Army Educational Outreach Program

Undergraduate Research Apprentice Program

2013 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

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Executive Summary

The Undergraduate Research Apprenticeship Program (URAP), managed by the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for undergraduate 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. URAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced Army-funded 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 US Army Research Office Youth Science programs office.

In 2013, URAP provided outreach to 47 apprentices and their mentors at 29 Army-sponsored university or college laboratory sites (herein called URAP sites).

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

Table 1. 2013 URAP Fast Facts	
Major Participant Group	College Students
Participating Students	47
Participating University Personnel	32[1] (18 Faculty, 14 Graduate Mentoring Fellows)
Participating Universities	29
Total Cost	$209,887
Total Stipends	$163,647
Cost Per Student Participant	$3,440[2]

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

Summary of Findings

The 2013 evaluation of URAP 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 URAP Evaluation Findings	
Participant Profiles	
All evaluation data contribute to the overall narrative of URAP's efforts and impact, and highlight areas for future exploration in programming and evaluation. However, confidence in evaluation findings varies by participant group.	• Statistical reliability calculated for the apprentice questionnaire (margin of error = ±8.0% at 95% confidence level) and alternative methods for establishing representativeness (statistical comparison of apprentice respondents' and participants' demographic information revealed no significant differences) suggest findings from the apprentice questionnaire may be sufficiently generalizable to the apprentice population.
	• Statistical reliability calculated for the mentor questionnaire (margin of error = ±14.5% at 95% confidence level) and lack of available demographic information with which to make alternative determinations suggest mentor respondents may not be representative of the mentor population. Mentors contribute valuable perspective to URAP evaluation and any findings from mentor questionnaires should be cautiously generalized with consideration given to the margin of error and with triangulation of findings with other data.
URAP had difficulty providing outreach to participants from historically underrepresented and underserved populations.	• Apprentice participants included a small proportion of female students (14%)—a population that is historically underrepresented in some STEM fields.
	• 11% of apprentices identified as populations among those historically considered underserved and underrepresented in STEM education; Black or African American (3%), Hispanic or Latino (8%), and American Indian or Alaskan Native (0%).
	• Mentors identified as predominantly male (73%), White or Caucasian (50%), or Asian or Other Pacific Islander 38%). Of the 26 mentor respondents, 0% identified as Black or African American, 0% as American Indian or Alaskan Native, and 4% as Hispanic or Latino.
URAP serves the Nation's future STEM workforce.	• Most URAP apprentices (94%) planned to pursue a degree in a STEM field (14% Bachelors, 29% Master's, 57% Doctorate).
	• Most URAP apprentices intended to pursue STEM careers. Most frequently, apprentices reported currently working on an engineering degree (39%) and having similar intentions to pursue an engineering career (43%). Physical science was the second most frequently listed career field (17%). Apprentices also intended to pursue careers in math or computer science (14%), medicine or health (11%), environmental science (3%), chemistry (3%), social science (3%), or another STEM field (3%).
Actionable Program Evaluation	
Marketing and recruitment of URAP apprentices and mentors depends almost entirely on the universities or colleges that host URAP	• ARO successfully marketed and recruited URAP mentors from university or college laboratories that conduct Army-sponsored research. Subsequently, university or college researchers marketed and recruited URAP apprentices using university or college channels.
	• Apprentices learned about URAP through university personnel, advertisements, classes, or other acquaintances associated with URAP site. Many apprentices had previous associations with their mentor prior to working as a URAP apprentice. Only 10% of URAP apprentices found out about the program through their own searches.
	• Most mentors reported recruiting apprentices within the university or college context. Some mentors had a previous association with the apprentice prior to URAP through a course or previous research.

