# Army Educational Outreach Program

## High School Apprentice Program

## 2013 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

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## Executive Summary

The High School Apprenticeship Program (HSAP), managed by the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for high school students who demonstrate an interest in science, technology, engineering, or mathematics (STEM) to work as an apprentice in an Army-funded university research laboratory. HSAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced scientists and engineers (herein called mentors) full-time during the summer or part-time during the school year.

Students receive an educational stipend equivalent to $10 per hour, and are allowed to work up to 300 hours total. The students contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the program, the students prepare final reports for submission to the US Army Research Office Youth Science programs office.

In 2013, HSAP provided outreach to 24 apprentices and their mentors at 12 Army-sponsored university or college laboratory sites (herein called HSAP sites).

This report documents the evaluation of the 2013 HSAP 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 HSAP included: in-person focus groups with apprentices and mentors at 3 HSAP sites, individual phone interviews with apprentices and mentors from 10 additional HSAP sites, and online post-program questionnaires distributed to all apprentices and mentors.

| Table 1. 2013 HSAP Fast Facts | |
|---|---|
| Major Participant Group | High School Students |
| Participating Students | 24 |
| Participating University Personnel | 16[1] (11 Faculty, 5 Graduate Mentoring Fellows) |
| Participating Universities | 12 |
| Total Cost | $80,594 |
| Total Stipends | $70,985 |
| Cost Per Student Participant | $2,779[2] |

[1] This number reflects university faculty members serving as the primary mentor and Graduate Mentoring Fellows (GMFs) that may have assisted with mentoring the HSAP apprentice.
[2] GMFs were included in the calculation of Cost Per Student Participant.

## Summary of Findings

The 2013 evaluation of HSAP 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 HSAP Evaluation Findings | |
|---|---|
| **Participant Profiles** | |
| Low participation of HSAP apprentices and mentors in evaluation assessments limit the reliability of findings. | • Statistical reliabilities achieved for the apprentice questionnaire sample (±15.8% margin of error) suggest limited representativeness of the samples. Geographically, the current sample of apprentices represents a limited proportion (75%) of the distribution of HSAP sites nationally<br>• Mentor respondents did not systematically identify themselves in the questionnaire and, as a result, the representativeness of this sample is not discernable.<br>• Alternative methods for establishing representativeness of the current samples were difficult to employ; demographic information for the population of apprentice and mentor participants was not available. |
| | • Findings from mentor and apprentice questionnaires should be cautiously generalized with consideration given to the calculated margin of error and with triangulation of findings with other data. |
| HSAP had limited success in providing outreach to participants from historically underrepresented and underserved populations. | • More apprentices identified themselves as racial or ethnic minorities in 2013 than in 2012. Black or African American (2012 = 0%, 2013 = 15%) and Hispanic or Latino (2012 = 0%, 2013 = 15%) populations are among those historically considered underserved and underrepresented in STEM education. |
| | • In 2012 and 2013, HSAP struggled to reach female high school students (2012 = 14%, 2013 = 8%), a population that is historically underrepresented in certain STEM fields. |
| | • In 2012 and 2013, most apprentices did not qualify for free/reduced lunch at school (86% and 73%, respectively). Free and reduced lunch recipients are generally considered an underserved population. |
| | • Mentors identified as predominantly male (78%) and either White or Caucasian (50%) or Asian or Other Pacific Islander (44%). Only 6% identified as Black or African American, and no mentors identified as Hispanic or Latino (0%) or American Indian or Alaskan Native (0%). |
| HSAP apprentices intend to pursue advanced STEM degrees in STEM. | • 100% of apprentices planned to pursue a master's degree or higher, 85% of whom intend to pursue that degree in a STEM field (38% STEM Master's, and 46% STEM Doctorate) |
| | • Large proportions of apprentices planned to pursue engineering (31%) and medicine/health-related fields (31%). Apprentices also intended to pursue physical science (15%), chemistry (15%), and social science (8%). |
| **Actionable Program Evaluation** | |
| HSAP marketing and recruitment is a bottom-up phenomenon occurring at the site-level. | • HSAP's marketing and advertising campaigns target the very specific population of Army-funded university and college researchers. |
| | • Apprentices most frequently learned about HSAP through individuals who are connected with HSAP sites. Apprentices reported that personnel from their high school (31%) or family or friends (15%) informed them about the program. |
| | • Most mentors recruited apprentices through connections with local high school staff (45%) and other informal programs (27%). |

| | |
|---|---|
| | • A majority of mentors (75%) selected apprentices from the AEOP applicant pool with assistance from ARO, and 25% knew students prior to their participation as an HSAP apprentice. |
| HSAP apprentices seek opportunities to clarify and advance their STEM pathways. | • Apprentices received encouragement to participate in HSAP from others who have connections to the HSAP program, such as high school staff or staff from other programs that they are already involved in. But many apprentices were motivated to participate in HSAP because it offered them an opportunity to clarify and advance their STEM pathways through experiences that are not available in school. |
| HSAP mentors seek opportunities to engage with STEM learners in their work. | • Mentors were motivated to participate in HSAP through their desire to outreach to youth, which was encouraged by their colleagues, departments, and universities. HSAP also provided mentors with an opportunity to advance their research through the funding of apprenticeships. |
| HSAP mentors engaged their apprentices in STEM research and provided guidance about educational and career pathways during the HSAP apprenticeship. | • HSAP mentors engaged their apprentices in STEM research and provided them with guidance about educational and career pathways. Apprentices and mentors reported similar engagement in mentor activities related to STEM research experiences, educational goals, and career goals |
| | • Apprentice and mentor accounts of educational and career advising differed. Mentors may have conflated their responses with interactions that they had with HSAP and URAP apprentices simultaneously. |
| HSAP mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers. | • Mentor interviewees had limited awareness of or direction from ARO to educate their apprentices about AEOP initiatives. Subsequently, mentors did not consistently educate their apprentices or encourage their participation in AEOP initiatives. |
| | • Mentors suggested that informational resources, mentor training, and an emphasis from ARO were necessary to accomplish this objective. |
| | • Mentors reported using a variety of strategies for mentoring apprentices about STEM careers, through few emphasized Army/DoD STEM careers. |
| | • Mentors perceived high school students are not advanced enough to engage in career discussions, that they lacked information about many aspects of Army/DoD STEM careers, and that they program was too short to initiate career conversations. |
| HSAP benefited apprentices as well as university and college S&E mentors and their laboratories. | • Apprentices and mentors perceived that HSAP 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 that HSAP helped them develop their own mentorship capacity, that the work of apprentices helped advance the work of the laboratory, and that it was rewarding to serve in a community service capacity. |
| HSAPs lack of visibility and programmatic processes are possible areas for improvement. | • Apprentices and mentors would like to see HSAP expand through increased funding and reach additional students by increasing its visibility. |
| | • Mentors invest significant time in the program and recommend streamlined and more efficient programmatic processes. |
| **Outcomes Evaluation** | |
| HSAP engaged apprentices in authentic STEM activities more | • Apprentices reported that HSAP provides more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (42%-58% in HSAP, 23-46% in school) and hands-on research activities (25%-75% in HSAP, 8%-33% at school). |

| | |
|---|---|
| frequently than their school environment. | • Moderate to very strong significant differences were found in apprentices perceptions of how frequently they did the following in HSAP as compared to school: used, cared for, and calibrated equipment; employed advanced measurement techniques; and defined research questions. |
| | • Apprentice and mentor data suggested HSAP 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. |
| HSAP apprentices become more confident in STEM, and mentors rate their research skills highly. | • Many apprentices (42%-75%) 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. |
| | • The majority of mentors (58%-74%) 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 (73%-86%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels. |
| HSAP apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities. | • Many apprentices (42%-92%) and mentors (42-65%) were unaware of other AEOP initiatives. For example, most mentors (88%) did not educate apprentices about the AEOP's high school STEM research competition, JSHS. Most apprentices (90%) were not intent on pursuing JSHS; however, 30% of apprentices expressed an interest in submitting their research to other science fairs or competitions including sponsored events such as INTEL-ISEF. |
| Mentoring HSAP apprentices about STEM and Army/DoD STEM careers varies by HSAP site but apprentices hold positive attitudes toward Army research and researchers | • Students and mentors provided conflicting accounts of the extent to which teaching and learning about STEM and Army/DoD STEM careers occurred during HSAP. It is likely that the amount of information provided to apprentices varies highly from site to site. |
| | • Most apprentices (72%) credited HSAP with improving their understanding Army/DoD STEM contributions and 81% would consider a civilian position in STEM with the Army/DoD. Most mentors (67%) reported that their apprentices' expressed a positive attitude toward Army/DoD STEM. |

## Recommendations

1. A commitment should be made to producing more reliable and valid evaluation of HSAP activities and benefits to participants. The 2013 evaluation provides valuable information regarding how HSAP is perceived by a proportion of participants, and begins to provide evidence for how the program has impacted HSAP apprentices. However, the low response rate from HSAP apprentices, the inability of mentors to correctly identify their role in the program, as well as the limited demographic information regarding the population of apprentice and mentor participants, all pose significant threats to the reliability and validity of these findings. In other words, we have limited confidence that the 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. Mentor participation in HSAP's evaluation is vital. Coordinated efforts should be made by the Army, and ARO to encourage and improve

apprentice and mentor participation in HSAP's evaluation efforts. Subsequently, evaluators should endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments to further maximize participation.

2. AEOP objectives include expanding participation of historically underrepresented and underserved populations. In HSAP, recruitment of apprentices is largely a bottom-up phenomenon that occurs at the site-level using connections or mechanisms available to the university or college site and community in which they lie. As a result, the ability of HSAP to recruit underserved or underrepresented populations of students depends upon the diversity of the local communities, and especially high schools, in which recruitment takes place. Guidance that ensures that "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 apply through the AEOP website is likely to help in recruitment efforts. Additionally, the AEOP and ARO may need to consider practical solutions to the challenge posed by HSAP 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).

3. Apprentice and mentor data suggested that HSAP 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. ARO should endeavor to provide HSAP mentors with 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 include 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.

4. ARO, universities, 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 HSAP apprentices and mentors were largely unaware of other AEOP initiatives and that HSAP serves as an entry point into the AEOP for students who have not yet been exposed the Army STEM outreach. Yet, substantial apprentice interest exists in participating in AEOP moving forward. This interest would benefit from more robust attention by ARO and mentors during HSAP program activities. Continued guidance by ARO is needed for educating mentors about AEOP opportunities nationwide. Adequate resources and guidance for using them with apprentices should be provided to all mentors in order that all apprentices leave HSAP with an idea of their next steps in AEOP.

5. Depending upon the university or college site in which they worked, apprentices had varying opportunities to learn about STEM research and careers during HSAP, especially Army/DoD STEM research and careers. Many mentors reported lack of awareness of Army/DoD STEM careers generally, lack of informational resources, and lack of direction to provide such information to their apprentices. This is of concern given HSAP mentors are Army-sponsored S&Es who are receiving "add-on" funding for their HSAP apprentices. In an effort to standardize the information provided to apprentices we strongly recommend an HSAP- or AEOP-wide effort to create a resource that profile 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. [3] Furthermore, ARO might consider a requirement, similar to that of the AEOP's high school UNITE program, through which HSAP sites connect participants with local Army research laboratories so that apprentices have first-hand opportunities to connect their university-based research to the Army's broader STEM interest and network with Army STEM professionals.

6. The Graduate Mentoring Fellows (GMF) Data Brief (Appendix E) suggests that the eWorkshop had varying degrees of success with teaching GMFs about the critical components of effective mentorships. The low frequencies with which GMFs reported employing these strategies suggest that awareness is insufficient for implementation. Further, GMFs did not feel well-supported by the program activities. GMF's offer insightful recommendations for programmatic revisions that would potentially improve the experience of GMFs and the apprentices they mentor. If the GMF program is to be implemented in FY14 and/or scaled up in future, substantial programmatic revision is needed, including increased communication between ARO, faculty mentors, and GMFs about expectations and objectives of mentorship, enhanced training and ongoing support of GMFs, and access to resources to enable GMFs to provide mentorship about AEOP offerings and Army STEM careers.

[3] 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 High School Apprenticeship Program (HSAP). HSAP is managed by the U.S. Army Research Office (ARO). 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 High School Apprenticeship Program (HSAP), managed by the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for high school students who demonstrate an interest in science, technology, engineering, or mathematics (STEM) to work as an apprentice in an Army-funded university or college research laboratory. HSAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced scientists and engineers (S&Es, herein called mentors) full-time during the summer or part-time during the school year.

Students receive an educational stipend equivalent to $10 per hour, and are allowed to work up to 300 hours total. The students contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the program, the students prepare final reports for submission to the U.S. Army Research Office's Youth Science Programs office.

In 2013, HSAP was guided by the following priorities:

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

In 2013, HSAP awards were made at 12 universities or colleges in 11 U.S. States (Table 3) and funded 24 apprentices and 5 Graduate Mentoring Fellows.

**Table 3. 2013 HSAP Sites**

| University or College | City | State |
|---|---|---|
| Arizona State University | Phoenix | Arizona |
| City College of New York | New York | New York |
| Marshall University | Huntington | West Virginia |
| North Carolina State University | Raleigh | North Carolina |
| Tennessee State University | Nashville | Tennessee |
| Texas Tech University | Lubbock | Texas |
| University of California San Bernardino | San Bernardino | California |
| University of Central Florida | Orlando | Florida |
| University of Chicago | Chicago | Illinois |
| University of Maryland Eastern Shore | Princess Anne | Maryland |
| University of Rochester | Rochester | New York |
| Western Michigan University | Kalamazoo | Michigan |

The total cost of 2013 HSAP was approximately $80,594. Funding was provided by ARO via Director discretionary funds matching program manager funds. The average cost per 2013 HSAP participant taken across all HSAP sites was $2,779. Table 4 summarizes these expenditures.

**Table 4. 2013 HSAP Costs**

| | |
|---|---|
| **2013 HSAP - Cost Per Participant** | |
| Total Participants (Apprentices + Graduate Mentoring Fellows) | 29 |
| Total Cost | $80,594 |
| **Cost Per Participant** | **$2,779** |
| **2013 HSAP - Cost Breakdown** | |
| Administrative Cost to ARO | $9,609 |
| Participant Stipends | $70,985 |
| **Total Cost** | **$80,594** |

## Evidence Based Program Change

In response to the FY12 evaluation, ARO made the following changes or additions to its administration of HSAP in 2013. The efforts were intended to enhance HSAP's ability to effectively and efficiently meet AEOP and program objectives:

1. Streamline the application, proposal, and review process for HSAP apprenticeships;
2. Provide online training to designated graduate student mentors (herein called Graduate Mentoring Fellows, GMFs), enhancing their ability to teach apprentices about the AEOP and Army STEM career opportunities;
3. Enhance apprentices' final project by initiating a unified format for project submission giving apprentices a choice of formats; research poster, video, NDSEG application, or SMART proposals; and
4. Encourage apprentices and mentors at all university sites to participate in evaluation efforts.

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 three HSAP sites;
2. Phone interviews conducted with apprentices and mentors at 10 HSAP sites;
3. Enhanced Actionable Program Evaluation, including apprentice and mentor perceptions of:
    - Marketing and recruitment to the HSAP program;
    - Motivation to participate in HSAP;
    - Satisfaction with HSAP activities;
    - Benefits of HSAP; and
    - Suggestions for improvement to HSAP.
4. Baseline data collection from mentors on current activities, challenges, and additional support needed related to:
    - Educating apprentices about AEOP opportunities; and
    - Educating apprentices about STEM jobs and careers, and specifically those within the Army or DoD sectors.
5. Assessment of Graduate Mentoring Fellow (GMF) pilot program, specifically perceptions of, learning from, and use of learning from the eWorkshops.

## 2013 Evaluation At-A-Glance

Virginia Tech, in collaboration with ARO, conducted a comprehensive evaluation study of the HSAP program. The HSAP logic model below presents a summary of the expected outputs and outcomes for the HSAP program in relation to the AEOP and HSAP-specific priorities. This logic model provided guidance for the overall HSAP evaluation strategy.

| Inputs | Activities | Outputs | Outcomes (Short term) | Impact (Long Term) |
|---|---|---|---|---|
| • Army sponsorship<br>• ARO providing oversight of programming<br>• Operations conducted by 12 Army-funded university/college labs (HSAP sites)<br>• 24 students participating in HSAP apprenticeships<br>• 16 university/college S&Es and GMFs as HSAP mentors<br>• Apprenticeship funds administered to university/college labs to support student participation<br>• Centralized branding and comprehensive marketing<br>• Centralized evaluation | • Students engage in authentic STEM research experiences through hands-on summer apprenticeships at Army-sponsored university/college labs<br>• University/college S&Es supervise and mentor students' research | • Number and diversity of student participants engaged in HSAP<br>• Number and diversity of university/college S&Es engaged in HSAP<br>• Number and Title 1 status of high schools served through student engagement<br>• Students, university/college S&Es, and ARO contributing to evaluation | • Increased student STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM)<br>• Increased student interest in future STEM engagement<br>• Increased students awareness of and interest in other AEOP opportunities<br>• Increased student awareness of and interest in STEM research and careers<br>• Increased student awareness of and interest in Army/DoD STEM research and careers<br>• Implementation of evidence-based recommendations to improve HSAP | • Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs<br>• Increased student pursuit of STEM coursework in secondary and post-secondary schooling<br>• Increased student pursuit of STEM degrees<br>• Increased student pursuit of STEM careers<br>• Increased student pursuit of Army/DoD STEM careers<br>• Continuous improvement and sustainability of HSAP |

The HSAP evaluation gathered information from apprentice and mentor participants about HSAP 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 HSAP program objectives:

**Key Evaluation Questions**

- What aspects of HSAP motivate participation?
- What aspects of HSAP structure and processes are working well?
- What aspects of HSAP could be improved?
- Did participation in HSAP:
  - 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 HSAP included: Onsite focus groups with apprentices and mentors at three HSAP sites in the Northeast U.S.; individual phone interviews with apprentices and mentors at ten additional sites in the West, Southeast, Midwest, and Northeast U.S.; a post-program apprentice questionnaire; and a post-program mentor questionnaire and rubrics. Graduate Mentoring Fellows completed an additional post-program questionnaire.

Tables 5 and 6 outline the information collected in apprentice and mentor assessments that are relevant to this evaluation report.

**Table 5. 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 HSAP, motivating factors for participation, satisfaction with and suggestions for improving the HSAP program |
| AEOP Goal 1 Indicators of Program Achievement | **STEM Competencies:** Perceptions of opportunities to engage in STEM activities in HSAP (as compared to at school), self-reported change in confidence in apprentices' STEM competencies |
| | **AEOP Opportunities:** Past participation, exposure to, and interest in participating in other AEOP programs |
| | **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:** Apprentices' perceptions of day-to-day mentor activities |

**Table 6. 2013 Mentor Assessments**

| Category | Description |
|---|---|
| Profile | **Demographics:** Participant gender, race/ethnicity, occupation, past participation |
| Satisfaction & Suggestions | Awareness of HSAP, motivating factors for participation, satisfaction with and suggestions for improving HSAP programs, benefits to participants |
| AEOP Goal 1 Indicators of Program Achievement | **STEM Competencies:** Perception of apprentices' opportunities to engage in STEM activities in HSAP, Mentors' assessment of apprentices' STEM competencies after HSAP and final presentation/project |
| AEOP Goal 1 & 2 Program Efforts | **AEOP Opportunities:** Mentor awareness and efforts to expose apprentices to AEOP opportunities, perceptions of apprentice interest in AEOP opportunities |
| | **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:** Mentors' perceptions of day-to-day mentor activities (STEM research engagement activities and academic/career advisory 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 and phone interview protocols are provided in Appendices D (apprentices) and E (mentors). Major trends in data and analyses are reported herein.

[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.

## Study Sample

The post-HSAP questionnaires were provided to the 2013 HSAP sites in electronic format using the Qualtrics® survey system hosted by Virginia Tech. A total of 15 apprentices representing 9 known HSAP sites responded to the apprentice questionnaire. In addition, 15 mentors representing 11 known HSAP sites responded to the mentor questionnaire.

Table 7 provides an analysis of apprentice and mentor participation in post-HSAP 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 apprentices (±15.8%) did not reach acceptable levels, and suggests that the current samples have limited representativeness of the participant populations. Participation rate and margin of error for the mentor sample appears excellent (>100%, ±0.0%,), however, mentor respondents did not identify themselves systematically in the questionnaire, which could limit the capacity of statistical indicators of reliability to provide interpretable results.

A comparison of apprentice questionnaire respondents and apprentice participant demographics (obtained from ARO's registration data) show no statistically significant differences in the key demographic characteristic of gender, however no other demographics are available for establishing representativeness of the apprentice sample. Apprentice respondents represent 75% of the 12 HSAP sites. Demographic information is not available for the population of mentor participants.

Statistical reliability, limited success employing alternative means of establishing sample representativeness, and the small population size all suggest that findings from the apprentice questionnaire respondents may not be generalizable to respective total population of apprentices. Apprentice and mentor respondents contribute valuable perspective to the overall HSAP 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, as well as clearly defined populations of participants, are critical for establishing reliable evaluation and are critical areas for attention in future HSAP programming.

**Table 7. 2013 HSAP Questionnaire Participation**

| Participant Group | Respondents (Sample) | Total Participants (Population) | Participation Rate | Margin of Error @ 95% Confidence[5] |
|---|---|---|---|---|
| Apprentices | 15 | 24 | 63% | ±15.8% |
| Mentors | 18[6] | 16 | >100% | ±0.0% |

[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.

[6] Eighteen individuals self-identified as HSAP mentors in the HSAP mentor questionnaire and rubrics. Discrepancies could be due to other laboratory personnel serving in a mentor capacity for an HSAP apprentice (though not considered mentor-of-record) completing evaluation assessments, incorrect self-identification as an HSAP mentor, or inaccuracies of university and/or ARO record keeping.

Focus groups were conducted at 3 HSAP sites in the Northeast U.S. Mentor focus groups included 6 HSAP and/or URAP mentors (1 female, 5 male). HSAP and URAP mentors were interviewed together (as they often worked together with High School and Undergraduate students), but herein they will be referred to as HSAP mentors. Apprentice focus groups included 3 male apprentices. Individual phone interviews were conducted with apprentices and mentors at 10 HSAP sites in the West, Southeast, Midwest, and Northeast, U.S. Phone interviews included 7 male mentors, 3 of who were graduate were GMFs. Phone interviews also included 8 apprentices (3 female, 5 male). Focus groups and phone interviews were not intended to yield widely 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 HSAP'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 HSAP apprentice questionnaire respondents are summarized in Table 8.

**Table 8. 2012 and 2013 HSAP Apprentice Questionnaire Respondent Demographics**

| Demographic Category | 2012 (n = 7/28) | 2013 (n = 13 to 15/33) | |
|---|---|---|---|
| **Gender** | | | |
| Female | 14% | 1 | 8% |
| Male | 86% | 12 | 92% |
| Choose not to report | 0% | 0 | 0% |
| **Race or Ethnicity** | | | |
| American Indian or Alaskan Native | 14% | 1 | 8% |
| Asian or Other Pacific Islander[7] | 43% | 5 | 38% |
| Black or African American | 0% | 2 | 15% |
| Hispanic or Latino | 0% | 2 | 15% |
| White or Caucasian | 29% | 2 | 15% |
| Other | 14% | 1 | 8% |
| Choose not to report | 0% | 0 | 0% |
| **Socioeconomic Indicators (most frequent responses given)** | | | |
| Public School Type | 100% | 11 | 100% |
| Suburban School Setting | 57% | 10 | 91% |
| Do Not Qualify for Free or Reduced Lunch | 86% | 8 | 73% |
| **Grade Level and Age** | | | |
| Rising Grade 10 | 0% | 1 | 7% |
| Rising Grade 11 | 14% | 4 | 27% |
| Rising Grade 12 | 43% | 9 | 60% |
| Rising College Freshman | 43% | 1 | 7% |
| Average Age | 17.14 years | 16.67 years | |

[7] 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.

