)		
	Freq.	**%**
(1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles	0	0%
(2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles	0	0%
(3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles	3	18%
(4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles	6	35%
(5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research	5	29%
(6): Uses expert reasoning, a variety of theories, and methods of inquiry to identify the main issue and create hypotheses. Has an expert understanding of ethical principles that guide research	3	18%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **8 (47%)**; 1&2 = **0 (0%).**

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Which of the following categories most accurately describes your apprentice's information literacy skills/abilities? (Avg. = 4.59, SD = .80)		
	Freq.	**%**
(1): Information searches are not connected to research needs and search is done entirely via web search engines. No information from sources is included nor consideration for sources	0	0%
(2): Information searches are vaguely tied to research needs and search is not systematic in nature. Sources are often not credible, plagiarism is evident, and ethical uses are not considered	0	0%
(3): Sometimes does not discern needed information and how or where to search for it. Sources are sometimes not credible and ethical uses of information are compromised occasionally	1	6%
(4): Has a rudimentary understanding of needed information and how or where to search for it. Finds mostly credible sources and understands that plagiarism is unacceptable	7	41%
(5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses	7	41%
(6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner	2	12%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **9 (53%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's quantitative literacy skills/abilities? (Avg. = 4.76, SD = 0.90)		
	Freq.	**%**
(1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation	0	0%
(2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation	0	0%
(3): Sometimes misunderstands quantitative information which results in inaccurate sets of findings. Judgments are occasionally not based on results and may not consider some limitations	1	6%
(4): Converts quantitative information into results but they are occasionally inaccurate. Judgments and conclusions are based on results but sometimes incomplete while consideration for limitations may also be incomplete during derivation	6	35%
(5): Adequately converts and interprets quantitative information into an accurate set of results. Applies the results of analysis to judgments and conclusions while considering assumptions and limitations in their derivation	6	35%
(6): Expertly converts and interprets quantitative information into a comprehensive set of accurate results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation	4	24%
Total	**17**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **10 (55%)**; 1&2 = **0 (0%).**

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Which of the following categories best describes your apprentice's Introduction/Purpose? (Avg. = 5.00, SD = 0.71)		
	Freq.	**%**
(1): The student provides no real purpose and makes little to no connection with existing research	0	0%
(2): The purpose of the research evades the student. Connections with existing research are often inaccurate or misinterpreted	0	0%
(3): Only partially understands the purpose of the research. Connections with existing research are sometimes inaccurate	0	0%
(4): The purpose of the research is accurate but sometimes unclear. Connections with existing research are incomplete	3	23%
(5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague	7	54%
(6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research	3	23%
Total	**13**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **10 (77%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Methods (e.g., description of equipment & procedures)? (Avg. = 5.14, SD = 0.77)		
	Freq.	**%**
(1): The student provides no list or description of the equipment or procedures for this study	0	0%
(2): Equipment and procedures are inaccurately listed and described. Replication would be impossible	0	0%
(3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult	0	0%
(4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information	3	21%
(5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification	6	43%
(6): Clearly describes all equipment and procedures used in the study. The purpose of each is also clearly understood and described. Could replicate the study from this report	5	36%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (79%)**; 1&2 = **0 (0%).**

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Which of the following categories best describes your apprentice's Results (e.g., data analysis, interpretation & findings) (Avg. = 4.86, SD = 0.77)		
	Freq.	**%**
(1): Does not report or analyze data. Interpretation of findings is non-existent or not based on the provided evidence	0	0%
(2): Analyzes data incorrectly. Interpretation of results is inaccurate.	0	0%
(3): Misunderstands some data analyses and makes several mistakes. Makes some errors interpreting results. No synthesis of findings	0	0%
(4): Understands data analysis but makes one or two mistakes. Only rudimentary interpretation of results. Synthesis of findings is incomplete	5	36%
(5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear	6	43%
(6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts	3	21%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **9 (64%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Conclusions? (Avg. = 4.79, SD = 0.80)		
	Freq.	**%**
(1): No conclusions, limitations, or future directions are offered	0	0%
(2): Discussion of findings is unstructured and does not tie back to the research question very well. Barely touches on limitations	0	0%
(3): Vaguely ties the findings back to the research questions. Limitations are only touched on. No future directions are offered	0	0%
(4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed	6	43%
(5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus	5	36%
(6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research	3	21%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **8 (57%)**; 1&2 = **0 (0%).**

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Which of the following categories best describes your apprentice's Structure? (Avg. = 4.92, SD = 0.79)		
	Freq.	**%**
(1): Does not include or distinguish between an abstract, body, appendix, or bibliography	0	0%
(2): Missing two or more components (abstract, body, appendix, or bibliography). Ordering, labeling, and grammar are not acceptable	0	0%
(3): Missing one component (abstract, body, appendix, or bibliography). Order of sections is disjointed or mislabeled. Grammar is minimally acceptable	0	0%
(4): Abstract, body, appendices, citations, and bibliography are included with mistakes. Order and labeling of sections is present but not always clear. Grammar is adequate	4	33%
(5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality	5	42%
(6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable	3	25%
Total	**12**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **8 (67%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Oral Communication? (Avg. = 5.00, SD = 0.88)		
	Freq.	**%**
(1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)	0	0%
(2): Fails to present one intro, purpose, and/or conclusion. Very few and non-credible supporting materials are used	0	0%
(3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best	1	7%
(4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question	2	14%
(5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility	7	50%
(6): Presentation of separate introduction, purpose, and conclusion information is very clear. Uses a wide variety of supporting material such as statistics, images, examples, and/or quotations to establish credibility	4	29%
Total	**14**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (79%)**; 1&2 = **0 (0%).**

Do you have any other comments or input regarding your apprentice's final project? (n = 1)		
List	**Freq.**	**Example Response(s)**
Apprentice does not have a final project	1	• "[My apprentice] does not have a final project."