	• Although many apprentices and mentors had previous associations prior to URAP, most mentors selected apprentices from the AEOP applicant pool. This pattern of responses suggests that apprentices are first recruited within universities and colleges and subsequently directed to the AEOP application as a formality.
URAP apprentices desired opportunities to engage in authentic research experiences and advance their STEM pathways.	• Apprentices were motivated to participate in URAP because the program offered opportunities to experience research in a lab setting and to advance their STEM pathways: experiencing research first hand, developing academically, building applications or resumes, and gaining new knowledge in their desired field of study.
URAP mentors sought an opportunity to outreach to STEM learners or develop professionally.	• Most mentors participated in URAP to satisfy their desire to mentor students and/or perform community service that benefitted youth. Less often, mentors mentioned that URAP offered them the opportunity to develop their mentorship or supervisory skills and abilities. A few mentors used URAP to expand their research laboratories with extra funding for undergraduate apprenticeships.
URAP mentors used team-based and one-on-one approaches to engage apprentices in STEM research activities but supported their educational and career pathways to a lesser extent.	• Apprentice and mentor questionnaire respondents reported similar frequencies of mentor activities related to engaging apprentices in hands-on STEM research and academic and career advising. Apprentices and mentors also generally agreed that mentorship focused more on productively engaging in STEM research and less on educational and career pathways.
	• Approximately the same proportions of mentors used team-based approaches as used one-on-one approaches to engage apprentices in STEM research activities. Data also suggests that mentors focus more on engaging and training apprentices about STEM research than on supporting educational and career pathways.
URAP mentors lacked awareness of or directives to promote AEOP opportunities and STEM careers during the program.	• Most mentor interviewees had limited awareness of AEOP initiatives and did not receive or perceive any direction from ARO to educate apprentices about AEOP. Subsequently, mentors did not consistently educate their apprentices about AEOPs or encourage apprentices to participate in them.
	• Mentors suggested that informational resources provided to mentors or apprentices, mentor training, and clear expectations for promoting other AEOPs were necessary to accomplish this objective.
	• Mentors reported using a variety of strategies for mentoring apprentices about STEM careers, some with an implied emphasis on Army/DoD STEM careers. In other words, most mentors believe that the experience itself educated apprentices about STEM research and working within Army-funded laboratories.
	• Mentors cited a lack of necessary knowledge about Army/DoD STEM careers and that the duration of the program was too short to facilitate career mentorship. Suggestions for improving included the provision of information resources for distribution to apprentices and facilitation of visits or tours to Army/DoD research laboratories.
URAP benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that URAP benefits apprentices by providing authentic research opportunities not typically available in school settings, opportunities to expand their STEM competencies and confidence, opportunities to advance their STEM pathway, and access to effective mentorship in a civilian Army research setting.
	• Mentors also perceived benefits to their own professional development, an opportunity to engage in community service, and an opportunity to expand the impact of their research laboratory through funded apprenticeships.

URAP funding is not transparent and the 8-week duration presents challenges to apprentices and mentors.	• Some mentors had a difficult time tracking funding coming from ARO to their university and felt that funding is not sufficient for the time commitment involved for apprentices and mentors.
	• Mentors suggested that URAP's 8-week duration is too short, making it difficult to meet apprentice expectations while trying to complete research project in a compressed time period.
Outcomes Evaluation	
URAP engaged apprentices in authentic STEM activities more frequently than their undergraduate courses.	• Apprentices reported that URAP provided more frequent opportunities to engage in authentic STEM activities as compared to their undergraduate courses, including academic research activities (24%-68% in URAP, 12%-39% in classes) and hands-on research activities (32%-63% in URAP, 9%-32% it classes). Small to large, significant differences were found between in-URAP and in-school engagement for 9 of 12 STEM activities.
	• Apprentice and mentor data suggested URAP had a slightly larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
URAP apprentices became more confident in STEM, and mentors rated their research and reporting skills highly.	• A majority of apprentices (63%-80%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (66%-79%) 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 (77-90%) also rated all 6 components of their apprentices' final research project or presentation as near expert or expert level.
URAP apprentices believe that serving as STEM mentor is an implicit part of STEM careers.	• Apprentice interviewees were interested in mentoring students in the future because it is an important part of the career of a STEM researcher. Others cited positive impacts that mentors have played in their STEM pursuits which motivates them to pursue opportunities to mentor other students in the future.
URAP apprentices were unaware of the many AEOP initiatives, but showed interest in future AEOP opportunities.	• Many apprentices (58-97%) and mentors (48-64%) were unaware of other AEOP initiatives.
	• URAP apprentices are interested in participating in other AEOP opportunities: college apprenticeships (21%), college scholarship programs (21%), and graduate fellowships (27%) offered by AEOP or DoD. This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
URAP improved and sustained apprentices' positive attitudes toward the defense community but does not systematically impact their interest or intent to pursue STEM or Army/DoD STEM careers.	• Apprentices and mentors disagree about the extent to which apprentices were given opportunities to learn about new STEM careers (apprentice=24%, mentor=46%) and Army/DoD STEM careers (apprentice=21%, mentor=31%).
	• URAP had limited success inspiring interest in new STEM careers (15%) or in Army/DoD STEM careers (24%). Data suggest that URAP apprentices enter URAP with well-established career intentions that do not change over the course of the program. However, 74% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society, suggesting that URAP sustained any existing interest in Army/DoD civilian careers.
	• Most apprentices (66%) credited URAP with improving their understanding Army/DoD STEM contributions. Most mentors (69%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Coordinated efforts should be made by the Army, ARO, and selected URAP PIs to encourage and improve apprentice and mentor participation in evaluation efforts. Low response rates to evaluation assessments, especially for programs that reach small populations, pose the most significant threat to the validity of findings from those assessments. Furthermore, low response rates prevent reliable comparisons of data year to year. While evaluators can assess representativeness of samples through alternative means, accurate demographic data must be available for the population in order to accomplish these determinations. With respect to the outcomes evaluation, mentors' assessment of apprentice performance are important for triangulating apprentices' perceptions of growing confidence in their STEM competencies. Future evaluation will continue to rely on mentors to provide an authoritative, albeit subjective, assessment of apprentices' performance and *growth* in apprentices' STEM competencies. Mentor-reported awareness of and efforts to promote AEOP and Army STEM are important for understanding related apprentice outcomes and identifying site-level programming needs (e.g., resources and/or training for mentors). Evaluators will endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments; however, evaluators necessarily rely on assistance from Army, ARO, and selected URAP PIs to promote a culture of evaluation among URAP apprentices and mentors.