In 2012 and 2013 similar proportions of males (86% and 92%, respectively) and females (14% and 8%, respectively) completed the apprentice questionnaire. In 2012 and 2013, more respondents identified themselves as Asian or Other Pacific Islander (43% and 38%, respectively) than any other race/ethnic category. In 2012, 14% of responding apprentices identified themselves as American Indian or Alaskan Native, and 8% of apprentices reported the same in 2013. In 2012, none of the apprentice respondents identified themselves as Black or African American or as Hispanic or Latino. In 2013, 15% identified as Black or African American or as Hispanic or Latino. In 2012 and 2013, all apprentice respondents reported attending public schools and a majority reported attending suburban schools (2012 = 57%, 2013 = 91%). In both 2012 and 2013, most respondents reported that they do not qualify for free or reduced lunch (FRL) at school (86% and 73%, respectively); qualifying for free or reduced lunch (FRL) is a common indicator of low-income status. The average reported age of apprentices was 17.14 year in 2012, and in 2013 it was 16.67 years. In 2012 43% of respondents were rising college freshmen; however, most 2013 apprentices (93%) had one or more years of high school left.

One objective of all AEOPs is to expand the participation of underrepresented and underserved segments of our population (e.g., women, students of Black or African American descent, Hispanic or Latino populations, and students from low-income families) in science and engineering education and careers through inspirational and supportive Army-sponsored programs. Although not conclusive, a comparison of 2012 and 2013 respondent data suggests that progress may have been made in attracting more students from underserved racial and ethnic minority and low-income groups. However, limited statistical reliability in 2012 and 2013 evaluation data (associated with small population and sample sizes) does not allow for a conclusive determination of year-to-year change.

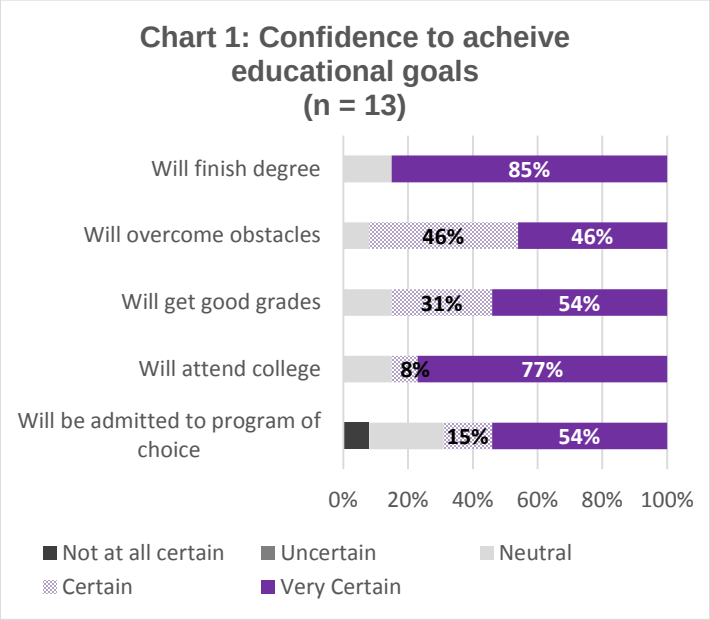
Outreach to specific underrepresented and underserved populations of high school students remains an area of potential growth for HSAP.

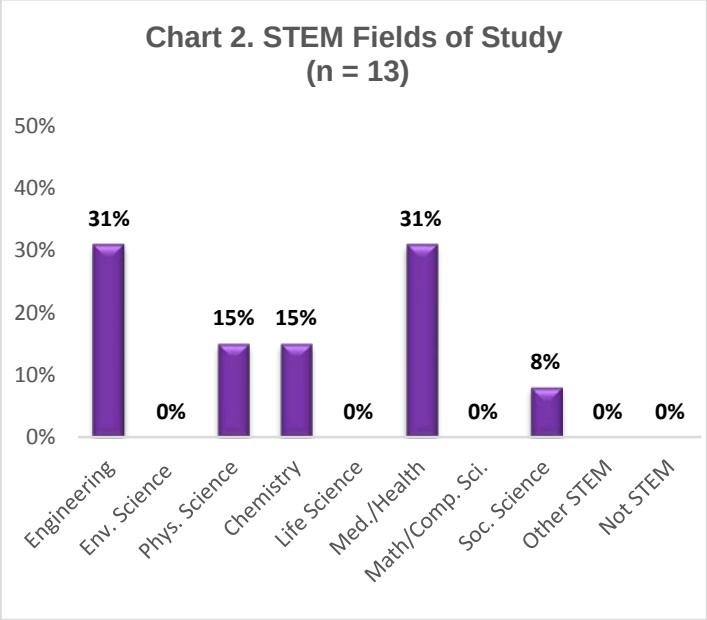
**Apprentice education intentions.** The apprentice questionnaire included items to elicit apprentices' educational goals (highest degree sought), their confidence to achieve these goals, and the STEM field they would like to pursue. When reporting their confidence to achieve their educational goals, 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 13, see Appendix B) HSAP apprentice respondents intended to pursue an advanced college degree (master's or higher), and most (n = 11, 85%) intended to pursue that degree in a STEM field. The majority of apprentices (69% or more) were "Certain" or "Very Certain" that they will achieve their educational goals (Chart 1). Apprentices were most certain (85%) that they will attain their ultimate educational goal—a degree. Apprentices were least certain (69%) they will be admitted to their college or program of choice. Of the STEM fields of study (Chart 2), apprentices reported most frequently that they want to pursue engineering (31%) or medical/health fields (31%).

HSAP apprentices intended to pursue advanced degrees in STEM and they were confident that they can achieve their educational goals. However, items pertaining to apprentices' degree intentions and pursuit of STEM fields did not discern when apprentices' educational goals were established (during HSAP or prior to HSAP), or to what extent HSAP participation affected their educational goals. Combining these findings with others in this report, we can surmise that most HSAP

apprentices entered the program with well-established goals for their STEM pathway and sought out HSAP to advance in their STEM pathway.




**Past AEOP experiences.** Apprentices were asked about their past experiences in HSAP and other AEOP programs. None of 2013's respondents were HSAP apprentices in the past, but three (25%) report participating in other high school internships programs such as REAP or SEAP. None of the apprentice respondents reported participating in UNITE, West Point Bridge Design Contest, or eCYBERMISSION, and only one participant reported participating in JSS (8%) and JSHS (8%) respectively. Generally, these data provide evidence that most HSAP participants have not been active in AEOP programming in the past; thus, HSAP may be reaching unique populations of students and serving as an entry-point into AEOP programming.

**Mentor demographics.** Demographic information was not collected from HSAP mentors in 2012, demographic information from 2013's HSAP mentor questionnaire respondents are summarized in Table 9.

In 2013, HSAP mentors were predominantly male (78%) and either White/Caucasian (50%) or Asian or Other Pacific Islander (44%). The 18 questionnaire respondents have mentored 4 apprentices on average, ranging from 1 (the current apprentice) to 12 apprentices in total. Of the 18 mentors, 28% worked as an HSAP apprentice in the past. Given that most mentors are either returning HSAP mentors or have worked as an HSAP apprentice in the past, data suggests that HSAP relies on repeated engagement (over the course of a multi-year ARO-funded grant) as a primary mechanism for recruiting university or college S&Es to serve as mentors.

| Table 9. 2013 HSAP Mentor Questionnaire Respondent Demographics | | | |
|---|---|---|---|
| **Demographic Category** | **2012 (n = 0)** | **2013 (n = 18/35)** | |
| **Gender** | | | |
| Female | | 3 | 17% |
| Male | | 14 | 78% |
| Choose not to report | | 1 | 6% |
| **Race/Ethnicity** | | | |
| American Indian or Alaskan Native | | 0 | 0% |
| Asian or Other Pacific Islander[8] | | 8 | 44% |
| Black or African American | | 1 | 6% |
| Hispanic or Latino | | 0 | 0% |
| White or Caucasian | | 9 | 50% |
| Other | | 0 | 0% |
| Choose not to report | | 0 | 0% |
| **Past Participation** | | | |
| Worked as an HSAP apprentice | | 5 | 28% |
| HSAP/URAP apprentices mentored historically | | Avg. = 4, Range = 2-12 | |

As HSAP endeavors to expand participation of students from underserved and underrepresented populations, it may be beneficial to contemplate how to effectively expand mentor diversity as well. In pertinent research, having access to mentors that share the same gender, or share the same racial or ethnic characteristic, have been identified 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.** In the mentor questionnaire, respondents were asked to describe their field of research with the same broad categories that were provided to apprentice respondents.

The majority of mentors (15 of 18, 83%) reported that one of three disciplines described their research field: Engineering (33%), Physical Science (28%), and Chemistry (22%). Mentors also reported that they work in the fields of Life Science (6%), Mathematics/Computer Science (6%), or Aerospace/Aviation (6%). Mentors generally did not work in the Medicine/Health field, which was among the most frequent field of interest reported by HSAP apprentices. This discrepancy is not surprising, considering that many students pursuing undergraduate degrees in STEM fields do so to obtain the necessary foundation of basic science and mathematics required for acceptance into professional degree programs in medicine/health sciences. [10] Recent studies suggest that as many as one third of students leaving undergraduate STEM majors are pre-medical students who have abandoned their pursuit of a medical career (known as the "pre-med phenomenon"). [11] Apprenticeship programs, such as HSAP, serve a critical need in providing authentic STEM experiences that both inspire and sustain students' interest in STEM fields and that provide students with exciting and obtainable STEM career options to the more highly competitive medicine/health fields.

[10] Georgetown Center on Education and the Workforce (2013), Author STEM http://genprogress.org/voices/2011/10/25/17168/report-more-jobs-this-year-for-recent-graduates/

[11] UCLA's post-Baccalaureate Experiences, Success, and Transition (BEST) project has studied barriers to and facilitators of underrepresented minority students' pathways toward careers in STEM fields since 2004. A number of applicable reports may be found at http://www.heri.ucla.edu/publications-brp.php, including Higher Education Research Institute (2010). *Degrees of success Bachelor's Degree Completion Rages among Initial STEM Majors*.

# 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 5 and 6.

A focus of the Actionable Program Evaluation are efforts toward the long-term goal of HSAP and 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 HSAP is marketed and ultimately recruits participants, the factors that motivate them to participate in HSAP, 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 HSAP apprentices and mentors in an effort to both understand current program efforts and to recommend evidence-based improvements toward achieving outcomes related to AEOP and program objectives.

## *Marketing and Recruiting Underserved Populations*

The HSAP manager, ARO, conducted two relatively independent marketing and recruitment efforts. First, distribution of email and print advertising to Army-funded university and college research laboratories nationwide were intended to reach ARO-funded personnel who then submit proposals requesting funds for HSAP apprenticeships. Second, for students, HSAP was advertised with the AEOP portfolio of programs, primarily through social media and traditional print campaigns, in an effort to attract students to apply online at www.usaeop.com. HSAP's marketing and advertising campaigns target the very specific population of Army-funded university and college scientists and engineers. However, it is unclear how any marketing or recruiting efforts target underserved or underrepresented student or mentor populations.

Focus groups, phone interviews, and questionnaires asked apprentices why they chose to participate in HSAP, including any personal connections that led them to HSAP (or to a specific site or mentor), any past experience participating in HSAP or other AEOPs, and how they were recruited to HSAP. Their responses revealed a variety of ways in which they became aware of and involved in HSAP, which help identify how HSAP ultimately attracts apprentices. Similarly, mentors were asked why they chose to participate in HSAP this year, to explain how they became connected with their apprentice, and to describe the recruiting process that they employed to attract apprentices. These data help us to understand how or why mentors became involved in HSAP and how apprentices were ultimately recruited and/or selected at the site level.

Most apprentices learned of HSAP through direct contact with individuals who have a current or past connection with HSAP at the site-level, including: friends who participated in the past; family members who know about HSAP; high school personnel who know about the program; university or college personnel who are connected to an HSAP site; and a different high school program that is hosted at an HSAP site. A small proportion of apprentice interviewees mentioned learning of HSAP through internet research and the AEOP website, or through an HSAP site's department or university website. From questionnaires, apprentices reported that a family member or friend worked at their HSAP site (23%),

personnel from their high school informed them about the program (31%), or that they were informed about the program through friends or family members (15%). Less frequently, apprentices reported that they learned about HSAP through another program (e.g., Upward Bound), that a mentor encouraged specific apprentices' to participate, or through apprentices' independent searching for a summer program.

In questionnaires, eleven mentors reported actively recruiting apprentices for HSAP. Most frequently, mentors recruited participants through connections with local high school staff (45%) and through connections with other programs (27%). Most mentors mentioned that they selected them from the AEOP applicant pool with assistance from ARO (75%). Only three mentors (25%) knew students prior to their participation as an HSAP apprentice. In focus groups and interviews, most mentors reported recruiting apprentices in classes or in advertisements city-wide.

From apprentice and mentor accounts, we can surmise that recruitment of apprentices occurs at the site-level using connections or mechanisms available to the site or mentor (e.g., high schools and other programs). Only rarely did students come into contact with HSAP national-level marketing efforts. As a result, the ability of HSAP to recruit underserved or underrepresented populations of students depends upon the diversity of the local communities in which recruitment takes place. Some mentors selected apprentices they already knew, but the majority of mentor respondents reported that they used the AEOP applicant pool to make their selections.

### *Motivating Factors for Participation*

Focus groups, interviews, and questionnaire items elicited apprentices' and mentors' motivation to participate in HSAP. The following trends emerged from their responses to questions about why they chose to participate in HSAP.

**Motivating factors for apprentices.** Apprentice interviewees and questionnaire respondents offered several factors that motivated them to participate. Most often, and aligned with the previous actionable evaluation section, other people motivated apprentices' participation. Apprentices received encouragement and/or had assistance in pursuing an HSAP apprenticeship through personal connections to the HSAP site via high school staff, other programs in which they participated, and family or friends who are connected to the HSAP site. In a single case, an apprentice mentioned that they worked as an HSAP apprentice previously. None of the responding apprentices mentioned that their experiences in other AEOP programs motivated them to participate in HSAP.

Frequently, apprentices perceived HSAP to be an opportunity for professional growth and educational experiences. Apprentices reported that HSAP offered opportunities to explore and clarify fields for future STEM education and/or careers. HSAP offered opportunities to prepare for STEM competitions and college-level research through authentic research experiences that they cannot get in high school. Weekly stipends motivated apprentices to pursue HSAP over other programs where they have to pay to participate.

**Motivating factors for mentors.** Mentors also expressed a variety of factors that motivated their participation. Most often, mentors became involved in HSAP because it satisfied an internal desire to mentor students and/or perform community

service that benefited youth; such service was often encouraged by other colleagues, or by their department or university. Others became involved because HSAP advanced their research programs in the form of funded apprentices. Less frequently, mentors reported HSAP offered them a high-quality professional development opportunity.

In sum, qualitative data suggests that apprentices were motivated to participate in HSAP through the active encouragement of someone who is aware of the HSAP program. Most often, these individuals are high school personnel, involved in other extracurricular activities, friends, or family members. After learning of the HSAP program, apprentices were most often motivated to participate because HSAP offered them professional and educational experiences that they could not get in school. Mentors were typically motivated to pursue HSAP through their own ambitions to outreach to youth. Additionally, mentors were motivated by the opportunity to expand existing research programs or by colleagues who encourage them to begin mentoring HSAP apprentices.

### *Mentor Capacity*

HSAP's second and fourth priorities are to benefit students from the expertise of a scientist or engineer as a mentor and provide hands-on science and engineering research experience to high school students. The nature and quality of mentoring provided to apprentices is a critical factor that determines 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.

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 of 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 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 HSAP and describe mentoring received or provided, respectively.

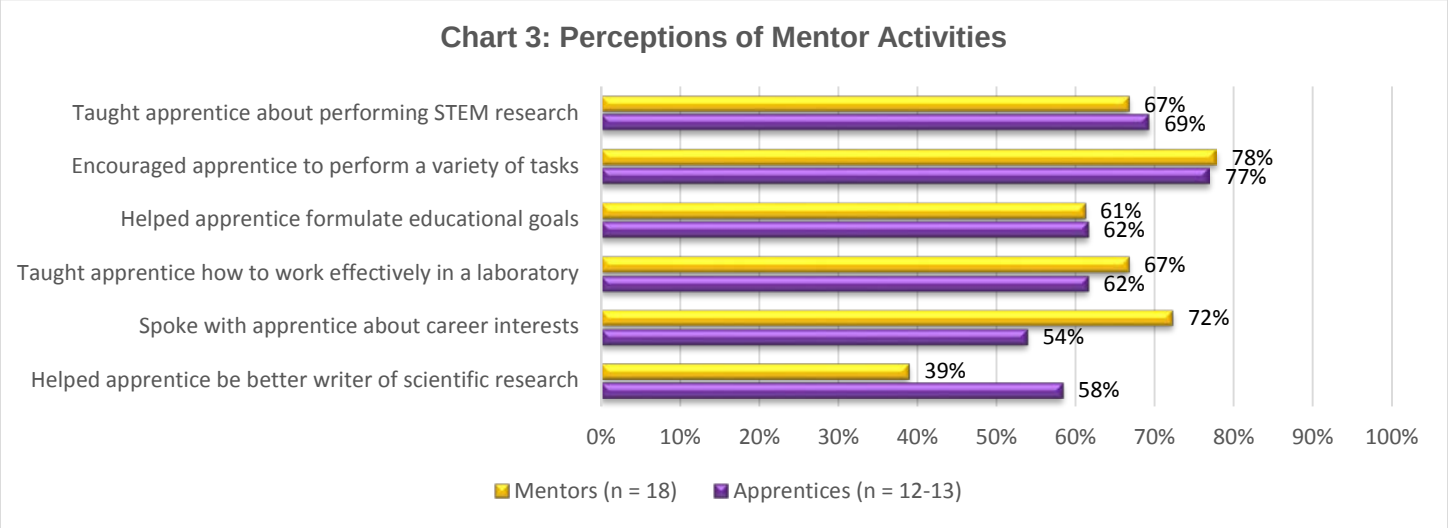
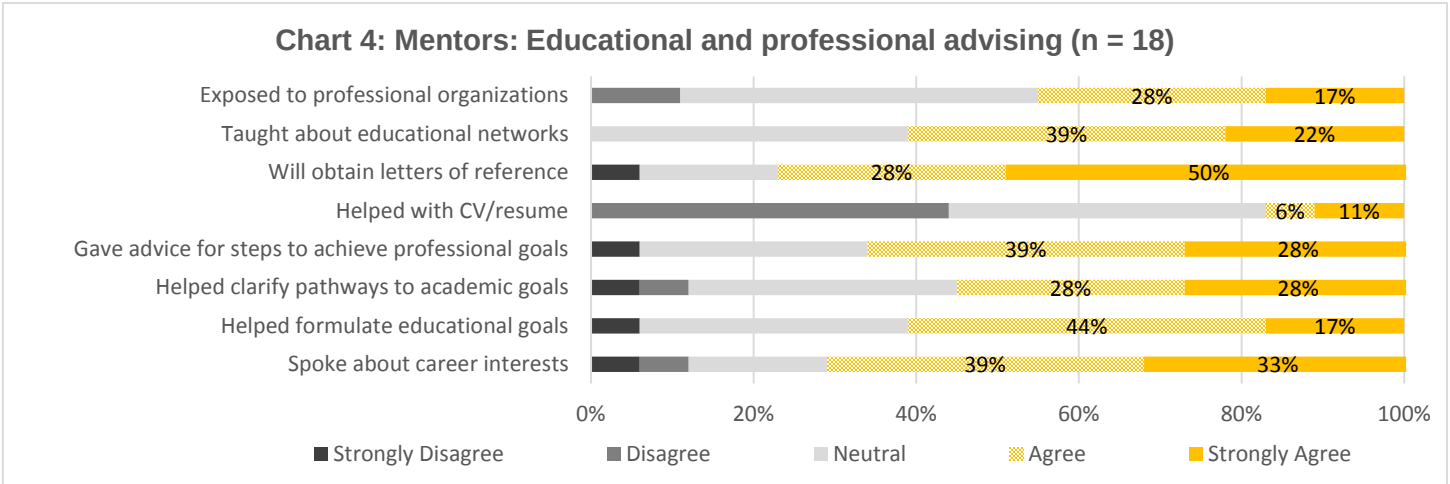



Chart 3 illustrates that apprentices and mentors reported they were exposed to or engaged in basic mentorship activities. Small proportions of apprentices (15-25%) and mentors (6-17%) "Strongly Disagree" or "Disagree" that any one of these mentor activities occurred (refer to Appendices B and C). Chart 3 suggests that apprentices and mentors perceived similar occurrences of most mentor activities similarly with two possible exceptions: 72% of mentors versus 54% of apprentices "Agree" or "Strongly Agree" that they spoke about career interests, and 39% of mentors and 58% of apprentices "Agree" or "Strongly Agree" that mentorship helped apprentices become better writers of scientific research. Statistically, neither of the observed differences between apprentice and mentor perceptions of mentor activities reached significance.

Mentors responded to six additional items, making eight total items, that measure the extent to which they engaged in educational and professional advisory mentorship with their apprentices. From Chart 4, very few mentors report that they did not engage in advisory mentorship activities. One exception, however, does exist; 44% of mentors "Disagree" that they helped their apprentices draft a CV or Resume.



When asked in focus groups to describe the mentoring received or provided in a typical day, apprentice and mentor interviewees described some similar mentor activities:

- Apprentices received mentorship from more than one mentor, typically a group of professors and graduate students that work in the laboratory;
- Mentors met regularly with apprentices, allowing apprentices to provide updates regarding their work, and giving mentors opportunities to give feedback, direction, or training; and
- Mentors provided background information for the research project, either through lectures or assigned readings.

Focus group data indicated mentorship is often specific to mentee-mentor partners. For example, one apprentice reported that they did not work closely with their mentor, while mentors of other apprentices reported working closely with their apprentices on a regular basis. Additionally, mentor questionnaire respondents indicated that apprentices received career and professional advising; however, none of the focus group responses from apprentices or mentors mentioned any type of professional or career advising. Focus groups and questionnaires were completed by mentors that work with both HSAP and URAP apprentices simultaneously, so mentors may have reported their professional and educational advising interactions in reference to URAP apprentices rather than HSAP apprentices.

HSAP mentors engaged their apprentices in STEM research and provided them with guidance about educational and career pathways during the HSAP apprenticeship. Apprentices and mentors reported similar engagement in mentor activities related to STEM research experiences, educational goals, and career goals. Mentorship related to educational and career advising that was reported by mentors may be conflated with interactions that they had with URAP apprentices simultaneously.