Do you have any other comments or input regarding your SEAP apprentice? (n = 1)		
List	**Freq.**	**Example Response(s)**
Experience with apprentice was valued	1	• "[My apprentice] is an intelligent intern with a good ability to analyze experimental designs and results and how to make the experiments better."

Appendix C:
2013 SEAP Mentor Questionnaire, Rubrics, and Data Summary

Please take a moment to tell us about any successes and/or challenges that you or your apprentice(s) experienced during SEAP this year. (n = 6)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Academic research activities		**3**	
	Apprentice successfully grew as a scientist	2	• "[apprentice] has seen that the path of research is not always straight forward but instead obstacles often arise unexpectedly. I am happy to report that [he] has responded to the challenges we have faced during his apprenticeship and his data will help the Army make their critical decision on the use of the drug in the future."
	Apprentice successfully added to the research field	1	• "The research that [apprentice] is doing this year is very important for the advanced development of a chemical countermeasure drug that may become part of the Army's standard of care for nerve agent exposure in the field.
	Challenge with apprentice growth	1	• "My apprentice did not seem to advance from last summer to this summer."
Satisfaction with program		**3**	
	Challenges with the laboratory organization	1	• "Due to changes in the local administration of the program it was much more difficult to use this year. I felt that there was little to no support from the local organization and what was provided was either wrong on just not helpful."
	Challenges with lab funding	1	• "Furloughs made the process more challenging this year."
	Challenges with apprentice performance	1	• "[apprentice's growth] resulted in more failed experiments than successful ones."
Effective Mentorship		**2**	
	Challenges teaching effectively in short time frame	1	• "The challenge I have faced with Nora is how to best teach her, who is only here with me for a short period of time. My interns in the past were with me for ~ 1year and therefore I am really able to cultivate them to think and reason critically and/or be good stewards of science"
	Challenges selecting appropriate project(s) for apprentice(s)	1	• "I made the assumption that another year of high school following the last SEAP summer would improve performance in the laboratory. This was a wrong assumption to make and I choose a project that was more advanced than last year's project assuming more skills with an additional year of education."

Appendix D:
2013 SEAP Apprentice Focus Group Protocol

Introductory questions:

1. Can we see a show of hands, who has participated in AEOP programs: [list]
    - Junior Solar Sprint
    - Junior Science and Humanities Symposium
    - West Point Bridge Design Competition
    - eCYBERMISSION
    - summer programs (GEMS/UNITE)
    - apprenticeship programs (REAP, SEAP/CQL, HSAP/URAP)
    - scholarship programs (SMART/NDSEG)

2. Why did you choose to participate in SEAP this year?
    - How did you learn about the program?
    - How did you "get connected" with your mentor?

Key questions:

3. Think of a typical day in SEAP and tell me about the mentoring you received?
    - What did your mentor do to support you?
    - What kind(s) of feedback did you get from your mentor?

Previous students have reported these things, have any of you experienced these? Reviews lab notebooks, chalk talks, group meetings, one-on-one demonstration/coaching?

4. What is the most valuable aspect of participating in SEAP?
    - What specific ways has it benefited you?
    - What does REAP offer that you don't get at school/college?

5. Are you interested in STEM jobs/careers offered by the Army and Department of Defense agencies? Why or why not?
    - What impact did your mentor have on your future career aspirations/pathway?

6. Are you interested in becoming a mentor yourself? Why/why not?

Ending questions:

7. If you had one minute to talk to an Army decision maker about SEAP, what would you say?
8. Have we missed anything? Tell us anything you want us to know that we didn't ask about.

Appendix E:
2013 SEAP Mentor Focus Group Protocol

Introductory questions:

1. Can we see a show of hands, who has mentored in AEOP programs before: [list]
    - Junior Solar Sprint
    - Junior Science and Humanities Symposium
    - West Point Bridge Design Competition
    - eCYBERMISSION
    - summer programs (GEMS/UNITE)
    - apprenticeship programs (REAP, SEAP/CQL, HSAP/URAP)
    - scholarship programs (SMART/NDSEG)

2. Why did you choose to participate in SEAP this year?
    - How did you learn about the program?
    - How did you "get connected" with your apprentice?

Key questions:

3. Think of a typical day in SEAP and tell me about the mentoring you provided?
    - What did you do to support your apprentice?
    - What kind(s) of feedback did you give to your apprentice?

4. What do you perceive as the value of the SEAP?
    - How have you benefited from participating?
    - How do you think apprentices benefit from participating?

5. How did you educate your apprentice about AEOP initiatives?
    [If no response, share brochures with mentors]

6. How did you educate your apprentice about STEM jobs/careers offered by the Army and Department of Defense agencies?
    - What resources do you need to educate apprentices about STEM careers at Army/DoD agencies?

7. What impact do you think you had on your apprentice's future STEM education/career aspirations?

Ending questions:

8. If you had one minute to talk to a Army decision maker about SEAP, what would you say?
9. Have we missed anything? Tell us anything you want us to know that we didn't ask about.