**Mentoring about AEOP opportunities.** Mentor questionnaires, focus groups, and interviews asked mentors to describe the strategies used, challenges faced, and ways in which HSAP could support them in their efforts to educate apprentices about AEOP opportunities. From questionnaires, four out of ten mentors (40%) reported that they did not or could not discuss AEOP programs with apprentices because they were unfamiliar with them. Of the remaining six respondents, three reported that they only discussed the SMART or NDSEG program with their apprentices. Only one respondent discussed the AEOP with their apprentice(s), one mentor gave their apprentice(s) an AEOP brochure, and one mentor encouraged their apprentice(s) to submit their research to other science competitions although they did not specify whether it was an AEOP competition or not. Similarly, less than half of all mentor interviewees reported handing out AEOP brochures to their apprentices, and fewer discussed the brochure with their apprentices. Nearly half of all mentor interviewees did not provide any information to their apprentice(s) about the AEOP. Two mentor interviewees requested more information to distribute about the AEOP because they were unfamiliar with it.

In online questionnaires, focus groups, and interviews 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, including emails with AEOP material;
- Provide additional information, direction, and training from ARO regarding AEOP initiatives;

- Distribute print information and deliver it earlier in the year;
- Initiate an annual conference or meeting for HSAP to educate apprentices about AEOP;
- Coordinate visits to laboratories, including Army/DoD labs;
- Create a website information video for participants; and
- Give current participants material to distribute after participation.

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 HSAP can support mentors in educating apprentices about STEM and specifically Army/DoD STEM careers. Mentors used different strategies in mentoring apprentices about STEM careers, including: discussions with and giving advice to apprentice(s) about various STEM and Army/DoD STEM careers; exposure to STEM careers through the program experience; and visiting a DoD laboratory. Some mentors reported that they encouraged their apprentices to publish in the STEM literature as a way of exposing them to STEM pathways while another reported that they do not engage in STEM pathway discussions with apprentices because they believe that their goals are already set.

In questionnaire responses, mentors cited a few challenges in educating apprentices about STEM and Army/DoD STEM careers, including: high school students are not advanced enough to fruitfully engage in career discussions; the mentor was not familiar with many aspects of Army/DoD careers; and the duration of the program was too short to engage in those discussions without interfering with the work to be done.

Mentors offered suggestions for HSAP programming that would enable them to effectively educate their apprentice(s) about STEM and Army/DoD STEM careers. Suggestions included: having ARO provide information directly to apprentices via electronic media, increase funding to facilitate the time and resources to educate apprentices about careers, create a workshop for apprentices during the program, provide mentors with information to distribute, and facilitate visits to Army/DoD laboratories to expose apprentice(s) to 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.

**Graduate Mentoring Fellows Pilot Program.** The Graduate Mentoring Fellows (GMFs) pilot program intended to provide professional development to ARO-sponsored graduate students who often provide mentorship for HSAP and URAP apprentices. The intended professional development consisted of multiple eWorkshops around relevant topics (e.g., effective mentorship and assessment) and an online forum for support through virtual roundtables. Personnel changes at ARO substantially impacted the implementation of the Graduate Mentoring Fellows pilot program. Only a 45-minute eWorkshop was provided and it quickly reviewed information about AEOP programs and strategies for effective mentoring.

Graduate Mentoring Fellows were asked to complete an assessment to elicit their perceptions of the eWorkshop, their learning from the eWorkshop, and their use of new learning during their mentoring of HSAP apprentices. All data from this assessment of the eWorkshop have been summarized and discussed previously in the 2013 Graduate Mentoring Fellows Data Brief (Report GMF_01_08302013) attached as Appendix F. Preliminary recommendations are offered within the 2013 Data Brief to support program improvement.

### *Perceptions of HSAP*

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

**Value of HSAP.** Apprentices and mentors were asked in focus groups and interviews what they perceived as the value of the HSAP 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 that they perceived from their HSAP experience, including:

- Authentic, hands-on research experiences within a professional research setting, including using resources, tools, and techniques not typically encountered in high school classrooms;
- Opportunities to clarify and/or advance their STEM pathway including college research previews, clarification of educational or career goals, and building applications or resume;
- Growth in STEM competencies that would not be possible in school including laboratory skills, critical thinking skills, and information literacy;
- Increased capacity to compete in STEM competitions by transporting research projects directly to national competitions such as INTEL-ISEF;
- Increased capacity of contribute to local communities or society in general by working on projects with real-world impact;
- Access to effective mentorship (e.g., interacting and sharing ideas with a Ph.D.-level researcher); and
- Increased interest in pursuing STEM research in the future.

Mentors most frequently described the ways in which HSAP benefits apprentices. Mentors reported that HSAP:

- Engages apprentices in authentic research experiences, exposes them to the research process, enhances their practical lab skills, and provides them with opportunities that are not possible in school;
- Helps apprentices clarify and/or advance their STEM pathway by providing a realistic preview, enhancing their preparation to pursue goals, clarifies their educational or career goals, and motivating them to continue in STEM;
- Enhances apprentices' STEM competencies including critical thinking and information literacy;
- Enhances apprentice confidence in research skills and abilities.

Evaluators also elicited HSAP's value in terms of its benefit to mentors or to their laboratories. Mentors reported that HSAP was valuable for:

- Developing mentorship capacity and skills, such as learning how to organize and set the direction of the lab, effective mentorship strategies, and professional development for working as a mentor or supervisor in the future;
- Advancing work in the laboratory with apprentices as valued members of the research team who contributed significantly to the work of the laboratory; and
- Mentors found it rewarding to serve in a community service capacity, helping students learn STEM through HSAP.

**Successes and challenges in HSAP.** The questionnaire asked mentors to report successes and challenges they or their apprentices experienced. Ten mentors responded to this item and most reported that they enjoyed working with their apprentices and were satisfied with the program. Mentors perceived that their apprentices successfully completed a research project, worked effectively in the laboratory context, and will benefit from the experience in the future. Mentors also reported that they developed their own mentorship skills through HSAP. None of the mentors expressed any challenges or dissatisfaction with HSAP in the questionnaire.

When apprentices were asked about their mentors, most expressed high levels of satisfaction with their mentor's ability to provide instruction, teach, and create a respectful environment for them to work. One apprentice, however, reported that their mentor was generally unavailable and would have liked more interactions with them.

**Overall satisfaction and areas for improvement.** In focus groups, phone interviews, and in questionnaires, apprentices and mentors were asked to gauge or describe their overall satisfaction with HSAP. These items also provided apprentices and mentors with opportunities to voice concerns and identify areas for HSAP to improve. Table 10 summarizes the satisfaction and improvement items from all assessments.

**Table 10. 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 HSAP, what would you say? |
| **Mentor Phone Interviews** | Would you recommend participating in the program as a mentor to others? If so, why? If not, why not? |
| **Apprentice Phone Interviews** | Would you recommend participating in the program as an apprentice to others? If so, why? If not, why not? |
| **Apprentice Questionnaire** | Given the opportunity, would you participate in HSAP again? Why or why not? |

In focus groups and interviews, mentors shared high levels of satisfaction and specific benefits that HSAP affords to apprentices, mentors, and laboratories. Specific benefits are echoed sentiments reported as the value of HSAP, unique feedback included that:

- funding for HSAP should be increased because it is has a direct impact on our nation and national security; and
- everyone involved benefits from HSAP including mentors, apprentices, and laboratories because students contribute meaningfully to the research being conducted.

Mentors also shared challenges and recommendations for improving HSAP including:

- funding for HSAP should be increased because the program has the capacity to expand;
- programmatic processes should be streamlined to improve efficiency and timeliness, and communication between ARO to HSAP should be improved;
- final report requirement could be more flexible (e.g., different formats) and less time sensitive, or the final report could be replaced with a post-program interview; and
- addition of a conference or presentation venue for apprentices to showcase their work may benefit participants and raise the profile of the HSAP program simultaneously.

Most HSAP apprentices spoke highly of their experience, and questionnaire respondents unanimously reported that they would participate in the program again if given the opportunity. HSAP apprentices expressed specific reasons for high levels of satisfaction and many benefits that they would share with Army decision makers; they are summarized in the Value of HSAP section above. Unique benefits and areas for potential improvement include:

- HSAP offers a superior STEM research experience compared to that are offered by other programs;
- HSAP offered flexible scheduling and locations which also make it more attractive to some apprentices; and
- HSAP should improve its visibility and reach more high school students by using social media, contacting more schools and school personnel, and expanding marketing resources.

## Outcomes Evaluation

The evaluation of HSAP 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 HSAP; apprentices' and mentors' post-HSAP perceptions of apprentices' STEM competencies; apprentices' interest in future STEM engagement; and apprentices' awareness and interest in educational and career opportunities in Army STEM.

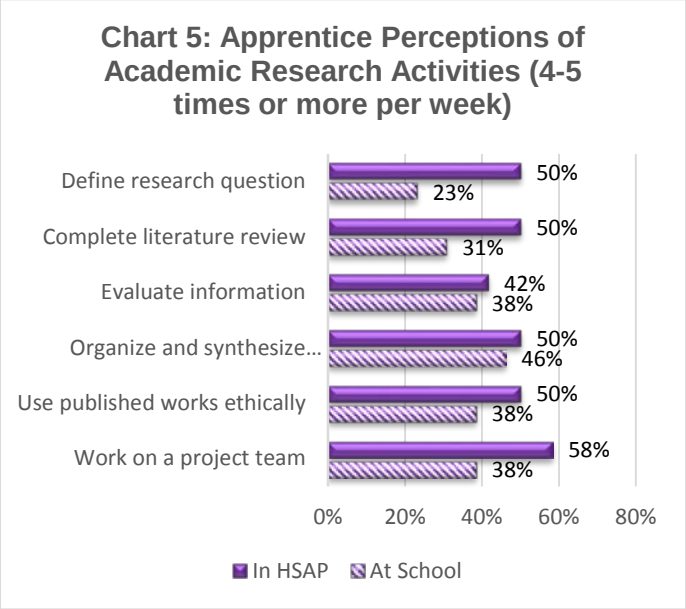
### *STEM Competencies*

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 HSAP priorities 1, 3, and 5: Provide hands-on science and engineering research experience to high school students; Provide students with experience in developing and presenting scientific research; and develop students' skills and background to prepare them for competitive entry to science and engineering undergraduate programs.

**Engagement in authentic STEM activities.** Twelve items measured apprentices' perceptions of opportunities to engage in STEM activities in HSAP as compared to in school. Six of the items included minds-on or academic research activities, such as 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; 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 5 and 6 on the next page summarize the proportions of apprentices reporting engaging in each activity 4-5 times per week or more in HSAP and at school. More detailed data summaries are provided in Appendix B. Statistical comparison of the frequency with which apprentices reported engaging in STEM activities in HSAP and at school is provided in Table 12.

As illustrated in Charts 5 and 6, the proportion of apprentices who reported engaging in these activities 4-5 times per week during HSAP exceeds 25% for all activities (25%-75%). For all items, smaller proportions of apprentices engaged in these kinds of activities at school with similar frequency (8%-46%). In HSAP, apprentices most frequently reported safely handling equipment or materials (75%) and using advanced measurement techniques (67%). On average, apprentices engaged in these activities more than 2-3 per week in HSAP (Avg.~3.5/6.0) and less than 2-3 times per week at school (Avg.~2.6/6.0).



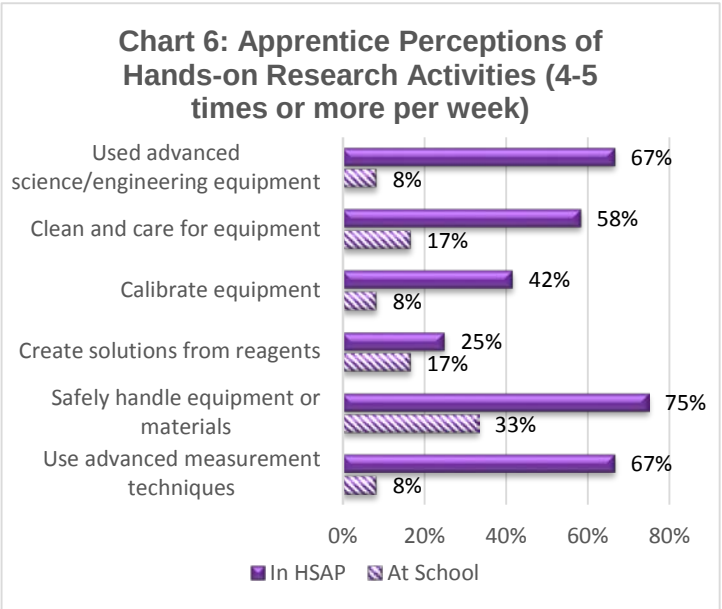




**Table 11. Engagement in STEM activities, matched cases At school vs. In HSAP**

| Item | At school Avg. (SD) | In HSAP Avg. (SD) | n | Mean Diff. | *t* | *p* | *d* |
|---|---|---|---|---|---|---|---|
| **I had to define a research question or thesis and determine its critical concepts** | 2.67 (1.44) | 3.25 (2.01) | 12 | **0.583** | 0.82 | .430 | .237 |
| **I had to use academic search strategies (e.g., databases and journals) to complete a literature review** | 2.67 (1.67) | 3.08 (1.83) | 12 | **0.417** | 0.63 | .539 | .183 |
| **I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)** | 3.00 (1.60) | 3.00 (1.95) | 12 | **0.000** | 0.00 | 1.000 | .000 |
| **I had to organize and synthesize information across academic sources** | 3.08 (1.38) | 3.33 (1.92) | 12 | **0.250** | 0.41 | .687 | .119 |
| **I had to determine appropriate ethical and legal uses of published academic research for my own work** | 2.67 (1.72) | 3.00 (1.86) | 12 | **0.333** | 0.45 | .662 | .130 |
| **I had to work as part of a team on research projects** | 2.75 (1.82) | 4.00 (2.09) | 12 | **1.250** | 1.76 | .105 | .509 |
| **I used advanced science or engineering equipment** | 1.67 (1.23) | 4.42 (1.83) | 12 | **2.750*** | 4.98 | .000 | 1.438 |
| **I cleaned and cared for the equipment in a science or engineering laboratory** | 2.25 (1.42) | 4.08 (2.19) | 12 | **1.833*** | 2.82 | .017 | .815 |
| **I calibrated laboratory equipment for experimentation** | 2.00 (0.95) | 3.42 (2.15) | 12 | **1.417*** | 2.20 | .050 | .634 |
| **I created solutions from reagents in preparation for experimental procedures** | 2.33 (1.23) | 2.42 (1.78) | 12 | **0.083** | 0.23 | .820 | .067 |
| **I used proper safety procedures when handling equipment and material in the lab** | 2.83 (1.53) | 4.58 (1.78) | 12 | **1.750*** | 3.09 | .010 | .893 |
| **I employed advanced measurement techniques in science or engineering procedures** | 2.00 (0.95) | 4.00 (2.09) | 12 | **2.000*** | 3.25 | .008 | .938 |

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

Table 11 reveals that observed differences between HSAP and school are statistically significant ($p < .05$) across most of the hands-on activities, with moderate to very strong effects. For example, the difference in calibrating laboratory equipment for experimentation is real and the effect is moderate in magnitude ($d = .634$). Observed differences in handling equipment and material safely in HSAP and at school is strong ($d = .893$) as is difference in using advanced science or engineering equipment in HSAP and at school ($d = .938$). The difference in using advanced science or engineering equipment in HSAP and at school is very strong ($d = 1.44$). While significance testing suggests that HSAP provided apprentices with significantly more frequent opportunity for hands-on research activities over regular school activities, it did not provide apprentices with more frequent opportunity to engage in academic (minds on) research activities over regular school activities. This is a potential area for growth for HSAP.[12]

[12] 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 HSAP program. In addition, six rubrics in the HSAP mentor questionnaire leveraged mentors' expertise as researchers and observations of apprentices during the program to provide 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 12.

**Table 12. 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<br><br>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.<br><br>**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<br><br>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 7 and 8 summarize apprentices’ and mentors’ responses to the STEM Competency items.

**Chart 7: Apprentice - More Confidence in STEM Competencies (n = 12)**

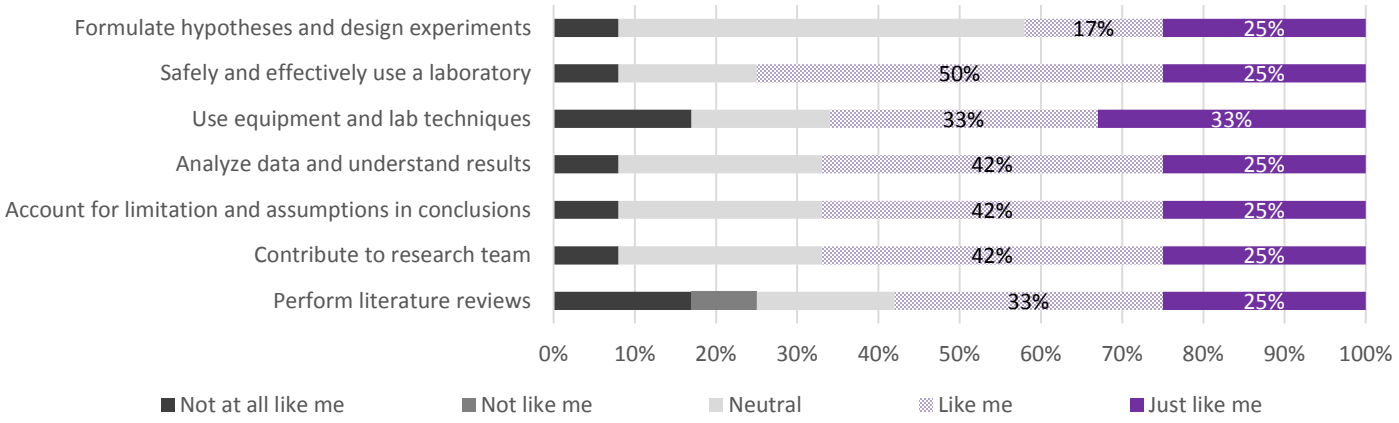
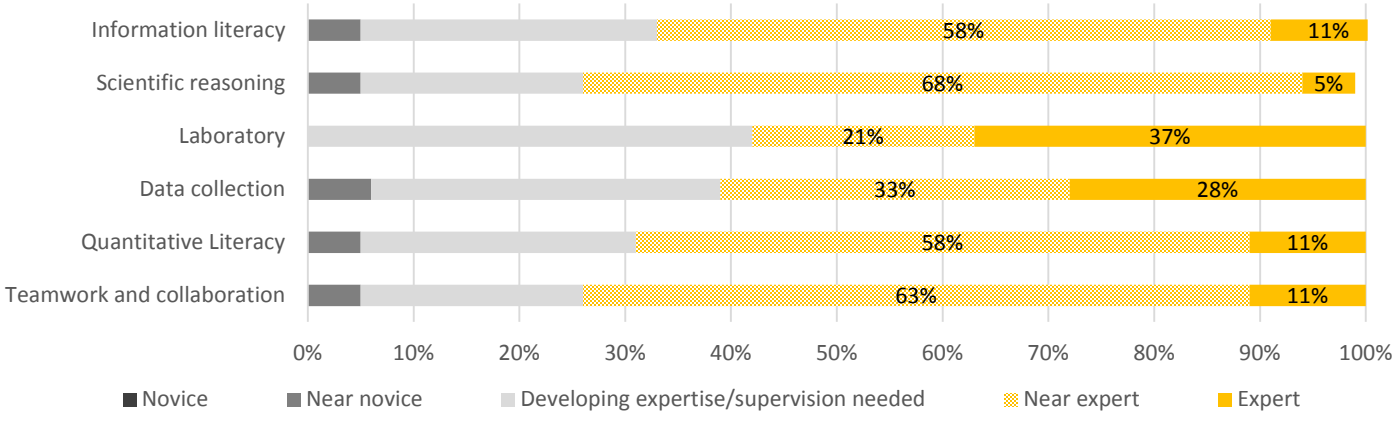



**Chart 8: Mentor - Assessment of Apprentice STEM Competencies (n = 18-19)**



From Chart 7, many apprentices (42%-75%) perceived growth in their confidence across the range of skills and abilities. A majority of apprentices perceived gains in their confidence to safely and effectively use a laboratory (75%) while a smaller proportion of apprentices perceived gains in their confidence to formulate hypotheses and design experiments (42%).

Chart 8 suggests that 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' scientific reasoning (74%) and teamwork and collaboration (74%). Average ratings generally approach the near expert level across all skills and abilities (4.63-4.95/6.0).

There is one instance of disagreement between apprentices' perceptions of gains in confidence and mentors' assessments of STEM skills and abilities. Apprentices perceived the least amount of gains in their confidence to formulate hypotheses and design experiments (Avg. = 4.33/6) while mentors rated their apprentices' scientific reasoning very highly (Avg. = 4.63/6). Apprentice data are consistent with the findings of the previous section, in which HSAP apprentices reported fewer opportunities to engage in the minds-on aspects of research than on the hands-on tasks. Thus, disagreement could be due to apprentices meeting or exceeding mentors' relatively low expectations to perform such tasks. Disagreement could also be due to apprentices' already high levels of confidence showing little change given few opportunities to challenge their notions of what it means to complete these tasks (i.e., a ceiling effect). In the remaining data, however, 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 12, we observe higher ratings in each participant group associated with teamwork and collaboration.

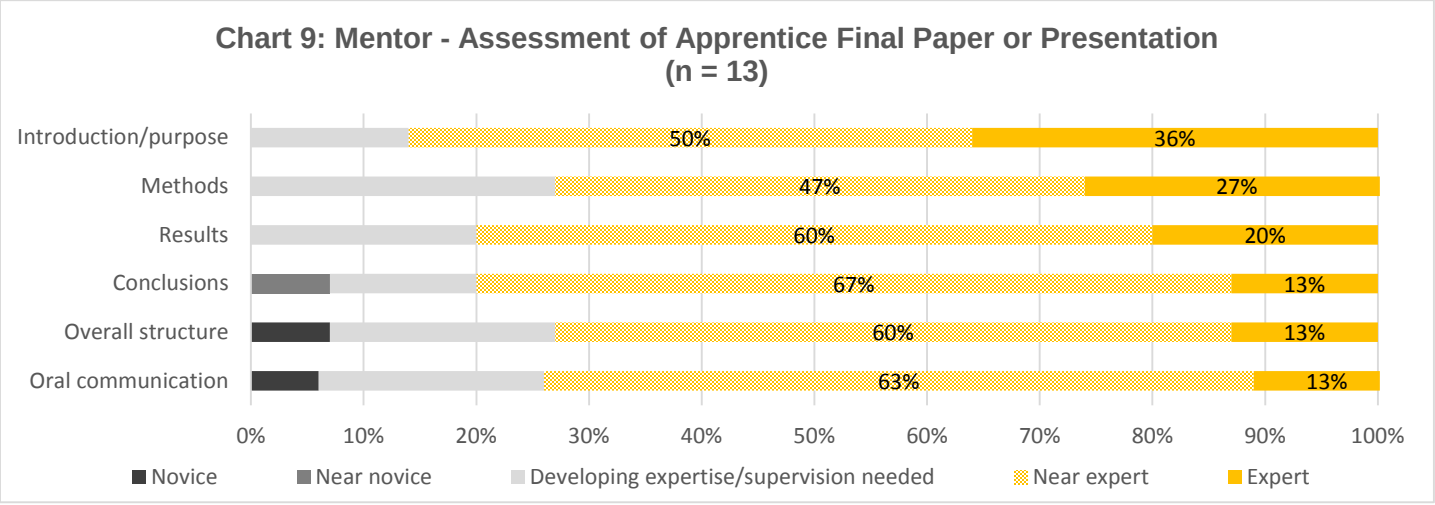
Taken together, we would conclude that apprentices perceived growth in their STEM skills, and mentor assessment of their performance potentially corroborates those perceptions. Apprentices' perceived growth and mentor rubric ratings are also consistent with what we might expect given the difference in frequencies for which apprentices conduct these activities in HSAP 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 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 13 summarizes each dimension as it is defined at the expert level.

| Table 13. 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 9 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.

From Chart 9, mentors rated all six components of their apprentices' final research project very highly. The average apprentice received a rating approaching near expert for all components of their research program (Avg. 4.63-5.21/6.0). These data suggest that most HSAP apprentices not only conduct research, but are also capable of producing high level research papers and presentations within the Army-sponsored laboratories where they worked.



### *Army STEM*

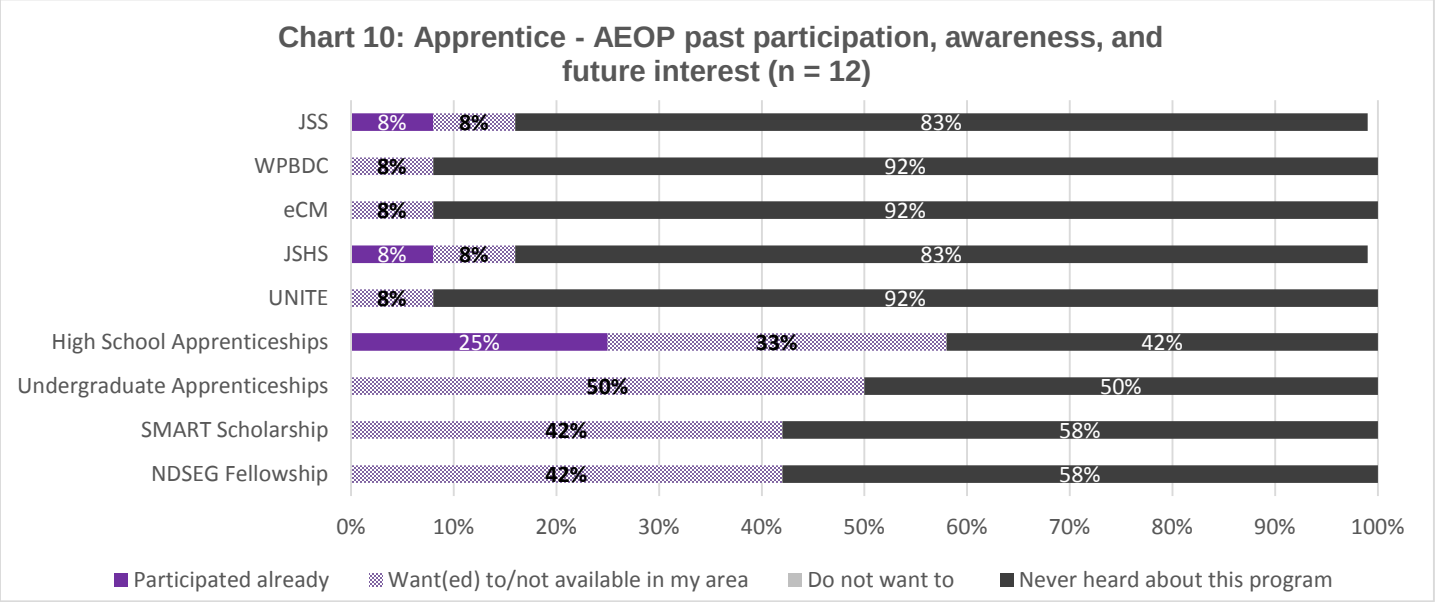
The Army's goal of establishing a coherent pipeline of opportunities for engaging and developing STEM talent from kindergarten to college, and then attracting that talent to Army/DoD careers, requires that each program promote its participants' awareness of both AEOP initiatives and Army/DoD STEM careers. 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)

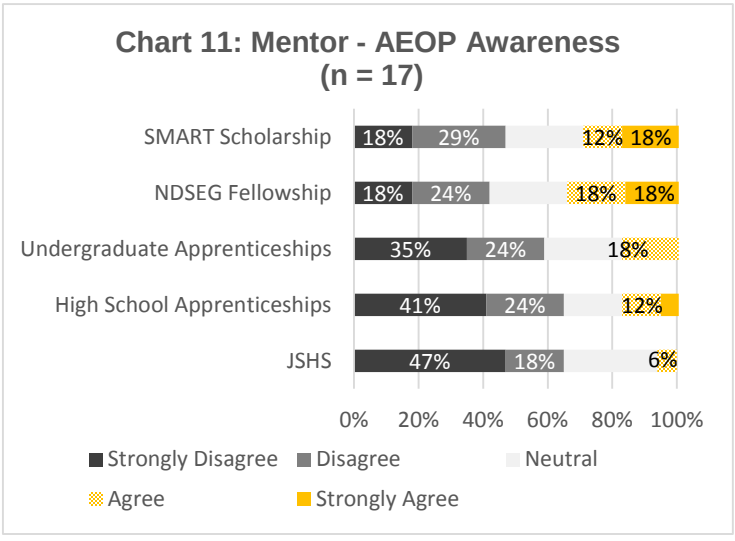
The assessments measured apprentice awareness and interest in participating in AEOP opportunities and Army/DoD STEM careers. In addition, the apprentice assessment measured apprentice attitudes toward Army/DoD STEM research and careers. Mentor assessments included corresponding items to corroborate apprentice findings and are shown here for comparison. These measures correspond to one HSAP Priority 2: Educate students about the Army's interest and investment in science and engineering research and the associated educational opportunities available to students through the AEOP.

**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 10 on the next page. According to these items a small proportion of apprentices have previously participated in High School apprenticeships such as REAP or SEAP (25%) while smaller proportions have participated in Junior Science and Humanities Symposium (8%) and Junior Solar Sprint (8%).




The most striking finding is that at the time of this questionnaire (near or after the conclusion of most HSAP apprenticeships), large proportions of apprentices (42-92%) indicated that they have never heard about various AEOP opportunities, most notably those programs that are geared towards middle and high school students; UNITE (92%), JSHS (83%), eCYBERMISSION (92%), West Point Bridge Design Contest (92%), and Junior Solar Sprint (83%). A considerable proportion of apprentices want to participate (or would participate but perceive unavailability of the program in their area) in AEOP programs that they may qualify for in the future. For example, apprentices were interested in high school apprenticeships (33%), undergraduate apprenticeships (50%), and college scholarship or fellowship programs (42%) for which they still may qualify.

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 11, many mentors (42-65%) were unaware of these AEOP and DoD opportunities. The majority of mentors were aware of undergraduate apprenticeships, such as the CQL program and fewer than 40% were familiar with other DoD scholarship/fellowship programs for attracting talented individuals to DoD research laboratories. When asked whether they provided

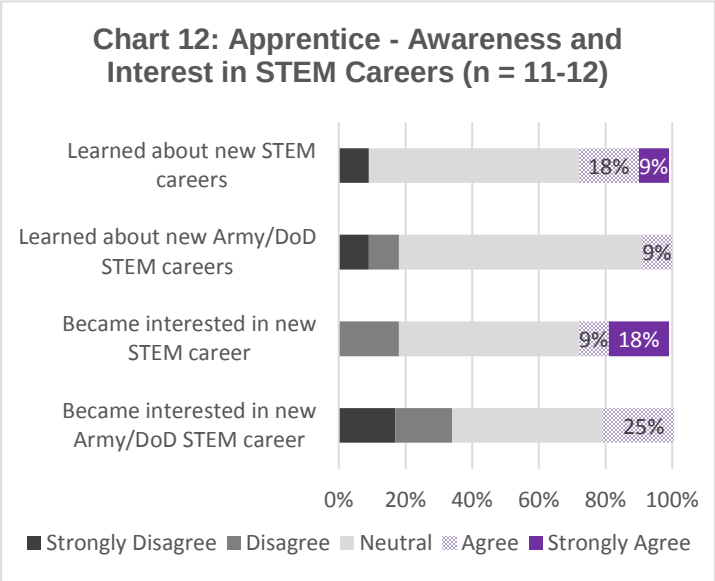
information to their apprentices about AEOP and DoD educational programs, only 12% (see Appendix C) of mentors answered affirmatively with agree or strongly agree.

The apprentice questionnaire introduced JSHS as an Army-sponsored regional research symposia and a national scholarship-awarding research competition. This program is a possible next step for all participants of AEOP high school apprenticeship programs such as HSAP. In response to a question asking how certain they are that they will submit their HSAP research project to JSHS, 10% (of 10) reported high levels of certainty that they would submit their project to JSHS this year. This is not surprising given that only 12% of 17 mentors reported encouraging their apprentices to do so. Yet, 30% of apprentices expressed interest in submitting their research to other science fairs or competitions, including sponsored fairs such as Intel International Science & Engineering Fair. More robust cross-promotion of JSHS to HSAP alumni is a potential way to capture interest in competing in science fairs while simultaneously retaining apprentices in the AEOP pipeline of programs.

In summary, these data suggest that HSAP sites and mentors had limited success educating apprentices about AEOPs and that HSAP is largely an entry-point into AEOP programming for students that have not participated in AEOP's in the past. There is, however, substantial interest in the HSAP population that may be leveraged during targeted cross-promotion of programs.

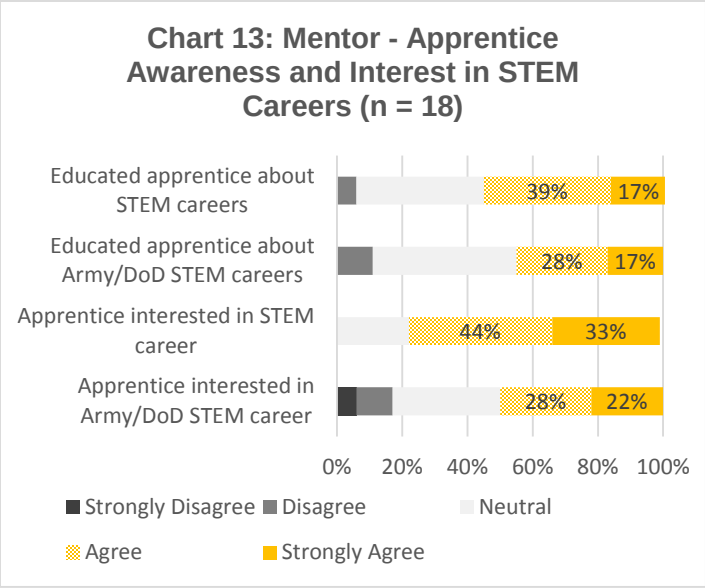
**Army/DoD STEM Careers.** Items in the apprentice questionnaire measured the extent to which participants perceived learning about new STEM jobs and careers (herein called careers), and specifically, STEM careers within the Army/DoD. Subsequently, apprentices were asked whether they became interested in those new STEM careers. Chart 12 summarizes apprentices' perceptions of exposure to STEM and Army/DoD STEM careers during HSAP, and resulting interest. Chart 13 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 12 and 13 illustrate that apprentices and mentors perceived efforts to expose and interest apprentices in STEM and Army/DoD STEM careers differently. Small proportions of apprentices reported learning about new STEM careers (27%) or new Army/DoD STEM careers (9%) during HSAP. Most apprentices responding using neutral categories (63% and 73%, respectively). Yet, 55% of mentors reported educating their apprentices about STEM careers and 45% report educating their apprentice about Army/DoD STEM careers. Further discordance is observed between apprentice and mentor questionnaire respondents and interviewees. Apprentice respondents reported that they did not learn about STEM or Army/DoD STEM careers while apprentice interviewees report that they did learn about



STEM or Army/DoD STEM careers. Similarly, mentor questionnaire respondents report that they did educate their apprentices about STEM and Army/DoD STEM careers while many mentor interviewees reported that they did not discuss Army/DoD careers with their apprentices.

Of the apprentice respondents, 27% reported becoming interested in a new STEM career during HSAP and 25% reporting becoming interested in new Army/DoD STEM careers; again, large proportions of apprentices responded using neutral categories (55% and 45%, respectively). Meanwhile, 77% of mentors agreed that their apprentices expressed genuine interest in future STEM careers and 50% reported that their apprentices were interested in Army/DoD STEM careers.




A comparison of mentor 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 lower expressions of apprentices' interest in Army/DoD STEM careers than in STEM careers in general.[13]

When asked which three new STEM jobs they found most interesting, seven apprentices listed 16 different jobs or careers (see Appendix B). Of those listed, careers in engineering disciplines were most prevalent. Chemical engineering was most frequently mentioned by apprentices (71%), followed by physicist (29%) and professor (29%, no field given); other engineering disciplines included aerospace (14%), biochemical (14%), electrical (8%), and general (14%). A range of STEM disciplines, career fields, and career levels were mentioned. The prevailing interest in engineering is reflected in mentor research fields (33%), however, we do not know whether apprentices were matched to mentors according to their interests, or if interests developed as a result of their HSAP experience.

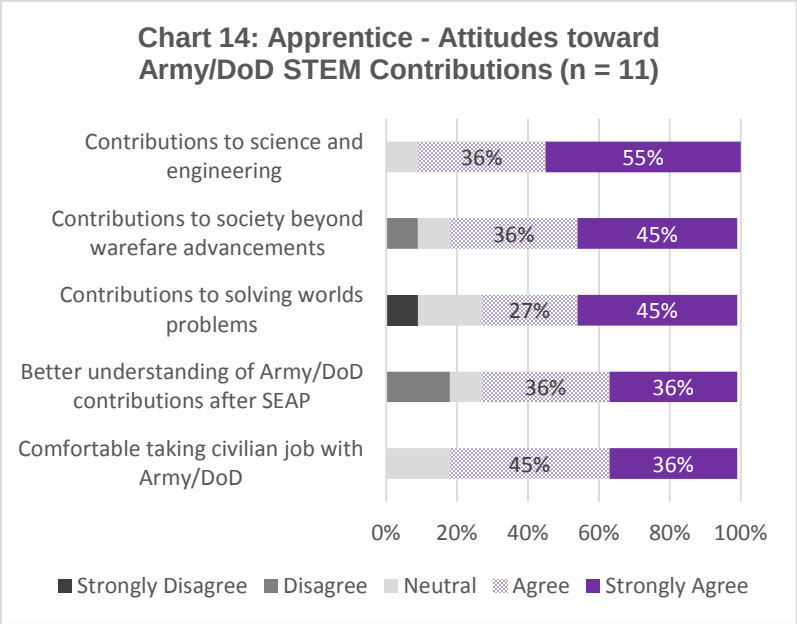
Student and mentor accounts revealed conflicting reports of opportunities to learn about new STEM and Army/DoD STEM careers during HSAP. In questionnaires, apprentices reported that they did not learn about new STEM careers or Army/DoD STEM careers, while more than half of apprentice interviewees reported to the contrary. Similarly, in questionnaires mentors reported that they did educate their apprentices about STEM and Army/DoD STEM careers, while many mentor interviewees reported to the contrary. It is likely that the nature and amount of information provided to apprentices about STEM and Army/DoD STEM careers, and the mechanism for conveying that information, varied substantially by HSAP site and by HSAP apprentice-mentor partners.

[13] $p < .05$ with paired samples t-test (2-tailed); Mean Diff: .833, t = 2.95, $p = .009$, $d = .694$, moderate effect

**Attitudes toward Army/DoD STEM.** Five items measured apprentices' attitudes toward Army STEM research and careers. Chart 14 summarizes apprentices' responses.

Most apprentices (72-91%) expressed agreement that Army research and researchers have made valuable contributions to science and engineering fields and to society. A majority of HSAP apprentices (72%) credited HSAP with improving their understandings of Army/DoD STEM contributions. In contrast to the 25% who became interested in a job or career with the Army/DoD during HSAP, 81% expressed they would be comfortable taking a civilian position in STEM with the Army/DoD. Subsequently, 67% of the 18 mentor respondents agreed or strongly agreed that their apprentices expressed a positive attitude toward the Army/DoD and STEM careers it offers.

HSAP apprentice focus groups provide elaboration of these data. Over half of apprentice interviewees suggested they would consider STEM jobs or careers with Army or other DoD agencies. Interviewees' motives for their interest in Army/DoD STEM careers centered around their desire to learn more or explore more opportunities in the Army/DoD. Of those who did not answer in the affirmative, most mentioned that they simply did not know about specific Army/DoD STEM careers.




We can conclude from apprentice data that HSAP did not consistently impact students' awareness of, or interest in Army STEM. Mentors and apprentices report conflicting accounts of the extent to which HSAP delivered information about Army STEM to apprentices as well as the extent to which apprentices were interested in pursuing Army STEM careers. From focus group and interview data, we can reasonably conclude that there is considerable variability in the extent to which Army STEM career information is delivered to apprentices.

It is likely, however, that HSAP did encourage apprentices' to hold positive attitudes toward Army STEM. Many apprentices (50%) became interested in a new STEM career with the Army/DoD. Since 81% would consider a civilian position in STEM with the Army/DoD, it is also likely that HSAP sustains pre-HSAP interest in Army/DoD STEM careers. Furthermore, 72% of apprentices credited HSAP with improving their understanding Army/DoD STEM contributions.

## What Participants are Saying

An overwhelming majority of apprentices and mentors surveyed and interviewed spoke highly of their HSAP experiences. Apprentices and mentors alike frequently encouraged expansion of HSAP 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.

**HSAP Apprentices value the experience HSAP offers:**

- "If you want students in the classroom to understand why they are learning science in the first place, you have to keep doing programs like this, when you are in a classroom you don't see the scientists or the engineers. You don't really know what they do, as a high school student, until you are actually in the laboratory."
- "…it's a change from school where a lot of times no one cares about anything. But here, people are really passionate about their specific field. I think the environment is really good."
- "We [HSAP apprentices] want other high school students to be able to understand what it means to be in the lab, to experience what we have so far over the summer, to gain similar experiences."
- "People want to be interested in careers in science; it is really hard to decide based just on classes…you need to be in the lab. To cut away these programs is to take away opportunities to get these experiences."
- "I was highly satisfied with the HSAP research project/final presentation. I gained a wide range of valuable knowledge over this summer and it surprised me how much I had really learned when making my presentation."
- "It was satisfying to have grown over these past few weeks from knowing virtually nothing to being able to have a discussion with Ph.D. based on my topic. It is not a usual thing for students like me to have to opportunity to present my work to well-established scientists. Furthermore, I feel very fortunate to have researchers teach me their work and try to show me their passions in their respective fields."
- "The HSAP research project/final presentation was represented the brief conclusion of my working experience this summer. Although it was short, it lets other people know how much I've learned and accomplished. The experience I've done in the lab this summer brings me so much advanced scientific knowledge and makes me more interested working on scientific research."
- "This is an excellent program for high school student to get involved in science careers. The most valuable part of this experience was all the knowledge I gained that can help me in my future endeavors."
- "I feel very humbled to be part of this program and to know that my work is helping future society. I feel good about that, besides learning and becoming a better researcher, I feel happy that I can make an impact on other peoples' lives."
- "I also am looking for a career in science in the future. I believe that working in the lab setting will allow me to gain the experience that other students in my school wouldn't be able to get."
- "If you want students in the classroom to understand why they are learning science in the first place, you have to keep doing programs like this. When you are in a classroom, you don't see the scientists or the engineers. You don't really know what they do, as a high school student, until you are actually in the laboratory."
- "…we should let more students in on this. We [HSAP students] want other high school students to be able to understand what it means to be in the lab, to experience what we have so far over the summer, to gain similar experiences."

**HSAP offers mutual benefit to mentors and apprentices. According to mentors:**

- "This year we had an excellent cohort from various research programs including the NSF REU, NSF RET and the HSAP. This provided us with an amazing environment for conducting stem research. The interaction between the HSAP student and the RET teachers was also very interesting. By providing us access to the high school student through the HSAP a more clear picture on transitional stem research from high school to university to teaching emerged and was a rewarding experience for all the participants."

- "I enjoyed working with my HSAP/URAP apprentices this summer. It was a great opportunity to introduce these students with research and work with them every day. They also enjoyed working as a team, particularly having the opportunity to present their research progress to our technical monitor at ARL."
- "The HSAP/URAP is a great program that is exposing its students to cutting-edge scientific research, which excited them about pursuing careers in science. They become aware of the support and opportunities available through Army/DOD."

## Summary of Findings

The 2013 evaluation of HSAP 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 14.

| Table 14. 2013 HSAP Evaluation Findings | |
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| **Participant Profiles** | |
| Low participation of HSAP apprentices and mentors in evaluation assessments limit the reliability of findings. | • Statistical reliabilities achieved for the apprentice questionnaire sample (±15.8% margin of error) suggest limited representativeness of the samples. Geographically, the current sample of apprentices represents a limited proportion (75%) of the distribution of HSAP sites nationally<br>• Mentor respondents did not systematically identify themselves in the questionnaire and, as a result, the representativeness of this sample is not discernable.<br>• Alternative methods for establishing representativeness of the current samples were difficult to employ; demographic information for the population of apprentice and mentor participants was not available. |
| | • Findings from mentor and apprentice questionnaires should be cautiously generalized with consideration given to the calculated margin of error and with triangulation of findings with other data. |
| HSAP had limited success in providing outreach to participants from historically underrepresented and underserved populations. | • More apprentices identified themselves as racial or ethnic minorities in 2013 than in 2012. Black or African American (2012 = 0%, 2013 = 15%) and Hispanic or Latino (2012 = 0%, 2013 = 15%) populations are among those historically considered underserved and underrepresented in STEM education. |
| | • In 2012 and 2013, HSAP struggled to reach female high school students (2012 = 14%, 2013 = 8%), a population that is historically underrepresented in certain STEM fields. |
| | • In 2012 and 2013, most apprentices did not qualify for free/reduced lunch at school (86% and 73%, respectively). Free and reduced lunch recipients are generally considered an underserved population. |
| | • Mentors identified as predominantly male (78%) and either White or Caucasian (50%) or Asian or Other Pacific Islander (44%). Only 6% identified as Black or African American, and no mentors identified as Hispanic or Latino (0%) or American Indian or Alaskan Native (0%). |
| HSAP apprentices intend to pursue advanced STEM degrees in STEM. | • 100% of apprentices planned to pursue a master's degree or higher, 85% of whom intend to pursue that degree in a STEM field (38% STEM Master's, and 46% STEM Doctorate) |
| | • Large proportions of apprentices planned to pursue engineering (31%) and medicine/health-related fields (31%). Apprentices also intended to pursue physical science (15%), chemistry (15%), and social science (8%). |
| **Actionable Program Evaluation** | |
| HSAP marketing and recruitment is a bottom-up phenomenon occurring at the site-level. | • HSAP's marketing and advertising campaigns target the very specific population of Army-funded university and college researchers. |
| | • Apprentices most frequently learned about HSAP through individuals who are connected with HSAP sites. Apprentices reported that personnel from their high school (31%) or family or friends (15%) informed them about the program. |
| | • Most mentors recruited apprentices through connections with local high school staff (45%) and other informal programs (27%). |

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| | • A majority of mentors (75%) selected apprentices from the AEOP applicant pool with assistance from ARO, and 25% knew students prior to their participation as an HSAP apprentice. |
| HSAP apprentices seek opportunities to clarify and advance their STEM pathways. | • Apprentices received encouragement to participate in HSAP from others who have connections to the HSAP program, such as high school staff or staff from other programs that they are already involved in. But many apprentices were motivated to participate in HSAP because it offered them an opportunity to clarify and advance their STEM pathways through experiences that are not available in school. |
| HSAP mentors seek opportunities to engage with STEM learners in their work. | • Mentors were motivated to participate in HSAP through their desire to outreach to youth, which was encouraged by their colleagues, departments, and universities. HSAP also provided mentors with an opportunity to advance their research through the funding of apprenticeships. |
| HSAP mentors engaged their apprentices in STEM research and provided guidance about educational and career pathways during the HSAP apprenticeship. | • HSAP mentors engaged their apprentices in STEM research and provided them with guidance about educational and career pathways. Apprentices and mentors reported similar engagement in mentor activities related to STEM research experiences, educational goals, and career goals |
| | • Apprentice and mentor accounts of educational and career advising differed. Mentors may have conflated their responses with interactions that they had with HSAP and URAP apprentices simultaneously. |
| HSAP mentors lacked awareness and resources needed for promoting AEOP opportunities and STEM careers. | • Mentor interviewees had limited awareness of or direction from ARO to educate their apprentices about AEOP initiatives. Subsequently, mentors did not consistently educate their apprentices or encourage their participation in AEOP initiatives. |
| | • Mentors suggested that informational resources, mentor training, and an emphasis from ARO were necessary to accomplish this objective. |
| | • Mentors reported using a variety of strategies for mentoring apprentices about STEM careers, through few emphasized Army/DoD STEM careers. |
| | • Mentors perceived high school students are not advanced enough to engage in career discussions, that they lacked information about many aspects of Army/DoD STEM careers, and that they program was too short to initiate career conversations. |
| HSAP benefited apprentices as well as university and college S&E mentors and their laboratories. | • Apprentices and mentors perceived that HSAP 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 that HSAP helped them develop their own mentorship capacity, that the work of apprentices helped advance the work of the laboratory, and that it was rewarding to serve in a community service capacity. |
| HSAPs lack of visibility and programmatic processes are possible areas for improvement. | • Apprentices and mentors would like to see HSAP expand through increased funding and reach additional students by increasing its visibility. |
| | • Mentors invest significant time in the program and recommend streamlined and more efficient programmatic processes. |
| **Outcomes Evaluation** | |
| HSAP engaged apprentices in authentic STEM activities more | • Apprentices reported that HSAP provides more frequent opportunities to engage in authentic STEM activities as compared to their school setting, including academic research activities (42%-58% in HSAP, 23-46% in school) and hands-on research activities (25%-75% in HSAP, 8%-33% at school). |

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| frequently than their school environment. | • Moderate to very strong significant differences were found in apprentices perceptions of how frequently they did the following in HSAP as compared to school: used, cared for, and calibrated equipment; employed advanced measurement techniques; and defined research questions. |
| | • Apprentice and mentor data suggested HSAP 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. |
| HSAP apprentices become more confident in STEM, and mentors rate their research skills highly. | • Many apprentices (42%-75%) 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. |
| | • The majority of mentors (58%-74%) 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 (73%-86%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels. |
| HSAP apprentices were unaware of the many AEOP initiatives, but showed substantial interest in future AEOP opportunities. | • Many apprentices (42%-92%) and mentors (42-65%) were unaware of other AEOP initiatives. For example, most mentors (88%) did not educate apprentices about the AEOP's high school STEM research competition, JSHS. Most apprentices (90%) were not intent on pursuing JSHS; however, 30% of apprentices expressed an interest in submitting their research to other science fairs or competitions including sponsored events such as INTEL-ISEF. |
| Mentoring HSAP apprentices about STEM and Army/DoD STEM careers varies by HSAP site but apprentices hold positive attitudes toward Army research and researchers | • Students and mentors provided conflicting accounts of the extent to which teaching and learning about STEM and Army/DoD STEM careers occurred during HSAP. It is likely that the amount of information provided to apprentices varies highly from site to site. |
| | • Most apprentices (72%) credited HSAP with improving their understanding Army/DoD STEM contributions and 81% would consider a civilian position in STEM with the Army/DoD. Most mentors (67%) reported that their apprentices' expressed a positive attitude toward Army/DoD STEM. |

## Recommendations

1. A commitment should be made to producing more reliable and valid evaluation of HSAP activities and benefits to participants. The 2013 evaluation provides valuable information regarding how HSAP is perceived by a proportion of participants, and begins to provide evidence for how the program has impacted HSAP apprentices. However, the low response rate from HSAP apprentices, the inability of mentors to correctly identify their role in the program, as well as the limited demographic information regarding the population of apprentice and mentor participants, all pose significant threats to the reliability and validity of these findings. In other words, we have limited confidence that the 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. Mentor participation in HSAP's evaluation is vital. Coordinated efforts should be made by the Army, and ARO to encourage and improve apprentice and mentor participation in HSAP's evaluation efforts. Subsequently, evaluators should endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments to further maximize participation.

2. AEOP objectives include expanding participation of historically underrepresented and underserved populations. In HSAP, recruitment of apprentices is largely a bottom-up phenomenon that occurs at the site-level using connections or mechanisms available to the university or college site and community in which they lie. As a result, the ability of HSAP to recruit underserved or underrepresented populations of students depends upon the diversity of the local communities, and especially high schools, in which recruitment takes place. Guidance that ensures that "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 apply through the AEOP website is likely to help in recruitment efforts. Additionally, the AEOP and ARO may need to consider practical solutions to the challenge posed by HSAP 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).

3. Apprentice and mentor data suggested that HSAP 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. ARO should endeavor to provide HSAP mentors with 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 include 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.

4. ARO, universities, 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 HSAP apprentices and mentors were largely unaware of other AEOP initiatives and that HSAP serves as an entry point into the AEOP for students who have not yet been exposed the Army STEM outreach. Yet, substantial apprentice interest exists in participating in AEOP moving forward. This interest would benefit from more robust attention by ARO and mentors during HSAP program activities. Continued guidance by ARO is needed for educating mentors about AEOP opportunities nationwide. Adequate resources and guidance for using them with apprentices should be provided to all mentors in order that all apprentices leave HSAP with an idea of their next steps in AEOP.

5. Depending upon the university or college site in which they worked, apprentices had varying opportunities to learn about STEM research and careers during HSAP, especially Army/DoD STEM research and careers. Many mentors reported lack of awareness of Army/DoD STEM careers generally, lack of informational resources, and lack of direction to provide such information to their apprentices. This is of concern given HSAP mentors are Army-sponsored S&Es who are receiving "add-on" funding for their HSAP apprentices. In an effort to standardize the information provided to apprentices we strongly recommend an HSAP- or AEOP-wide effort to create a resource that profile 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. [14] Furthermore, ARO might consider a requirement, similar to that of the AEOP's high school UNITE program, through which HSAP sites connect participants with local Army research laboratories so that apprentices have first-hand opportunities to connect their university-based research to the Army's broader STEM interest and network with Army STEM professionals.

6. The Graduate Mentoring Fellows (GMF) Data Brief (Appendix E) suggests that the eWorkshop had varying degrees of success with teaching GMFs about the critical components of effective mentorships. The low frequencies with which GMFs reported employing these strategies suggest that awareness is insufficient for implementation. Further, GMFs did not feel well-supported by the program activities. GMF's offer insightful recommendations for programmatic revisions that would potentially improve the experience of GMFs and the apprentices they mentor. If the GMF program is to be implemented in FY14 and/or scaled up in future, substantial programmatic revision is needed, including increased communication between ARO, faculty mentors, and GMFs about expectations and

[14] 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.

objectives of mentorship, enhanced training and ongoing support of GMFs, and access to resources to enable GMFs to provide mentorship about AEOP offerings and Army STEM careers.

# Appendices

**Appendix A:**
**2013 HSAP Evaluation Plan**

**Key Evaluation Questions**

The HSAP evaluation gathered information from apprentice and mentor participants about HSAP 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 HSAP program objectives:

- What aspects of HSAP motivate participation?
- What aspects of HSAP structure and processes are working well?
- What aspects of HSAP could be improved?
- Did participation in HSAP:
  - Increase apprentices' engagement in authentic STEM activities?
  - Increase apprentices' STEM competencies?
  - 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 HSAP included onsite focus groups with apprentices and mentors at three HSAP sites, phone interviews with apprentices and mentors representing 10 additional 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.

The evaluation team conducted focus groups with apprentices and mentors at three sites in the Northeast U.S. Mentor focus groups included six HSAP and/or URAP mentors (1 female, 5 males). Apprentice focus groups included three apprentices (3 males). Convenience sampling was employed for both apprentice and mentor focus groups—any participants providing appropriate permissions were invited to join the focus group, without regard to diversity represented by the group—to maximize participation in focus groups. HSAP and URAP apprenticeships often occurred at the same site. In these cases, HSAP and URAP mentors (no more than two) were interviewed together due to scheduling constraints and to acknowledge that some mentors served both HSAP and URAP programs. When necessary to interview HSAP and URAP

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

apprentices together, HSAP and URAP apprentice contributions to the focus group were carefully disaggregated for analysis.

Individual phone interviews were conducted with apprentices or mentors at ten additional sites in the West, Southeast, Midwest, and Northeast, U.S. Purposive sampling was employed by evaluators to maximize diversity in geographic locations, gender, race/ethnicity, and STEM interests. Mentor phone interviews included seven mentors (7 males), three of which were Graduate Mentoring Fellows. Apprentice phone interviews included eight apprentices (3 females, 5 males).

Evaluators administered online questionnaires to apprentice and mentor participants during a 10-day period in late July and early August. Questionnaires also employed convenience sampling. All apprentices and mentors were invited to participate in these questionnaires, which were emailed to them by the HSAP program administrator and/or university 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 (significance testing[2]) on key items to compare effect of HSAP 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

[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.

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 programs' 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 and by frequency of participants addressing a 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 represent consensus ratings.

To the extent possible, findings were triangulated across data sources (students, mentors), data types (quantitative questionnaire data and qualitative data from questionnaires, focus groups, and phone interviews), 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 cite major 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 HSAP or AEOP objectives.

[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 B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

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

**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 HSAP 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
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**Appendix B:**
**2013 HSAP 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 HSAP mentor?**

Your mentor's first name: _____

Your mentor's last name: _____

**At which University are you and your mentor working? _____**

**Have you ever participated in HSAP before?**

- ❍ No
- ❍ Yes: How many times? _____

**Briefly describe the process by which you were recruited and became an HSAP apprentice: _____**

_____

_____

_____

**Prior to becoming an HSAP apprentice, did you already know someone who works at the university where you got your HSAP apprenticeship?**

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

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

**Which of the following best describes you?**

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

**Which of the following best describes your race/ethnicity?**

- ❍ 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 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 HSAP Apprentice Questionnaire and Data Summary**

***Please take a moment to think about your HSAP mentor.*** **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 |
|---|---|---|---|---|---|---|
| My HSAP mentor frequently worked with me in the laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I learned a lot about performing STEM research from my HSAP mentor | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP mentor encouraged me to perform a variety of tasks in the laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP mentor helped me to formulate my educational goals | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP mentor taught me how to work more effectively in a laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| MY HSAP mentor spoke with me about my career interests | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP mentor helped me become a better writer of scientific research | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I would like to work with my HSAP mentor again | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

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

| | Less than Once a Month | Once a Month | 2-3 Times a Month | Once a Week | 2-3 Times a Week | Daily |
|---|---|---|---|---|---|---|
| In High 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 HSAP Apprentice Questionnaire and Data Summary**

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

| | Less than Once a Month | Once a Month | 2-3 Times a Month | Once a Week | 2-3 Times a Week | Daily |
|---|---|---|---|---|---|---|
| During HSAP, I had to define a research question or thesis and determine its critical concepts | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I had to organize and synthesize information across academic sources | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I had to determine appropriate ethical and legal uses of published academic research for my own work | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, 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.***
**Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:**

| | Less than Once a Month | Once a Month | 2-3 Times a Month | Once a Week | 2-3 Times a Week | Daily |
|---|---|---|---|---|---|---|
| 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 HSAP Apprentice Questionnaire and Data Summary**

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

| | Less than Once a Month | Once a Month | 2-3 Times a Month | Once a Week | 2-3 Times a Week | Daily |
|---|---|---|---|---|---|---|
| **During HSAP, I used advanced science or engineering equipment** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **During HSAP, I cleaned and cared for the equipment in a science or engineering laboratory** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **During HSAP, I calibrated laboratory equipment for experimentation** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **During HSAP, I created solutions from reagents in preparation for experimental procedures** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **During HSAP, I used proper safety procedures when handling equipment and material in the lab** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **During HSAP, I employed advanced measurement techniques in science or engineering procedures** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix B:**

**2013 HSAP Apprentice Questionnaire and Data Summary**

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

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

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

**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 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).***
**Using the scale provided, please 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** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**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

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

**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 |
|---|---|---|---|---|---|---|
| During HSAP I learned about new STEM-related jobs/careers. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I learned about STEM-related careers within the Army/Department of Defense (DoD) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, I became interested in a STEM job/career I did not know about before. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP, 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)**

1.

2.

3.

**Use the scale provided to indicate 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 HSAP, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

**Have you ever participated in or heard about any of the following programs that are sponsored by the U.S. Army?**

| | 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 | ❍ | ❍ | ❍ |

**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 not heard about this program |
|---|---|---|---|---|---|
| **High School Internships:** internships in laboratories at colleges throughout the country (REAP and SEAP) | ❍ | ❍ | ❍ | ❍ | ❍ |
| **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 | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

***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 in during the 2013-2014 school year** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

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

❍ No

❍ Yes, which one(s)? _____

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

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

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

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| What is your age (in years)? | | |
|---|---|---|
| | **Freq.** | **%** |
| **14 years** | 0 | 0% |
| **15 years** | 1 | 7% |
| **16 years** | 5 | 33% |
| **17 years** | 7 | 47% |
| **18 years** | 2 | 13% |
| **Other (specify)** | 0 | 0% |
| **Total** | **15** | **100%** |

**Note.** Average age = 16.67 years, SD = 0.87 years

| What grade/class rank will you start this fall? | | |
|---|---|---|
| | **Freq.** | **%** |
| **9th grade** | 0 | 0% |
| **10th grade** | 1 | 7% |
| **11th grade** | 4 | 27% |
| **12th grade** | 9 | 60% |
| **College freshman** | 1 | 7% |
| **Other** | 0 | 0% |
| **Total** | **15** | **100%** |

| At which University are you and your mentor working? | | |
|---|---|---|
| | **Freq.** | **%** |
| **City College of New York** | 3 | 25% |
| **University of Maryland Eastern Shore** | 2 | 17% |
| **California State University, San Bernardino (CSUSB)** | 1 | 8% |
| **Marshall University** | 1 | 8% |
| **North Carolina State University** | 1 | 8% |
| **Tennessee State University** | 1 | 8% |
| **Texas Tech University** | 1 | 8% |
| **University of Central Florida** | 1 | 8% |
| **University of New Mexico** | 1 | 8% |
| **Total** | **12** | **100%** |

| Have you ever worked as an HSAP apprentice before? | | |
|---|---|---|
| | **Freq.** | **%** |
| **No** | 11 | 100% |
| **Yes- this is my 2nd year in HSAP** | 0 | 0% |
| **Total** | **11** | **100%** |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Briefly describe the process by which you were recruited and became an HSAP apprentice? (n = 13) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme(s)** | **Freq.** | **Example Response(s)** |
| **AEOP Participation – getting involved in HSAP** | | **12** | |
| | General application process | 11 | • "I applied for the job and was accepted by [HSAP site]. I was then shown around by my mentor and began my apprenticeship.<br>• "I applied through the Army Research Office while living in Utah. I was then contacted about having a place to stay in order to complete my internship. […] I was then notified of my acceptance to University of Maryland-Eastern Shore HSAP program." |
| | Student contacted the potential mentor about the program | 1 | • "I then contacted Dr. Amir Shirkhodaie, whose lab I have worked in all summer. After contacting him, he requested that I meet with him regarding the program. Later on, I was told to complete an application online for the program." |
| **AEOP Awareness – becoming aware of HSAP** | | **9** | |
| | Friend or family member informed apprentice about the program | 2 | • "I was made aware of this program through my uncle…"<br>• "My friend told me about the program… |
| | High school personnel informed apprentice about the program | 4 | • "…I was made aware of the program through my school's guidance counselor."<br>• I was shown this opportunity by my engineering teacher |
| | Student found HSAP on their own | 1 | • "I [was searching] for summer programs from which I could choose this summer." |
| | Through another program | 1 | • "Upward Bound had given me an application to fill out." |
| | Mentor recruited student | 1 | • "The mentors of this program sent information to my parent, who works at UMES, requesting that I sign up for this program." |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Prior to becoming an HSAP apprentice, did you already know someone who works at the university where you got your HSAP apprenticeship? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Yes – a family member that works at this university** | 2 | 15% |
| **Yes – a family friend that works at this university** | 1 | 8% |
| **No – I did not know anyone that works at this university** | 10 | 77% |
| **Total** | **13** | **100%** |

| Which of the following best describes you? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Male** | 12 | 92% |
| **Female** | 1 | 8% |
| **Choose not to report** | 0 | 0% |
| **Total** | **13** | **100%** |

| Which of the following best describes your ethnicity/race? | | |
|---|---|---|
| | **Freq.** | **%** |
| **American Indian or Alaskan Native** | 1 | 8% |
| **Asian or Pacific Islander** | 5 | 38% |
| **Black or African American** | 2 | 15% |
| **Hispanic or Latino** | 2 | 15% |
| **White or Caucasian** | 2 | 15% |
| **Some other ethnicity/race** | 1 | 8% |
| **Choose not to report** | 0 | 0% |
| **Total** | **13** | **100%** |

**Note.** Other = "Half White, Half Asian"

| What kind of school do you attend? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Public** | 11 | 100% |
| **Private** | 0 | 0% |
| **Home School** | 0 | 0% |
| **Other (Please Specify)** | 0 | 0% |
| **Total** | **11** | **100%** |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Which of the following best describes your regular school? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Rural** | 0 | 0% |
| **Suburban** | 10 | 91% |
| **Urban** | 1 | 9% |
| **Other (Please Specify)** | 0 | 0% |
| **Total** | **11** | **100%** |

| Do you qualify for free/reduced lunch at school? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Yes** | 2 | 18% |
| **No** | 8 | 73% |
| **I don't know / choose not to answer** | 1 | 9% |
| **Total** | **11** | **100%** |

**Please take a moment to think about your HSAP Mentor. Then, 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 HSAP mentor frequently worked with me in the laboratory** | 0 (0%) | 2 (15%) | 0 (0%) | 2 (15%) | 2 (15%) | 7 (54%) | 13 | **4.92** | 1.50 |
| **I learned a lot from my HSAP mentor about performing STEM research** | 0 (0%) | 2 (15%) | 0 (0%) | 2 (15%) | 2 (15%) | 7 (54%) | 13 | **4.92** | 1.50 |
| **My HSAP mentor encouraged me to perform a variety of tasks in the laboratory** | 1 (8%) | 1 (8%) | 0 (0%) | 1 (8%) | 3 (23%) | 7 (54%) | 13 | **4.92** | 1.66 |
| **My HSAP mentor helped me to formulate my educational goals** | 0 (0%) | 3 (23%) | 1 (8%) | 1 (8%) | 4 (31%) | 4 (31%) | 13 | **4.38** | 1.61 |
| **My HSAP mentor taught me how to work more effectively in a laboratory** | 0 (0%) | 2 (15%) | 1 (8%) | 2 (15%) | 2 (15%) | 6 (46%) | 13 | **4.69** | 1.55 |
| **MY HSAP mentor spoke with me about my career interests** | 1 (8%) | 2 (15%) | 0 (0%) | 3 (23%) | 2 (15%) | 5 (38%) | 13 | **4.38** | 1.76 |
| **My HSAP mentor helped me become a better writer of scientific research** | 0 (0%) | 3 (25%) | 0 (0%) | 2 (17%) | 3 (25%) | 4 (33%) | 12 | **4.42** | 1.62 |
| **I would like to work with my HSAP mentor again** | 0 (0%) | 0 (0%) | 0 (0%) | 2 (15%) | 4 (31%) | 7 (54%) | 13 | **5.38** | 0.77 |

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

**Appendix B:**
**2013 HSAP 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** | 3 (23%) | 3 (23%) | 4 (31%) | 1 (8%) | 2 (15%) | 0 (0%) | 13 | **2.69** | 1.38 |
| **In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review** | 3 (23%) | 6 (46%) | 0 (0%) | 2 (15%) | 1 (8%) | 1 (8%) | 13 | **2.62** | 1.61 |
| **In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)** | 3 (23%) | 2 (15%) | 2 (15%) | 2 (15%) | 3 (23%) | 1 (8%) | 13 | **3.23** | 1.74 |
| **In school, I had to organize and synthesize information across academic sources** | 2 (15%) | 2 (15%) | 3 (23%) | 3 (23%) | 2 (15%) | 1 (8%) | 13 | **3.31** | 1.55 |
| **In school, I had to determine appropriate ethical and legal uses of published academic research for my own work** | 4 (31%) | 3 (23%) | 1 (8%) | 2 (15%) | 1 (8%) | 2 (15%) | 13 | **2.92** | 1.89 |
| **In school, I had to work as part of a team on research projects** | 4 (31%) | 3 (23%) | 1 (8%) | 2 (15%) | 2 (15%) | 1 (8%) | 13 | **2.85** | 1.77 |

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

| | 1 | 2 | 3 | 4 | 5 | 6 | n | Avg | SD |
|---|---|---|---|---|---|---|---|---|---|
| **In HSAP, I had to define a research question or thesis and determine its critical concepts** | 4 (33%) | 1 (8%) | 1 (8%) | 2 (17%) | 2 (17%) | 2 (17%) | 12 | **3.25** | 2.01 |
| **In HSAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review** | 4 (33%) | 1 (8%) | 1 (8%) | 3 (25%) | 2 (17%) | 1 (8%) | 12 | **3.08** | 1.83 |
| **In HSAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)** | 5 (42%) | 0 (0%) | 2 (17%) | 1 (8%) | 3 (25%) | 1 (8%) | 12 | **3.00** | 1.95 |
| **In HSAP, I had to organize and synthesize information across academic sources** | 3 (25%) | 2 (17%) | 1 (8%) | 2 (17%) | 2 (17%) | 2 (17%) | 12 | **3.33** | 1.92 |
| **In HSAP, I had to determine appropriate ethical and legal uses of published academic research for my own work** | 5 (42%) | 0 (0%) | 1 (8%) | 2 (17%) | 4 (33%) | 0 (0%) | 12 | **3.00** | 1.86 |
| **In HSAP, I had to work as part of a team on research projects** | 2 (17%) | 2 (17%) | 1 (8%) | 1 (8%) | 1 (8%) | 5 (42%) | 12 | **4.00** | 2.09 |

**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 HSAP 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** | 8 (67%) | 2 (17%) | 1 (8%) | 0 (0%) | 1 (8%) | 0 (0%) | 12 | **1.67** | 1.23 |
| **In school, I cleaned and cared for the equipment in a science or engineering laboratory** | 4 (33%) | 5 (42%) | 1 (8%) | 0 (0%) | 2 (17%) | 0 (0%) | 12 | **2.25** | 1.42 |
| **In school, I calibrated laboratory equipment for experimentation** | 4 (33%) | 5 (42%) | 2 (17%) | 1 (8%) | 0 (0%) | 0 (0%) | 12 | **2.00** | 0.95 |
| **In school, I created solutions from reagents in preparation for experimental procedures** | 3 (25%) | 5 (42%) | 2 (17%) | 1 (8%) | 1 (8%) | 0 (0%) | 12 | **2.33** | 1.23 |
| **In school, I used proper safety procedures when handling equipment and material in the lab** | 2 (17%) | 5 (42%) | 1 (8%) | 1 (8%) | 3 (25%) | 0 (0%) | 12 | **2.83** | 1.53 |
| **In school, I employed advanced measurement techniques in science or engineering procedures** | 4 (33%) | 5 (42%) | 2 (17%) | 1 (8%) | 0 (0%) | 0 (0%) | 12 | **2.00** | 0.95 |

| Please take a moment to consider your HSAP research experiences. Use the scale provided to indicate how often you performed each of the following activities in HSAP: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **n** | **Avg.** | **SD** |
| **In HSAP, I used advanced science or engineering equipment** | 1 (8%) | 1 (8%) | 2 (17%) | 2 (17%) | 0 (0%) | 6 (50%) | 12 | **4.42** | 1.83 |
| **In HSAP, I cleaned and cared for the equipment in a science or engineering laboratory** | 3 (25%) | 0 (0%) | 2 (17%) | 1 (8%) | 0 (0%) | 6 (50%) | 12 | **4.08** | 2.19 |
| **In HSAP, I calibrated laboratory equipment for experimentation** | 4 (33%) | 0 (0%) | 3 (25%) | 1 (8%) | 0 (0%) | 4 (33%) | 12 | **3.42** | 2.15 |
| **In HSAP, I created solutions from reagents in preparation for experimental procedures** | 6 (50%) | 1 (8%) | 2 (17%) | 1 (8%) | 1 (8%) | 1 (8%) | 12 | **2.42** | 1.78 |
| **In HSAP, I used proper safety procedures when handling equipment and material in the lab** | 1 (8%) | 1 (8%) | 1 (8%) | 2 (17%) | 1 (8%) | 6 (50%) | 12 | **4.58** | 1.78 |
| **In HSAP, I employed advanced measurement techniques in science or engineering procedures** | 3 (25%) | 0 (0%) | 1 (8%) | 3 (25%) | 0 (0%) | 5 (42%) | 12 | **4.00** | 2.09 |

**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 HSAP Apprentice Questionnaire and Data Summary**

| Use the scale provided to tell us how accurately each statement describes you AFTER HSAP: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **n** | **Avg.** | **SD** |
| **After HSAP, I am more confident in my ability to formulate hypotheses and design experiments to test them** | 1 (8%) | 0 (0%) | 1 (8%) | 5 (42%) | 2 (17%) | 3 (25%) | 12 | **4.33** | 1.44 |
| **After HSAP, I am more confident that I can analyze data and understand the results of an experiment** | 1 (8%) | 0 (0%) | 0 (0%) | 3 (25%) | 5 (42%) | 3 (25%) | 12 | **4.67** | 1.37 |
| **After HSAP, I am more confident in my abilities to effectively and safely use a science or engineering laboratory** | 1 (8%) | 0 (0%) | 1 (8%) | 1 (8%) | 6 (50%) | 3 (25%) | 12 | **4.67** | 1.44 |
| **After HSAP, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions** | 1 (8%) | 0 (0%) | 2 (17%) | 1 (8%) | 5 (42%) | 3 (25%) | 12 | **4.50** | 1.51 |
| **After HSAP, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques** | 2 (17%) | 0 (0%) | 1 (8%) | 1 (8%) | 4 (33%) | 4 (33%) | 12 | **4.42** | 1.83 |
| **After HSAP, I am more confident in my ability to complete academic literature reviews for my own research projects** | 2 (17%) | 1 (8%) | 2 (17%) | 0 (0%) | 4 (33%) | 3 (25%) | 12 | **4.00** | 1.91 |
| **After HSAP, I am more confident that I can make significant research contributions as an effective part of a research team** | 1 (8%) | 0 (0%) | 0 (0%) | 3 (25%) | 5 (42%) | 3 (25%) | 12 | **4.67** | 1.37 |

**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 HSAP 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.** | 0 | 0% |
| **Bachelor's degree in something other than a STEM-related field.** | 0 | 0% |
| **Master's degree in a STEM-related field.** | 5 | 38% |
| **Master's degree in something other than a STEM-related field.** | 1 | 8% |
| **Doctoral degree in a STEM-related field.** | 6 | 46% |
| **Doctoral degree in something other than a STEM-related field.** | 1 | 8% |
| **Total** | **13** | **100%** |

| 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: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **n** | **Avg.** | **SD** |
| **I will be admitted into my program of choice** | 1 (8%) | 0 (0%) | 0 (0%) | 3 (23%) | 2 (15%) | 7 (54%) | 13 | **5.00** | 1.47 |
| **I will attend college to pursue this educational degree** | 0 (0%) | 0 (0%) | 0 (0%) | 2 (15%) | 1 (8%) | 10 (77%) | 13 | **5.62** | 0.77 |
| **I will get good grades in my classes** | 0 (0%) | 0 (0%) | 0 (0%) | 2 (15%) | 4 (31%) | 7 (54%) | 13 | **5.38** | 0.77 |
| **I will be able to overcome any obstacle between me and this educational degree** | 0 (0%) | 0 (0%) | 0 (0%) | 1 (8%) | 6 (46%) | 6 (46%) | 13 | **5.38** | 0.65 |
| **I will finish this degree** | 0 (0%) | 0 (0%) | 0 (0%) | 2 (15%) | 0 (0%) | 11 (85%) | 13 | **5.69** | 0.75 |

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

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Which of the following categories best describes the STEM field you want to pursue? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Engineering (e.g., technology, robotics, computers, etc.)** | 4 | 31% |
| **Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)** | 0 | 0% |
| **Physical Science (e.g., physics, astronomy, etc.)** | 2 | 15% |
| **Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)** | 2 | 15% |
| **Life Science (e.g., biology, animal science, ecology, etc.)** | 0 | 0% |
| **Medicine / Health (e.g., behavioral science, medicine, public health, etc.)** | 4 | 31% |
| **Mathematics / Computer Science** | 0 | 0% |
| **Social Science (e.g., sociology, psychology, economics, etc.)** | 1 | 8% |
| **Other STEM Field** | 0 | 0% |
| **A field unrelated to STEM** | 0 | 0% |
| **Total** | **13** | **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 HSAP, I learned about new STEM-related jobs/careers.** | 1 (9%) | 0 (0%) | 1 (9%) | 6 (55%) | 2 (18%) | 1 (9%) | 11 | **4.00** | 1.26 |
| **In HSAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)** | 1 (9%) | 1 (9%) | 3 (27%) | 5 (45%) | 1 (9%) | 0 (0%) | 11 | **3.36** | 1.12 |
| **In HSAP, I became interested in a STEM job/career I did not know about before.** | 0 (0%) | 2 (18%) | 2 (18%) | 4 (36%) | 1 (9%) | 2 (18%) | 11 | **3.91** | 1.38 |
| **In HSAP, I became interested in a new STEM-related job/career with the Army/DoD** | 2 (17%) | 2 (17%) | 1 (8%) | 4 (33%) | 3 (25%) | 0 (0%) | 12 | **3.33** | 1.50 |

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

| Of the new STEM jobs/careers that you learned about, which three did you find most interesting? (n = 7) | | | | | |
|---|---|---|---|---|---|
| **List** | **Freq.** | **%** | **List** | **Freq.** | **%** |
| **Chemical engineer** | 5 | 71% | **Biochemical engineer** | 1 | 14% |
| **Physicist** | 2 | 29% | **Computer scientist** | 1 | 14% |
| **Professor** | 2 | 29% | **Electrical engineer** | 1 | 14% |
| **Aerospace engineer** | 1 | 14% | **Engineer (general)** | 1 | 14% |
| **Any job** | 1 | 14% | **Medical Practitioner** | 1 | 14% |
| | | | **Total** | **16** | **100%** |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Use the scale provided to tell us how much you agree or disagree with the following statements about the Department of Defense (DoD): | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **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%) | 0 (0%) | 0 (0%) | 1 (9%) | 4 (36%) | 6 (55%) | 11 | **5.45** | 0.69 |
| **Army/DoD researchers contribute much more to society than just "warfare" advancements** | 0 (0%) | 1 (9%) | 0 (0%) | 1 (9%) | 4 (36%) | 5 (45%) | 11 | **5.09** | 1.22 |
| **Army/DoD researchers use cutting-edge technology to solve the world's problems** | 1 (9%) | 0 (0%) | 0 (0%) | 2 (18%) | 3 (27%) | 5 (45%) | 11 | **4.91** | 1.51 |
| **I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society** | 0 (0%) | 0 (0%) | 1 (9%) | 1 (9%) | 5 (45%) | 4 (36%) | 11 | **5.09** | 0.94 |
| **After HSAP, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life** | 0 (0%) | 2 (18%) | 0 (0%) | 1 (9%) | 4 (36%) | 4 (36%) | 11 | **4.73** | 1.49 |

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

| 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 have never heard about this program** |
| **Junior Solar Sprint (JSS):** | 1 (8%) | 1 (8%) | 10 (83%) |
| **Junior Science and Humanities Symposium (JSHS):** | 1 (8%) | 1 (8%) | 10 (83%) |
| **UNITE:** | 0 (0%) | 1 (8%) | 11 (92%) |
| **West Point Bridge Contest:** | 0 (0%) | 1 (8%) | 11 (92%) |
| **eCYBERMISSION:** | 0 (0%) | 1 (8%) | 11 (92%) |

**Appendix B:**
**2013 HSAP 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: (REAP and SEAP)** | 3 (25%) | 4 (33%) | 0 (0%) | 0 (0%) | 5 (42%) |
| **College Internships: (CQL and URAP)** | 0 (0%) | 6 (50%) | 0 (0%) | 0 (0%) | 6 (50%) |
| **The Science, Mathematics And Research for Transformation (SMART) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM** | 0 (0%) | 5 (42%) | 0 (0%) | 0 (0%) | 7 (58%) |
| **The National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense** | 0 (0%) | 5 (42%) | 0 (0%) | 0 (0%) | 7 (58%) |

**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** | 3 (30%) | 2 (20%) | 3 (30%) | 1 (10%) | 0 (0%) | 1 (10%) | 10 | **2.60** | 1.58 |

**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 HSAP research project/final presentation to any other science fairs or competition**

| | Freq. | % |
|---|---|---|
| **No** | 7 | 70% |
| **Yes, which one(s)?** | 3 | 30% |
| **Total** | **10** | **100%** |

**Note**. Which one(s)? = "ISEF", "SCCUR", "I have heard we are submitting our project to a science fair, but don't have any details."

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| Given the opportunity, would you participate in this HSAP program again? Why or why not? (n = 8) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme** | **Freq.** | **Example Response(s)** |
| **Yes** | | **8** | |
| **Hands-On Research Activities** | | **4** | |
| | Getting hands-on experience in the lab | 2 | • "I would like to improve my lab experience more and continue to accomplish on science area." |
| | Performing actual scientific research | 1 | • "It is an opportunity to immerse myself in actual research." |
| | Developing lab skills/techniques | 1 | • "I would love to participate in this program because [I learned] many basic engineering skills." |
| **General Satisfaction** | | **2** | |
| | Great / fun experience | 1 | • "I've had a great experience throughout the past few weeks that I have been here." |
| | Liked / loved the program | 1 | • "I enjoyed myself this summer in this program." |
| **Academic Research Activities** | | **3** | |
| | Learned a lot of information / Positive learning experience | 3 | • "It was an excellent learning opportunity for me, in which I gained infinite amounts of knowledge in the fields of chemistry and biology." |
| **Other** | | **2** | |
| | Positive environment | 2 | • "The lab environment is great and my mentor has taught me a lot." |
| **STEM Pathway** | | **1** | |
| | Prepares students for the future | 1 | • "It not only enriches my summer life, but also gives the best guide for college studying..." |

| Do you have any other comments or input to provide us regarding your HSAP mentor? (n = 5) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme** | **Freq.** | **Example Response(s)** |
| **Effective Mentorship** | | **7** | |
| | Mentor was very helpful | 4 | • "My mentor did an amazing job guiding me and helping me throughout this summer in a multitude of different areas." |
| | Mentor was respectable/nice | 2 | • "[My mentor] is someone who deserves a lot of respect." |
| | Was not available enough | 1 | • "I wish he was available more." |

**Appendix B:**
**2013 HSAP Apprentice Questionnaire and Data Summary**

| In a couple of sentences, tell us about your overall satisfaction with the HSAP research project/final presentation: What was the most valuable part of that experience? (n = 8) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme** | **Freq.** | **Example Response(s)** |
| **Academic Research Activities** | | **6** | |
| | Satisfied with growth in scientific research | 4 | • "…over these past few weeks [I went] from knowing virtually nothing to being able to have a discussion with PhDs based on my topic." |
| | Satisfied with the presentation experience | 2 | • "I gained a wide range of valuable knowledge over this summer and it surprised me how much I had really learned when making my presentation." |
| **General Satisfaction** | | **4** | |
| | It was a positive experience | 4 | • "This is an excellent program for high school student to get involved in science careers." |
| **STEM Pathway** | | **4** | |
| | Learning about educational / career pathways | 2 | • "[HSAP] taught me…about the classes that I should choose with the career that I want to pursue."<br>• **"**Learning about different STEM jobs and working with the second most powerful laser in the world was really cool." |
| | Increased interest in STEM research | 2 | • "The most valuable part of this experience was all the knowledge I gained that can help me in my future endeavors."<br>• "…makes me more interested working on scientific research" |
| **Effective Mentorship** | | **2** | |
| | Satisfied with mentorship received | 2 | • "Furthermore, I feel very fortunate to have researchers teach me their work and try to show me their passions in their respective fields." |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

## 2013 High School Apprentice Program, Undergraduate Apprentice Program, and Graduate Mentoring Fellows: Mentor Questionnaire and Rubrics

Thank you for your participation in this study about the 2013 High School Apprenticeship Program (HSAP) and the Undergraduate Research Apprenticeship Program (URAP) that are sponsored by the U.S. Army. The following assessment will collect information about you and your HSAP/URAP 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 HSAP and URAP.

**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 HSAP/URAP apprentice(s).
- We do hope that you will finish the survey because your responses will give HSAP/URAP valuable information for improvement and for generating reports for our supporting organizations

**By choosing to completed this assessment, you are providing your consent to participate in the HSAP/URAP 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

Ashley Wade, U.S. Army Research Office
Cooperative Agreement Manager, AEOPCA
(919) 549-4205, ahsley.wade@us.army.mil

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Provide your personal information below (optional):**

First Name: _____
Last Name: _____
Email Address: _____
At which university are you and your apprentice(s) working?_____

**Which of the following describes your roll in the HSAP/URAP program?** [Respondents who report working as GMFs on this item will receive additional questions denoted by *]

- ❍ I worked as Graduate Mentoring Fellow (GMF)
- ❍ I am a university researcher working as an HSAP or a URAP mentor

**In total, how many HSAP and URAP apprentices have you mentored through the years?**

Total # of apprentices mentored: _____ , apprentices.

**Including 2013, for how many consecutive years have you mentored HSAP/URAP apprentice(s)?**

# of consecutive years: _____, years.

**For your information - HSAP apprentices are high school students and URAP apprentices are undergraduate students. Which of the following options best describes the apprentices that you are mentoring this summer?**

- ❍ One or more HSAP apprentice(s)
- ❍ One or more URAP apprentice(s)
- ❍ Both HSAP and URAP apprentices

**In the past, have you ever worked as an HSAP/URAP apprentice?**

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

**Do you serve as a mentor for apprentices or students in programs other than HSAP/URAP?**

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

**Appendix C:**
**2013 HSAP 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 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

***Which Graduate Mentoring Fellows (GMF) program eWorkshop did you attend?**

- ❍ Monday, July 24th 2013
- ❍ Thursday, July 27th 2013
- ❍ I did not attend an eWorkshop

***Take a moment to reflect on your experiences in the eWorkshop you attended. 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 learned about the HSAP/URAP program and its objectives.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **I learned about other AEOP initiatives available to apprentices.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **I learned about pedagogical strategies for effective mentoring.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **I learned about novice and expert behaviors.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **I learned about assessing/measuring success of apprentices.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **I learned from others' mentoring experiences during roundtable discussions.** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| **The GMF eWorkshop prepared me to mentor student apprentices in STEM research** | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

***Take a moment to reflect on your experiences as an HSAP/URAP Graduate Mentoring Fellow. Then, use the scale provided to estimate how often you completed each of the following:**

| | Never | Once per week | 2 or 3 times per week | 4 or 5 times per week | Every day | Multiple times per day |
|---|---|---|---|---|---|---|
| I educated my apprentice(s) about the HSAP/URAP program and its objectives. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I educated my apprentice(s) about other AEOP initiatives available to him/her. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I applied new learning about pedagogical strategies for effective mentoring. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I applied new learning about novice and expert behaviors. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I applied new learning about assessing/measuring success of apprentices. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I shared my mentoring experiences with other mentors during roundtable discussions. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I shared my mentoring experiences with other mentors through informal conversations or email. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

***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 |
|---|---|---|---|---|---|---|
| The GMF program provided ongoing support to me as a mentor | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| The GMF program helped me felt like part of a community of mentors | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I developed professionally through my experiences as a Graduate Mentoring Fellow | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I would like to be Graduate Mentoring Fellow again | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I would encourage other graduate students to be Graduate Mentoring Fellows | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

***In your opinion, what are the most critical aspects of mentoring student apprentices in STEM research?**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

***How can the GMF Program improve the preparation and ongoing support offered to Graduate Mentoring**

**Use the scale provided to estimate how often your apprentice(s) conducted or were exposed to each of the following experiences during their HSAP/URAP apprenticeship:**

| | Never | Once per week | 2 or 3 times per week | 4 or 5 times per week | Every day | Multiple times per day |
|---|---|---|---|---|---|---|
| Observed an experiment and took notes | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Used a workbook or a pre-defined set of procedures to conduct an experiment | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Created their own hypotheses and conclusions after witnessing an experiment | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Designed their own experiment to answer a set of their own hypotheses | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Used advanced laboratory equipment including necessary adjustments | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Cleaned, handled, and cared for laboratory equipment | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Organized and handled experimental data | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Analyzed experimental data | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| Interpreted the results of an experiment and drew their own conclusions | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Please take a moment to think about your HSAP/URAP mentoring 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 HSAP/URAP apprentice(s) in the laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I taught my HSAP/URAP apprentice(s) about performing STEM research | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I encouraged my HSAP/URAP apprentice(s) to perform a variety of tasks in the laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I helped my HSAP/URAP apprentice(s) formulate their educational goals | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I taught my HSAP/URAP apprentice(s) how to work more effectively in a laboratory | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I spoke with my HSAP/URAP apprentice(s) about their career interests | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I helped my HSAP/URAP apprentice(s) be better writers of scientific research | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I would like to work with my HSAP/URAP apprentice(s) again | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Take a moment to reflect on any HSAP/URAP mentoring 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 HSAP/URAP apprentice(s) about a wide variety of STEM jobs/careers. | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I educated my HSAP/URAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| During HSAP/URAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP/URAP apprentice(s) expressed a lot of interest about pursuing a STEM career | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP/URAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| My HSAP/URAP 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 HSAP/URAP apprentice(s) about STEM-related careers, especially those within the Army/DoD**.

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

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Take a moment to reflect on any HSAP/URAP mentoring 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 Science and Engineering Apprenticeship (SEAP) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |
| 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 HSAP/URAP apprentice(s) about AEOP programs:**

**Please describe any challenges you faced when educating your HSAP/URAP apprentice(s) about AEOP programs.**

| |
|---|
| |

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

| |
|---|
| |

**Appendix C:**
**2013 HSAP 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: _____

**[Apprentice's name] works as a/an:**

❍ HSAP apprentice
❍ URAP apprentice

**How was [Apprentice's name] recruited and selected for this apprenticeship?**

| |
|---|
| |

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

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

**Appendix C:**
**2013 HSAP 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] 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

**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] 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] 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

**Appendix C:**
**2013 HSAP 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] 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] 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

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

**Appendix C:**
**2013 HSAP 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] 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] 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] final project?**

**Do you have any other comments or input to provide us regarding your HSAP/URAP 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 HSAP/URAP this year:**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| At which University are you and your apprentice working? | | |
|---|---|---|
| | **Freq.** | **%** |
| **California State University San Bernardino** | 2 | 12% |
| **University of Central Florida** | 2 | 12% |
| **University of Maryland Eastern Shore** | 2 | 12% |
| **Arizona State University** | 1 | 6% |
| **CCNY** | 1 | 6% |
| **Marshall** | 1 | 6% |
| **N.C. State University** | 1 | 6% |
| **Oakland University, Rochester, Michigan** | 1 | 6% |
| **Polytechnic Institute of New York University** | 1 | 6% |
| **Tennessee State University** | 1 | 6% |
| **Texas Tech University** | 1 | 6% |
| **University of Chicago** | 1 | 6% |
| **University of New Mexico** | 1 | 6% |
| **Western Michigan University** | 1 | 6% |
| **Total** | **17** | **100%** |

| In total, how many HSAP and URAP apprentices have you mentored through the years? (Avg. = 3.71 Apprentices, SD =2.57) | | |
|---|---|---|
| **# of Apprentices** | **Freq.** | **%** |
| **12 apprentices** | 1 | 6% |
| **11 apprentices** | 0 | 0% |
| **10 apprentices** | 0 | 0% |
| **9 apprentices** | 0 | 0% |
| **8 apprentices** | 0 | 0% |
| **7 apprentices** | 0 | 0% |
| **6 apprentices** | 2 | 12% |
| **5 apprentices** | 1 | 6% |
| **4 apprentices** | 3 | 18% |
| **3 apprentices** | 2 | 12% |
| **2 apprentices** | 8 | 47% |
| **1 apprentices** | 0 | 0% |
| **Total** | **17** | **100%** |

| Including 2013, for how many consecutive years have you mentored HSAP/URAP apprentice(s)? (Avg. = 1.78 Years, SD = 0.88) | | |
|---|---|---|
| **# of Consecutive Years** | **Freq.** | **%** |
| **3 consecutive years** | 4 | 22% |
| **2 consecutive years** | 7 | 39% |
| **1 consecutive years** | 6 | 33% |
| **0 consecutive years** | 1 | 6% |
| **Total** | **18** | **100%** |

| For your information - HSAP apprentices are high school students and URAP apprentices are undergraduate students. Which of the following options best describes the apprentices that you are mentoring this summer? | | |
|---|---|---|
| | **Freq.** | **%** |
| **One or more HSAP apprentice(s)** | 9 | 50% |
| **One or more URAP apprentice(s)** | 0 | 0% |
| **Both HSAP and URAP apprentices** | 9 | 50% |
| **Total** | **18** | **100%** |

| In the past, have you ever worked as an HSAP/URAP apprentice? | | |
|---|---|---|
| | **Freq.** | **%** |
| **No** | 13 | 72% |
| **Yes – for how many years?** | 5 | 28% |
| **Total** | **18** | **100%** |

| CONTINUED - In the past, have you ever worked as an HSAP/URAP apprentice? (n = 5 mentors who have worked as HSAP/URAP apprentices previously) | | |
|---|---|---|
| **Yes – for how many years?** | **Freq.** | **%** |
| **5 years** | 1 | 6% |
| **4 years** | 0 | 0% |
| **3 years** | 0 | 0% |
| **2 years** | 2 | 11% |
| **1 year** | 2 | 11% |

**Note. %** = proportion of the total number of HSAP mentors (n = 18).

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Do you serve as a mentor for apprentices or students in programs other than HSAP/URAP? | | |
|---|---|---|
| | **Freq.** | **%** |
| **No** | 6 | 33% |
| **Yes – which program(s)?** | 12 | 67% |
| **Total** | **18** | **100%** |

| CONTINUED - Do you serve as a mentor for apprentices or students in programs other than HSAP/URAP? (n = 11 mentors report mentoring for 11 different programs) | | |
|---|---|---|
| **Program** | **Freq.** | **%** |
| **NSF REU** | 3 | 17% |
| **NSF** | 2 | 11% |
| **ACS project SEED** | 1 | 6% |
| **Chemistry Department at University of Chicago** | 1 | 6% |
| **DOE MURA** | 1 | 6% |
| **GOALI Girl Camp/Intrepid Museum** | 1 | 6% |
| **NASA URC** | 1 | 6% |
| **NSF RET** | 1 | 6% |
| **NYU-Poly's SURP** | 1 | 6% |
| **STEP** | 1 | 6% |
| **Upward Bound** | 1 | 6% |

**Note. %** = proportion of the total number of HSAP mentors (n = 18).

| Which of the following best describes you? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Male** | 14 | 78% |
| **Female** | 3 | 17% |
| **Choose not to report** | 1 | 6% |
| **Total** | **18** | **100%** |

| Which of the following best describes your ethnicity/race? | | |
|---|---|---|
| | **Freq.** | **%** |
| **American Indian or Alaskan Native** | 0 | 0% |
| **Asian or Pacific Islander** | 8 | 44% |
| **Black or African American** | 1 | 6% |
| **Hispanic or Latino** | 0 | 0% |
| **White or Caucasian** | 9 | 50% |
| **Some other ethnicity/race** | 0 | 0% |
| **Choose not to report** | 0 | 0% |
| **Total** | **18** | **100%** |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories best describes your research field? | | |
|---|---|---|
| | **Freq.** | **%** |
| **Engineering (e.g., technology, robotics, computers, etc.)** | 6 | 33% |
| **Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)** | 0 | 0% |
| **Physical Science (e.g., physics, astronomy, etc.)** | 5 | 28% |
| **Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)** | 4 | 22% |
| **Life Science (e.g., biology, animal science, ecology, etc.)** | 1 | 6% |
| **Medicine / Health (e.g., behavioral science, medicine, public health, etc.)** | 0 | 0% |
| **Mathematics / Computer Science** | 1 | 6% |
| **Social Science (e.g., sociology, psychology, economics, etc.)** | 0 | 0% |
| **Other STEM Field** | 1 | 6% |
| **A field unrelated to STEM** | 0 | 0% |
| **Total** | **18** | **100%** |

**Note.** Other = "Aerospace/Aviation"

| Use the scale provided to estimate how often your apprentice(s) conducted or were exposed to each of the following experiences during their HSAP/URAP apprenticeship: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **n** | **Avg.** | **SD** |
| **Observed an experiment and took notes** | 1 (6%) | 2 (11%) | 3 (17%) | 2 (11%) | 4 (22%) | 6 (33%) | 18 | **4.33** | 1.64 |
| **Used a workbook or a pre-defined set of procedures to conduct an experiment** | 4 (22%) | 1 (6%) | 5 (28%) | 3 (17%) | 3 (17%) | 2 (11%) | 18 | **3.33** | 1.68 |
| **Created their own hypotheses and conclusions after witnessing an experiment** | 1 (6%) | 7 (39%) | 2 (11%) | 2 (11%) | 5 (28%) | 1 (6%) | 18 | **3.33** | 1.53 |
| **Designed their own experiment to answer a set of their own hypotheses** | 2 (11%) | 8 (44%) | 2 (11%) | 2 (11%) | 3 (17%) | 1 (6%) | 18 | **2.94** | 1.51 |
| **Used advanced laboratory equipment including necessary adjustments** | 3 (17%) | 2 (11%) | 1 (6%) | 5 (28%) | 3 (17%) | 4 (22%) | 18 | **3.83** | 1.79 |
| **Cleaned, handled, and cared for laboratory equipment** | 4 (22%) | 2 (11%) | 1 (6%) | 5 (28%) | 3 (17%) | 3 (17%) | 18 | **3.56** | 1.82 |
| **Organized and handled experimental data** | 1 (6%) | 3 (17%) | 3 (17%) | 5 (28%) | 4 (22%) | 2 (11%) | 18 | **3.78** | 1.44 |
| **Analyzed experimental data** | 2 (11%) | 3 (17%) | 4 (22%) | 5 (28%) | 3 (17%) | 1 (6%) | 18 | **3.39** | 1.42 |
| **Interpreted the results of an experiment and drew their own conclusions** | 2 (12%) | 3 (18%) | 4 (24%) | 4 (24%) | 2 (12%) | 2 (12%) | 17 | **3.41** | 1.54 |

**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 C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Please take a moment to think about your HSAP/URAP mentoring 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 HSAP/URAP apprentice(s) in the laboratory** | 1 (6%) | 3 (17%) | 0 (0%) | 6 (33%) | 4 (22%) | 4 (22%) | 18 | **4.17** | 1.54 |
| **I taught my HSAP/URAP apprentice(s) about performing STEM research** | 1 (6%) | 1 (6%) | 0 (0%) | 4 (22%) | 7 (39%) | 5 (28%) | 18 | **4.67** | 1.37 |
| **I encouraged my HSAP/URAP apprentice(s) to perform a variety of tasks in the laboratory** | 1 (6%) | 0 (0%) | 0 (0%) | 3 (17%) | 6 (33%) | 8 (44%) | 18 | **5.06** | 1.26 |
| **I helped my HSAP/URAP apprentice(s) formulate their educational goals** | 1 (6%) | 0 (0%) | 0 (0%) | 6 (33%) | 8 (44%) | 3 (17%) | 18 | **4.61** | 1.14 |
| **I taught my HSAP/URAP apprentice(s) how to work more effectively in a laboratory** | 1 (6%) | 1 (6%) | 0 (0%) | 4 (22%) | 10 (56%) | 2 (11%) | 18 | **4.50** | 1.25 |
| **I spoke with my HSAP/URAP apprentice(s) about their career interests** | 1 (6%) | 1 (6%) | 0 (0%) | 3 (17%) | 7 (39%) | 6 (33%) | 18 | **4.78** | 1.40 |
| **I helped my HSAP/URAP apprentice(s) be better writers of scientific research** | 1 (6%) | 0 (0%) | 0 (0%) | 10 (56%) | 3 (17%) | 4 (22%) | 18 | **4.44** | 1.20 |
| **I would like to work with my HSAP/URAP apprentice(s) again** | 1 (6%) | 0 (0%) | 0 (0%) | 2 (11%) | 3 (17%) | 12 (67%) | 18 | **5.33** | 1.28 |

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| 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 HSAP/URAP apprentice(s) clarify their educational goals and pathways** | 1 (6%) | 1 (6%) | 0 (0%) | 6 (33%) | 5 (28%) | 5 (28%) | 18 | **4.56** | 1.38 |
| **I provided guidance to my HSAP/URAP apprentice(s) about the steps they will need to achieve their professional and educational goals** | 1 (6%) | 0 (0%) | 1 (6%) | 4 (22%) | 7 (39%) | 5 (28%) | 18 | **4.72** | 1.27 |
| **I helped my HSAP/URAP apprentice(s) draft their CV/Résumé** | 0 (0%) | 8 (44%) | 1 (6%) | 6 (33%) | 1 (6%) | 2 (11%) | 18 | **3.33** | 1.41 |
| **I will write or help my HSAP/URAP apprentice(s) obtain letters of reference** | 1 (6%) | 0 (0%) | 0 (0%) | 3 (17%) | 5 (28%) | 9 (50%) | 18 | **5.11** | 1.28 |
| **I introduced my HSAP/URAP apprentice(s) to professional and educational networks that will help them in the future** | 0 (0%) | 0 (0%) | 2 (11%) | 5 (28%) | 7 (39%) | 4 (22%) | 18 | **4.72** | 0.96 |
| **I exposed my HSAP/URAP apprentice(s) to professional organizations that can help them pursue their career/educational goals** | 0 (0%) | 2 (11%) | 1 (6%) | 7 (39%) | 5 (28%) | 3 (17%) | 18 | **4.33** | 1.19 |
| **My HSAP/URAP apprentice(s) were interested in pursuing AEOP programs in the future** | 0 (0%) | 3 (17%) | 0 (0%) | 5 (28%) | 7 (39%) | 3 (17%) | 18 | **4.39** | 1.29 |
| **I am interested in mentoring more HSAP/URAP apprentices in the future** | 0 (0%) | 0 (0%) | 0 (0%) | 1 (6%) | 6 (33%) | 11 (61%) | 18 | **5.56** | 0.62 |
| **I would recommend my HSAP/URAP apprentice(s) for future Army internships** | 0 (0%) | 0 (0%) | 0 (0%) | 1 (6%) | 3 (17%) | 14 (78%) | 18 | **5.72** | 0.57 |

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Take a moment to reflect on any HSAP/URAP mentoring 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 HSAP/URAP apprentice(s) about a wide variety of STEM jobs/careers.** | 0 (0%) | 1 (6%) | 0 (0%) | 7 (39%) | 7 (39%) | 3 (17%) | 18 | **4.61** | 0.98 |
| **I educated my HSAP/URAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)** | 0 (0%) | 2 (11%) | 2 (11%) | 6 (33%) | 5 (28%) | 3 (17%) | 18 | **4.28** | 1.23 |
| **During HSAP/URAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD** | 0 (0%) | 1 (6%) | 3 (17%) | 7 (39%) | 4 (22%) | 3 (17%) | 18 | **4.28** | 1.13 |
| **My HSAP/URAP apprentice(s) expressed a lot of interest about pursuing a STEM career** | 0 (0%) | 0 (0%) | 0 (0%) | 4 (22%) | 8 (44%) | 6 (33%) | 18 | **5.11** | 0.76 |
| **My HSAP/URAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career** | 1 (6%) | 2 (11%) | 1 (6%) | 5 (28%) | 5 (28%) | 4 (22%) | 18 | **4.28** | 1.49 |
| **My HSAP/URAP apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers** | 0 (0%) | 1 (6%) | 1 (6%) | 4 (22%) | 7 (39%) | 5 (28%) | 18 | **4.78** | 1.11 |

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Please describe the ways in which you educated your HSAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=14)**

| Broad Theme | Narrow Theme(s) | Freq. | Example Response(s) |
|---|---|---|---|
| **Awareness of Army/DoD careers** | | **6** | |
| | Discussed various Army/DoD careers | 6 | • "I highlighted the emerging field of remote sensing in both the military and civilian world."<br>• "Careers in DoD laboratories, such as ARL, NRL." |
| **STEM Pathway** | | **6** | |
| | Hands-on nature of the material introduced apprentices to careers | 5 | • "The interdisciplinary research required a lot of reading that introduces a world of requirements for STEM personnel in the workforce."<br>• "Direct hands-on training on multiple short-term research assignments." |
| | AEOP awareness | 1 | • "…at one point we discussed the AEOP pamphlet that was distributed to us." |
| **Awareness of STEM Careers** | | **4** | |
| | Discussed various STEM careers | 3 | • "I met with my student about their career goals and have them list out what they would like to do in the future." |
| | Did not yet discuss STEM careers | 1 | • "I plan to do it... this survey is in the middle of their internship." |
| **Other** | | **2** | |
| | General Discussions | 2 | • "We had multiple conversations."<br>• "Informal conversations." |

**Please describe any challenges you faced when educating your HSAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=12)**

| List of Suggestions | Freq. | Example Response(s) |
|---|---|---|
| **Limitations of high school students / apprentices were not developed enough yet** | 3 | • "I advised a URAP last year and in comparison the HSAP student is less aware of STEM research as well as DoD centric STEM research and opportunities."<br>• "The students were very enthusiastic, but mathematical background was weak." |
| **No challenges** | 3 | • "No challenges to report." |
| **Unfamiliar with aspects of Army/DoD careers** | 3 | • "I do not have a military background and therefore cannot speak from experience about many potentially important topics."<br>• "For army/DoD careers, it is unclear what the steps are to obtain positions and what types of positions available." |
| **Students were distracted** | 1 | • "During the first 2-3 days, students showed multi-media distraction (e.g., texting, gaming, watching You-tube videos not related to research)." |
| **More daily support is needed** | 1 | • "Need support for the trainers to oversee the students on daily basis." |
| **Duration of program is too short to get students involved** | 1 | • "Hard to get them really involved in a project when the student works for only summer months." |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Please describe how HSAP could better support you in your efforts to educate your apprentice(s) about STEM-related careers, especially those within the Army/DoD. (n = 15) | | |
|---|---|---|
| **List of Suggestions** | **Freq.** | **Example Response(s)** |
| **Provide information to apprentices using electronic media** | 3 | • "If there was some information about Army/DoD jobs and a website/link to such jobs, that might help."<br>• "Also, an interactive video would be good" |
| **Increase funding for students and/or the lab** | 3 | • "Provide additional funds in addition to the stipends for purchasing small lab devices."<br>• "Maybe increase stipend for longer period in summer may help attract students to solely focus on this program during the summer." |
| **Suggest a teleconference / workshop for apprentices during the program** | 2 | • "A URAP/HSAP teleconference would help so that the Army/DoD can directly communicate STEM opportunities with the student."<br>• "In August plan a mandatory workshop for all HSAP/URAP participants and highlight these points in an engaging way. NSF does this for their undergraduate research fellows and the students love it!" |
| **Provide mentors a packet of information to distribute to apprentices** | 2 | • "It would have been helpful to have a pre-made packet of materials from the Army/DoD that highlighted the STEM-related careers that we could have handed the students on day one and gone through together." |
| **Mentors are satisfied with the support from HSAP/URAP** | 2 | • "The HSAP/URAP is a great program that is exposing its students to cutting-edge scientific research, which excited them about pursuing careers in science. They become aware of the support and opportunities available through Army/DoD." |
| **Informal mentoring prior to program** | 1 | • "…start mentoring them informally in the spring semester before they come to campus." |
| **Support a conference of HSAP/URAP apprentices** | 1 | • "Maybe a conference consisting of other HSAP/URAP students from across the country." |
| **Support an informative field trip** | 1 | • "Maybe some trips to Army research facilities." |
| **Advertise more in high schools** | 1 | • "HSAP/URAP should advertise more in high schools about the possibility of research, my two students learn about this program because they have family connection in the US army." |
| **Suggest training mentors** | 1 | • "One webinar per summer overviewing the highlights of what you would like to communicate would maybe make certain that your goals are met." |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

**Take a moment to reflect on any HSAP/URAP mentoring 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 (47%) | 3 (18%) | 0 (0%) | 5 (29%) | 1 (6%) | 0 (0%) | 17 | **2.29** | 1.49 |
| **I encouraged my apprentice(s) to submit his/her research project/final report to JSHS** | 5 (29%) | 6 (35%) | 1 (6%) | 3 (18%) | 2 (12%) | 0 (0%) | 17 | **2.47** | 1.42 |
| **My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS** | 5 (29%) | 6 (35%) | 2 (12%) | 2 (12%) | 2 (12%) | 0 (0%) | 17 | **2.41** | 1.37 |
| **I know about the other High School Internship programs offered by the AEOP: The Research in Engineering Apprenticeship Program (REAP) & the Science and Engineering Apprenticeship (SEAP)** | 7 (41%) | 4 (24%) | 1 (6%) | 2 (12%) | 2 (12%) | 1 (6%) | 17 | **2.47** | 1.70 |
| **I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL)** | 6 (35%) | 4 (24%) | 2 (12%) | 2 (12%) | 3 (18%) | 0 (0%) | 17 | **2.53** | 1.55 |
| **I provided information to my apprentice(s) about one or more AEOP program(s)** | 5 (29%) | 5 (29%) | 1 (6%) | 4 (24%) | 2 (12%) | 0 (0%) | 17 | **2.59** | 1.46 |
| **My apprentice(s) expressed interest in pursuing AEOP programs in the future** | 5 (29%) | 3 (18%) | 1 (6%) | 2 (12%) | 6 (35%) | 0 (0%) | 17 | **3.06** | 1.75 |
| **I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense** | 3 (18%) | 4 (24%) | 0 (0%) | 4 (24%) | 3 (18%) | 3 (18%) | 17 | **3.53** | 1.84 |
| **I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense** | 3 (18%) | 5 (29%) | 0 (0%) | 4 (24%) | 2 (12%) | 3 (18%) | 17 | **3.35** | 1.84 |

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

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Please describe the ways in which you educated your HSAP apprentice(s) about AEOP programs. (n = 10) | | |
|---|---|---|
| **List of Suggestions** | **Freq.** | **Example Response(s)** |
| **Could not discuss because programs were unknown/not familiar** | 4 | • "I did not since I was not aware of the opportunities myself. I will improve upon this aspect of the program next year."<br>• "I did not provide much information in this area." |
| **Discussed the SMART/NDSEG program** | 3 | • "The only AEOP program I have discussed with my students is the NDSEG and she had applied." |
| **Sent students towards the website** | 1 | • "Make them aware of the programs through the websites and published material." |
| **Discussed with apprentices during the program** | 1 | • "Went over it when we discussed future opportunities." |
| **Gave apprentices fliers or brochures** | 1 | • "Brochures." |
| **Encouraged apprentices to enter competitions** | 1 | • "I have encouraged my HSAP student to submit her research to a variety of science competitions." |

| Please describe any challenges you faced when educating your HSAP apprentice(s) about AEOP programs. (n = 11) | | |
|---|---|---|
| **List of Suggestions** | **Freq.** | **Example Response(s)** |
| **Need more information about other AEOP Programs** | 7 | • "I know very little about these programs."<br>• "The challenge is that I am not really aware of all the AEOP programs."<br>• "Primarily my lack of knowledge about undergraduate and high school programs." |
| **No challenges** | 3 | • "No challenges." |
| **Education should be addressed by AEOP website** | 1 | • "Present a web seminar about AEOP during summer time so that HSAP/URAP attending research can participate and learn about AEOP educational mission and research opportunities." |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Please describe how HSAP could better support you in your efforts to educate your apprentice(s) about AEOP programs. (n = 11) | | |
|---|---|---|
| **List of Suggestions** | **Freq.** | **Example Response(s)** |
| **Deliver information via electronic media** | 4 | • "Just a simple email alert from AEOP with a PDF brochure attachment would be a great way to publicize the programs better."<br>• "…create a website where HSAP/URAP can visit and learn more about AEOP programs and opportunities." |
| **Provide print information about the AEOP** | 3 | • "…send me a package to review prior to the onset of the HASP program." |
| **Provide deadlines** | 2 | • "If we could be sent links to each AEOP program with deadlines…" |
| **Suggest a meeting with apprentices** | 1 | • "I would suggest either a national phone conference or regional meeting to educate the HSAP mentors on these other programs." |
| **Suggest visits or events at lab sites** | 1 | • "Possibly arrange visits to DoD laboratories or hold science fairs at DoD laboratories." |
| **Suggest educating mentors** | 1 | • "Perhaps relevant information could be brought to mentors attention in a more effective way." |
| **Suggest improving the brochure** | 1 | • "The brochure materials are a bit thin." |
| **Satisfied with the program** | 1 | • "The programs are performing an excellent job of exposing students to the research frontier." |

| How was your HSAP apprentice recruited and selected for this apprenticeship? (n = 25) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme(s)** | **Freq.** | **Example Response(s)** |
| **AEOP participation: Application & Selection** | | **12** | |
| | Selected from AEOP applicant pool | 9 | • "[She] was on the list of applicants sent from the ARO office."<br>• "He applied through the gateway "spontaneously", selected as most competitive candidate." |
| | Aware of student before application | 3 | • "On the basis of my personal knowledge of her academic skills and personal characteristics, as well as her prior experience in Africa." |
| **AEOP Awareness: Recruiting & Marketing** | | **11** | |
| | Recruit students through local high school staff | 5 | • "Through email announcement to high schools."<br>• "Through the local high school." |
| | Recruit using other events / programs / organizations | 3 | • "Upward Bound, California State University, San Bernardino." |
| | Social Media | 2 | • "HSAP website." |
| | Recruited through Outreach coordinator | | • "Through our outreach coordinator Stefi Wiesburd." |
| **Other** | | **2** | |
| | Convenience | 1 | • "[My apprentice's] parents are local residents." |
| | Through research | 1 | • "High school research." |

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Please rate [your apprentice]'s laboratory skill level. (Avg. = 4.95, SD = 0.91) | | |
|---|---|---|
| | **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 | 42% |
| **(5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision** | 4 | 21% |
| **(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** | 7 | 37% |
| **Total** | **19** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (58%)**; 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. = 4.78, SD = 1.06) | | |
|---|---|---|
| | **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** | 0 | 0% |
| **(4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor** | 6 | 33% |
| **(5): Understands and uses techniques competently without supervision. Yielded results are useful** | 6 | 33% |
| **(6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques** | 5 | 28% |
| **Total** | **18** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (61%)**; 1&2 = **1 (6%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories most accurately describes [your apprentice]'s scientific teamwork/collaboration abilities in your laboratory? (Avg. = 4.74, SD = 0.87) | | |
|---|---|---|
| | **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** | 1 | 5% |
| **(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** | 0 | 0% |
| **(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** | 4 | 21% |
| **(5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates** | 12 | 63% |
| **(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** | 2 | 11% |
| **Total** | **19** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **14 (74%)**; 1&2 = **1 (5%).**

| Which of the following categories most accurately describes [your apprentice]'s scientific reasoning skills/abilities? (Avg. = 4.63, SD = 0.90) | | |
|---|---|---|
| | **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** | 1 | 5% |
| **(3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles** | 1 | 5% |
| **(4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles** | 3 | 16% |
| **(5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research** | 13 | 68% |
| **(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** | 1 | 5% |
| **Total** | **19** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **14 (74%)**; 1&2 = **1 (5%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories most accurately describes [your apprentice]'s information literacy skills/abilities? (Avg. = 4.63, SD = 0.96) | | |
|---|---|---|
| | **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** | 1 | 5% |
| **(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 | 5% |
| **(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** | 4 | 21% |
| **(5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses** | 11 | 58% |
| **(6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner** | 2 | 11% |
| **Total** | **19** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (68%)**; 1&2 = **1 (5%).**

| Which of the following categories most accurately describes [your apprentice]'s quantitative literacy skills/abilities? (Avg. = 4.68, SD = 0.89) | | |
|---|---|---|
| | **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** | 1 | 5% |
| **(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** | 0 | 0% |
| **(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 | 26% |
| **(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** | 11 | 58% |
| **(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** | 2 | 11% |
| **Total** | **19** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **13 (68%)**; 1&2 = **1 (5%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories best describes [your apprentice]'s Introduction/Purpose? (Avg. = 5.21, SD = 0.70) | | |
|---|---|---|
| | **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** | 2 | 14% |
| **(5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague** | 7 | 50% |
| **(6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research** | 5 | 36% |
| **Total** | **14** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (86%)**; 1&2 = **0 (0%).**

| Which of the following categories best describes [your apprentice]'s Methods (e.g., description of equipment & procedures)? (Avg. = 5.00, SD = 0.76) | | |
|---|---|---|
| | **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** | 4 | 27% |
| **(5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification** | 7 | 47% |
| **(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** | 4 | 27% |
| **Total** | **15** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (73%)**; 1&2 = **0 (0%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories best describes [your apprentice]'s Results (e.g., data analysis, interpretation & findings) (Avg. = 5.00, SD = 0.65) | | |
|---|---|---|
| | **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** | 3 | 20% |
| **(5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear** | 9 | 60% |
| **(6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts** | 3 | 20% |
| **Total** | **15** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (80%)**; 1&2 = **0 (0%).**

| Which of the following categories best describes [your apprentice]'s Conclusions? (Avg. = 4.80, SD = 0.94) | | |
|---|---|---|
| | **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** | 1 | 7% |
| **(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** | 2 | 13% |
| **(5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus** | 10 | 67% |
| **(6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research** | 2 | 13% |
| **Total** | **15** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (80%)**; 1&2 = **1 (7%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Which of the following categories best describes [your apprentice]'s Structure? (Avg. = 4.67, SD = 1.18) | | |
|---|---|---|
| | **Freq.** | **%** |
| **(1): Does not include or distinguish between an abstract, body, appendix, or bibliography** | 1 | 7% |
| **(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** | 3 | 20% |
| **(5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality** | 9 | 60% |
| **(6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable** | 2 | 13% |
| **Total** | **15** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **11 (73%)**; 1&2 = **1 (7%).**

| Which of the following categories best describes [your apprentice]'s Oral Communication? (Avg. = 4.63, SD = 1.20) | | |
|---|---|---|
| | **Freq.** | **%** |
| **(1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)** | 1 | 6% |
| **(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 | 6% |
| **(4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question** | 2 | 13% |
| **(5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility** | 10 | 63% |
| **(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** | 2 | 13% |
| **Total** | **16** | **100%** |

**Note.** Frequency and percentage of apprentices receiving ratings of: 5&6 = **12 (75%)**; 1&2 = **1 (6%).**

**Appendix C:**
**2013 HSAP Mentor Questionnaire, Rubrics, and Data Summary**

| Do you have any other comments or input to provide us regarding your HSAP apprentice's final project? (n = 5) | | |
|---|---|---|
| **List of Comments** | **Freq.** | **Example Response(s)** |
| **Apprentice has not finished the project yet** | 3 | • "The student is still in the process of submitting this document." |
| **Apprentice has excellent work** | 1 | • "Her work is stellar. I expect we will write a paper on her research." |
| **Apprentice has improved during the program** | 1 | • "His skill has greatly improved." |

| Do you have any other comments or input to provide us regarding your HSAP apprentice? (n = 5) | | |
|---|---|---|
| **List of Comments** | **Freq.** | **Example Response(s)** |
| **Apprentice demonstrates interest for the material** | 2 | • "[My apprentice is] a very good student interested in his work."<br>• "She was able to gain insight into a new field of science and possibly now a career choice." |
| **Apprentice has learned/developed due to the program** | 2 | • "[My apprentice] has benefited tremendously from the HSAP/URAP program."<br>• "She has learned many skills that will help her in the future." |
| **Apprentice is intelligent** | 1 | • "[My apprentice is] a very bright and skillful student." |
| **Apprentice exceeded expectations** | 1 | • "[My apprentice performed] beyond my expectations." |
| **Apprentice is motivated** | 1 | • "[My apprentice is] VERY motivated." |

**Appendix C:**
**2013 HSAP 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 HSAP this year. (n = 10) | | | |
|---|---|---|---|
| **Broad Theme** | **Narrow Theme(s)** | **Freq.** | **Example Response(s)** |
| **General Satisfaction** | | **6** | |
| | Mentors enjoyed working with apprentices | 3 | • "This year we had an excellent cohort from various research programs including the NSF REU, NSF RET and the HSAP." |
| | Mentors were satisfied with the program | 2 | • "This provided us with an amazing environment for conducting stem research." |
| | Apprentice expressed satisfaction with HSAP | 1 | • "[apprentices] seem to be enjoying the experience." |
| **Effective Mentorship** | | **2** | |
| | Mentors developed their own mentoring skills/abilities | 1 | • "[HSAP provided] a more clear picture on transitional stem research from high school to university to teaching." |
| | Mentors worked closely with students | 1 | • "It was a great opportunity to introduce these students with research and work with them every day." |
| **Academic Research Activities** | | **1** | |
| | Apprentices completed a research project | 1 | • "[apprentices] both finished their projects." |
| **Hands-on / Laboratory Research Experiences** | | **1** | |
| | Apprentices successfully working in a laboratory | 1 | • "Both of my high school students have integrated themselves into our laboratory environment…" |
| **STEM pathway** | | **1** | |
| | Apprentices will benefit from HSAP in the future | 1 | • "…[apprentices in HSAP are] learning a great deal that will benefit their future." |

**Appendix D:**
**2013 HSAP Apprentice Focus Group and Phone Interview Protocols**

**Focus Group**

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 HSAP 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 HSAP 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 HSAP?
    - What specific ways has it benefited you?
    - What does HSAP 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 HSAP, what would you say?
8. Have we missed anything? Tell us anything you want us to know that we didn't ask about.

**Appendix D:**
**2013 HSAP Apprentice Focus Group and Phone Interview Protocols**

**Phone Interview**

This is _____ (name) from Virginia Tech. Thank you for agreeing to be interviewed. I will ask you questions about your experiences in HSAP.

Before we begin, do you have any questions about the evaluation study or your participation in it?

This conversation will be recorded for my note taking purposes. Do I have your permission to audio record this conversation? [Turn on recorder if permission granted.] Do I have your consent to participate in this interview?

We are now going to begin the interview.

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

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

3. Have you learned about other Army Educational Outreach Programs while participating in the HSAP program? If so, which ones?

4. Are you interested in STEM jobs/careers offered by the Army and Department of Defense agencies? If so, why? If not, why not?
    - What impact did your mentor have, if any, on your future career aspirations?

5. Would you recommend participating in this program as an apprentice to others? If so, why. If not, why not?

Thank you again for taking time to speak with me about your experiences. We also hope that you will complete our online survey that you will receive in the upcoming weeks. We value your participation in the evaluation study.

**Appendix E:**
**2013 HSAP Mentor Focus Group and Phone Interview Protocols**

**Focus Group**

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 HSAP 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 HSAP 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 HSAP?
    - 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 HSAP, what would you say?
9. Have we missed anything? Tell us anything you want us to know that we didn't ask about.

**Appendix E:**
**2013 HSAP Mentor Focus Group and Phone Interview Protocols**

**Phone Interview**

This is _____ (name) from Virginia Tech. Thank you for agreeing to be interviewed. I will ask you questions about your experiences in HSAP.

Before we begin, do you have any questions about the evaluation study or your participation in it?

This conversation will be recorded for my note taking purposes. Do I have your permission to audio record this conversation? [Turn on recorder if permission granted.] Do I have your consent to participate in this interview?

We are now going to begin the interview.

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

2. What do you perceive as the value of HSAP?
   - How have you/your lab benefited from participating?
   - How do you think apprentices benefit from participating?

3. How have you educated your apprentice about other Army Educational Outreach Programs for which they might qualify?
   - [If response seems affirmative] Which program(s) have you recommended as a next step?
   - [If response seems negative] What resources do you need to educate apprentices about other Army Educational Outreach Programs?

4. How have you educated your apprentice about STEM jobs/careers offered by the Army and Department of Defense agencies?
   - [If response seems negative] What resources do you need to educate apprentices about STEM careers at Army/DoD agencies?

5. Would you recommend participating in this program as a mentor to others? If so, why. If not, why not?

Thank you again for taking time to speak with me about your experiences. We also hope that you will complete our online survey that you will receive in the upcoming weeks. We value your participation in the evaluation study.

# Army Educational Outreach Program

## Graduate Mentoring Fellows Program

## 2013 Data Brief

*Virginia Tech, AEOP CA*

*August 30, 2013*

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## Overview

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative, cohesive, portfolio of Army sponsored STEM programs that effectively engage, inspire, and attract the next generation of STEM talent through K-12 programs and expose them to DoD STEM careers. All programs are evaluated based on specific metrics and evidence-based approaches to achieve key objectives of Army outreach; increased efficiency and coherence; ability to share and leverage best practices; as well as focus on Army goals and objectives.

The evaluation team from Virginia Tech compiled data from FY2013 program implementations during spring and summer 2013. For the purposes of informing potential programmatic revision for FY2014, evaluators analyzed only a sub-set of data focused on key objectives of the AEOP outlined in Table 1.

| **Table 1. AEOP objectives for pre-APP evaluation study** | |
|---|---|
| **Goal 1: STEM Literate Citizenry** | |
| **Objective A** | Increase participation of underserved populations in the AEOP |
| | • Consortium objective: Implement marketing and recruitment strategies that promote diversity and inclusion in all AEOP elements. |
| **Objective B** | Increase awareness of DoD STEM career opportunities |
| | • Consortium objective: Introduce programming in each AEOP element to provide participants with information about DoD STEM career opportunities and additional opportunities within the AEOP. |
| | |
| **Goal 2: STEM "Savvy" Educators** | |
| **Objective C** | Provide and expand mentor capacity for the Army's highly qualified scientists and engineers. |
| | • Consortium objective: Expose [educators] to topics in Army science and engineering and the offerings of the AEOP. (for the purpose of this brief, addressed with Objective B) |

The Graduate Mentoring Fellow Program is an effort to acknowledge and support the critical role that graduate students assume in the mentoring of high school and undergraduate apprentices in AEOP programs. These pre-APP evaluation study findings, reported herein, provide a baseline measure for the program's attempts to address Objective C by expand mentor capacity of graduate student mentors.

This evaluation study of the Graduate Mentoring Fellows Program represents perspectives of Graduate Mentoring Fellows, herein referred to as GMFs, who serve as mentors for apprentices of the High School Apprenticeship Program (HSAP) and the Undergraduate Research Apprenticeship Program (URAP).

These findings should inform program-specific planning for FY14, and, potentially, be considered for consortium-wide planning around Objective C. A full study of the program, using the complete data sets, will be reported in fall 2013. This brief is organized around the three objectives listed above, but primarily focuses on Objective C.

## Methods

The FY2013 evaluation approach included a mixed methods approach (Creswell, 2003; Quinn 2001, Greene & Caracelli, 1997) to allow for broad generalization (e.g., with forced-response "quantitative" survey items) and for more in-depth focusing (e.g., with constructed-response "qualitative" survey, interview, and focus group items) of evaluation. Evaluation assessments for the larger study of HSAP and URAP programs included:

- online surveys administered to apprentices and mentors (inclusive of GMFs),
- onsite focus groups with apprentices and mentors (inclusive of GMFs),
- phone interviews with apprentices and mentors (inclusive of GMFs) of select programs, and
- when possible, unstructured observations of apprentices and mentors engaging in their work.

Data from HSAP and URAP program evaluations have been, to the extent possible, triangulated across data sources (apprentices and mentors) and across data types (quantitative survey data, qualitative survey and interview/focus group data). Data summaries from this larger study are reported elsewhere, and include GMFs' perspectives and contributions as mentors to HSAP and URAP apprentices.

The findings reported herein originate from a subset of the online survey that was administered only to GMFs to ascertain the impact of the Graduate Mentoring Fellows program activities on their learning about mentorship and on their actual mentoring activities.

Data was collected through an online survey during a 10-day period from late July to early August, near the conclusion of the program site's summer activities. In total, 11 GMFs (3 female, 8 males) from 11 university sites participated in the online survey. Only 6 GMFs who participated in an online eWorkshop were invited to respond to related surveys items.

## OBJECTIVE A

*Increase participation of underserved populations in the AEOP*

*Increasing participation of underserved populations in AEOP is dependent upon the marketing, recruitment, and selection efforts implemented. Findings regarding* ***participant diversity***, ***participant awareness of the Graduate Mentoring Fellows Program***, *and* ***participant recruitment*** *will help identify areas of improvement for future efforts.*

**Participant Diversity**

The online survey included items addressing participant gender and race/ethnicity. Tables 2 and 3, and the bulleted statements that follow, summarize trends in apprentice and mentor demographics from evaluation assessments.

| Table 2. Participant gender | % of GMFs (n=11) |
|---|---|
| Males | 73% |
| Females | 27% |

| Table 3. Participant race/ethnicity | % of GMFs (n=11) |
|---|---|
| American Indian or Alaskan Native | 0% |
| Asian or Pacific Islander | 18% |
| African American | 9% |
| Caucasian | 55% |
| Hispanic or Latino | 18% |

- **While, the major demographic characteristics of GMFs are male and Caucasian, the gender and race/ethnicities reported suggest that graduate students from underserved or underrepresented populations participate in the program. As the program expands, so should efforts to increase inclusion of GMFs from underserved or underrepresented groups.**

**Participant Awareness and Participant Recruitment**

The online survey included items addressing how participants originally learned about the Graduate Mentoring Fellows program, including any personal connections that led them to the program or to the university site, and past experience participating in the program. The following summarizes important trends:

- GMFs most frequently report learning about the Graduate Mentoring Fellows Program from their research advisors (Principal Investigators on ARO-funded research) who are in direct contact with ARO. Of 11 GMFs, none have participated as a GMF in the past (this was a pilot program in 2013) and 18% report being an HSAP or URAP apprentice in the past.

## OBJECTIVE B

### *Increase awareness of DoD STEM career opportunities*

*If AEOP is to establish a collaborative, coherent pipeline for developing STEM talent from K-college, each program plays a pivotal role in promoting participants' (apprentices and mentors alike)* ***awareness of AEOP initiatives.*** *Apprentices and mentors who are aware of the portfolio of AEOP programs can serve as stewards or ambassadors 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. Apprentices who are knowledgeable of and encouraged to take next steps in AEOP are more likely to do so. Similarly, if AEOP is to attract STEM talent to the Army/DoD, each program also plays a pivotal role in promoting participants'* ***awareness of Army/DoD STEM career opportunities.*** *Mentors who are knowledgeable about DoD STEM career opportunities can inspire apprentices' interest and appreciation of them and provide guidance about educational/career pathways. Apprentices that have greater awareness of and positive attitudes toward DoD STEM careers are more likely to seek them out in the future.*

**Awareness of AEOP Initiatives**

The online survey included items addressing GMFs' learning about AEOP through the Graduate Mentoring Fellows Program communications and activities (e.g., the eWorkshop), and their efforts to educate their apprentices.

Tables 4 and 5 compares and contrasts opportunities to learn about AEOP with awareness of specific programs. For awareness of AEOP programs, the frequency reporting "Strongly disagree" or "Disagree" provided the clearest trend.

| Table 4. GMFs' learning about AEOP | % of GMFs (n=6) Agree or Strongly Agree |
|---|---|
| I learned about HSAP/URAP program and its objectives | 83% |
| I learned about other AEOP initiatives available to apprentices | 67% |

| Table 5. GMFs' awareness of specific AEOP programs | % of GMFs (n=11) Strongly disagree or Disagree (I know about program) |
|---|---|
| Competitions (JSHS reported) | 55% |
| High School Internships—SEAP, REAP | 55% |
| College Internships—CQL | 46% |
| SMART scholarship program | 18% |
| NDSEG fellowship program | 0% |

- Notable disparity is evident in GMFs' reports of learning about AEOP initiatives and awareness of specific programs as a result of program activities. This is not surprising given the shallow level of detail provided to GMFs about AEOP, and the rapid pace in which it was delivered, during the eWorkshop. Familiarity often does not translate into knowledge unless reinforced with multiple exposures.

Table 5 and bulleted statements below describe GMFs' efforts to educate apprentices about AEOP. The frequency of GMFs reporting "Never" or "Once Per Week" provided the clearest trend.

| Table 5. GMFs' efforts to educate apprentices about AEOP initiatives | % of GMFs (n=10) Never or Once Per Week |
|---|---|
| I educated my apprentice about the HSAP/URAP program and its objectives | 80% |
| I educated my apprentice about one or more AEOP programs | 70% |

- Most GMFs reported not educating their apprentices about one or more AEOP initiatives. Most frequently, GMFs reported educating apprentices about SMART and NDSEG programs and encouraging them to apply. Other GMFs reported providing the brochure and/or website to apprentices and encouraging them to explore opportunities available to them (without further discussion). One GMF admitted to not having a level of awareness that would allow for

conversation about AEOP opportunities. Again, these are typical mechanisms for delivering information (or not delivering it) when relying on vague familiarity alone.

Taken together, these data suggest that the mechanism and/or resources used to bring about GMF awareness of AEOP initiatives, does not provide them with sufficient depth of awareness needed to educate their apprentices about the portfolio of programs.

**Army/DoD STEM Career Awareness**

The online survey included items eliciting GMFs' perceptions of mentoring activities related to educating apprentices about Army/DoD STEM careers. Table 7 reports efforts to educate apprentices about STEM careers in a broad sense as well as STEM careers specific to Army/DoD.

| Table 7. Educating apprentices about STEM careers | % of GMFs (n=11) Strongly Agree or Agree |
|---|---|
| **I educated my apprentice about a wide variety of STEM careers** | **55%** |
| **I educated my apprentice about STEM Careers with Army/DoD** | **36%** |
| **I educated my apprentice about civilian research programs within the Army/DoD** | **46%** |

- A notable finding evident in Table 7 is that GMFs report addressing STEM careers in general more frequently than addressing Army/DoD STEM careers/research programs. One GMF reported that his limited experience prevented him from discussing Army/DoD STEM careers or research programs. Two GMFs described explicitly how they accomplished this:

  "From the beginning I discussed my students career paths with them. As they both desire research careers after graduate school, that's where we focused our discussion. I pointed them towards some of the work happening at my own university on Army/DoD grants (and the Army/DoD research centers doing related work), and we discussed universities and research labs."

  "With the URAP apprentice, we spent a substantial amount of time discussing STEM-related careers -- including those within the Army/DoD -- and looking up additional information on Army/DoD websites."

  Considering that a majority of HSAP and URAP faculty mentors are expecting graduate students, much like the GMFs, to perform this mentoring activity, the program might consider additions to its programming to support all mentors in these endeavors.

## OBJECTIVE C

*Provide and extend mentor capacity for the Army's highly qualified scientists and engineers.*

*A critical factor to maximizing apprentices' participation (and benefit) in research, and sustaining their interest in future STEM work, is the mentorship provided. Understanding the* ***mentor activities*** *and* ***perceived needs of mentors****, especially those working with diverse populations, can inform programmatic improvement for sustaining apprentices' interest in STEM.*

**Mentor Activities**

The online survey included items addressing the extent to which GMFs learned about effective mentorship in the eWorkshop and applied these learnings in their own mentoring practices. Tables 8 and 9 contrasts GMFs' reports of learning and practice or implementation. The frequency reporting "Never" or "Once per week" provided the clearest trend for practicing effective mentorship in Table 8.

| Table 8. Learning about effective mentorship | % of GMFs (n=6) Strongly Agree or Agree |
|---|---|
| I learned about pedagogical strategies for effective mentoring | 84% |
| I learned about novice and expert behaviors | 34% |
| I learned about assessing/measuring success of apprentices | 67% |

| Table 9. Practicing effective mentorship | % of GMFs (n=10) Never or Once Per Week (lowest frequency rating) |
|---|---|
| I applied new learning about pedagogical strategies for effective mentoring | 30% |
| I applied new learning about novice and expert behaviors | 50% |
| I applied new learning about assessing/measuring success of apprentices | 50% |

- Table 8 data suggest that the eWorkshop had varying degrees of success with teaching GMFs about critical components of effective mentorship. However, the low frequencies of practice reported for these critical components of effective mentorship (which are strategies effective mentors find necessary on a daily basis), suggest that awareness of these components may not be sufficient for implementation.

The online surveys included items addressing the GMF's perceptions of impact of the program activities and their participation in the program, and subsequent opportunities to suggest ways of improving the program for maximal impact. These findings are summarized in Tables 10 and 11.

| Table 10. Impact of GMF program/participation | % of GMFs (n=10) Agree or Strongly Agree |
|---|---|
| **The GMF workshop prepared me to mentor student apprentices** | 34% |
| **The GMF program provided ongoing support to me as a mentor** | **30%** |
| **The GMF program helped me feel like part of a community of mentors** | **20%** |
| **I developed professionally through my experiences as a Graduate Mentoring Fellow** | **60%** |

- Despite not feeling well supported by the program activities, the experience itself of mentoring an apprentice contributed to the professional development of GMFs.

**Perceived Needs of Mentors**

Table 11 provides major trends and illustrative comments from GMFs' suggestions for programmatic improvements. Embedded in these suggestions are the perceived needs of GMFs.

| Table 11. Suggestions for improvement (n=8) | | |
|---|---|---|
| List of Suggestions | **Freq.** | **Example Response(s)** |
| *Provide objectives to GMFs for students* | ***2*** | • ***"It was not clear from my first correspondence with the GMF program that we were expected to encourage the apprentices to work with Army Research in the future."*** |
| *Fix any technical issues* | ***2*** | • ***"I haven't received any emails which might cover things mentioned in this survey, such as the eWorkshops, discussions with other mentors, and so on."***<br>• ***"I think the powerpoint presentation did not change from first slide during the entire presentation during roundtable. The technical glitch undermined the discussion."*** |
| *Communicate more with GMFs* | ***2*** | • ***"It seemed as though there was a bit of a scramble at the beginning of the summer with the changes in program personnel, and I think this resulted in a lack of communication over the course of the program."*** |

| | | |
|---|---|---|
| *Provide better training or mentoring techniques* | ***2*** | • ***"…it is important to give [the GMFs] specific training and instruction if needed. [Every] GMF should feel comfortable to work with High School or Undergraduate apprentices…"*** |
| *Access to more material* | ***1*** | • ***"If we can have an access to all the database[s] for papers [it] would be good."*** |
| *Hold more eWorkshops* | ***1*** | • ***"More contact in general, maybe more eWorkshops."*** |

- GMFs' comments suggest that the program experienced some challenges in the execution stages of the program that were visible to participants. The GMFs offer insightful recommendations for programmatic improvements that would improve the experience of GMFs (and the apprentices they mentor) and, ultimately, increase the program's effectiveness.

## Overall Satisfaction of GMF Participants

**GMFs recognize critical aspects of mentoring student apprentices in STEM research:**

- "When mentoring student apprentices, it is important to teach technical and non-technical skills necessary to do STEM research, discuss their current academic status and goals, advise them about future opportunities, and guide them toward short-term and long-term progress."
- "I believe it's important as a mentor to help students separate threads of research, and build a coherent plan for progress…Encouragement is necessary, and it's important to keep pointing out what the end goals are, what the contribution will be, and why it all matters."
- "Bolstering enthusiasm…after years of almost painfully rigorous coursework, many have lost their fervor for engineering…Finding ways to get students excited about engineering again results in much improved work quality and more thorough understanding on the students part - after all, the more you love something, the better odds you have to be great at it."

**The program contributed to the development of GMFs as mentors:**

- "It was a challenge for me to tailor the summer experience to the needs of each of the apprentices (one being a high school freshman and the other being a soon-to-graduate physics undergraduate). This challenge made the experience feel more like a genuine mentoring opportunity, and I felt like I learned valuable mentoring skills as a result. I think the apprentices also benefited from a genuine research opportunity, where all aspects of the research process were developed."