2. AEOP objectives include expanding participation of historically underrepresented and underserved populations. In URAP, 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. As a result, the ability of URAP to recruit underserved or underrepresented populations of students depends upon the diversity of the universities or colleges in which recruitment takes place. Indications are that many URAP apprentices are informally selected by mentors and subsequently sent to the AEOP application site as a mere formality. Guidance ensuring 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 Army and ARO may need to consider practical solutions to the challenge posed by URAP locations, as the student population of some universities and colleges is likely to advantage some groups of students more than others.

3. Apprentice and mentor data suggested that URAP 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. At the undergraduate level, students are more capable of and should have frequent opportunities to make conceptual contributions to their research: generate research questions, design experiments, analyze and interpret data, formulate conclusions, and contribute to technical writing about the research in which they are engaged. ARO should encourage mentors to use strategies that productively engage apprentices in these critical aspects of work, ensuring that apprentices are more than simply laboratory assistants. 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 and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encouraging continued participation (even as a mentor or volunteer) in programs which are available. Evaluation data suggests that URAP apprentices and mentors were largely unaware of other AEOP initiatives and that URAP served 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 URAP 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 URAP with an idea of their next steps in AEOP and/or the capability to serve as an AEOP ambassador.

5. Depending upon the university or college site and/or mentor for which they worked, apprentices had varying opportunities to learn about STEM research and careers during URAP, 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. In an effort to standardize the information provided to apprentices we strongly recommend a URAP- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public, web-based, resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[3]

[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 Undergraduate Research Apprentice Program (URAP). URAP 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 Undergraduate Research Apprentice Program (URAP), managed by the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for undergraduate 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. URAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced Army-funded 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, URAP was guided by the following priorities:

1. Provide hands-on science and engineering research experience to undergraduates in science or engineering majors;
2. Educate students about the Army's interest and investment in science and engineering research and the associated educational and career opportunities available to students through the Army and the Department of Defense;
3. Provide participants with experience in developing and presenting scientific research;
4. Provide participants with experience to develop an independent research program in preparation for research fellowships;
5. Develop students' research skills with the intent of preparing them for graduate school and careers in science and engineering research; and
6. Benefit from the expertise of a scientist or engineer as a mentor.

Apprenticeships were completed at 29 Army-funded university and college research laboratories in 17 U.S states and 1 U.S. Territory (Puerto Rico), summarized in Table 3.

Table 3. 2013 URAP Sites

University/College	City	State	University/College	City	State
Arizona State University	Glendale	AZ	University of California - Los Angeles	Los Angeles	CA
Auburn University	Auburn	AL	University of California - Santa Barbara	Santa Barbara	CA
City College of New York	New York	NY	University of California - Riverside	Riverside	CA
Colorado School of Mines	Golden	CO	University of Central Florida	Orlando	FL
Georgia State University	Atlanta	GA	University of Chicago	Chicago	IL
Harvard University	Cambridge	MA	University of Illinois – Urbana-Champaign	Urbana	IL
Indiana University	Bloomington	IN	University of Massachusetts Amherst	Amherst	MA
Marshall University	Huntington	WV	University of Michigan	Ann Arbor	MI
Mississippi State University	Starkville	MS	University of Missouri	Columbia	MO
Oakland University	Rochester	MI	University of Puerto Rico - Mayaguez	Mayaguez	PR
Polytechnic University of New York	New York	NY	University of Rochester	Rochester	NY
Princeton University	Princeton	NJ	University of South Florida	Tampa	FL
State University of New York - Buffalo	Buffalo	NY	University of Southern Mississippi	Hattiesburg	MS
Tennessee State University	Nashville	TN	University of Texas at Austin	Austin	TX
University of California - Berkeley	Berkeley	CA	**Total Universities**	**29**	

In 2013, URAP provided outreach to approximately 47 apprentices and their mentors at 29 university and college research laboratory sites (herein called URAP sites).

The total cost of 2013 URAP was approximately $209,887. Funding was provided by ARO via Director discretionary funds matching program manager funds. The average cost per 2013 URAP participant taken across all HSAP sites was $3,440 Table 4 summarizes these expenditures.

Table 4. 2013 URAP Costs	
2013 URAP - Cost Per Participant	
Total Participants (Apprentices + Graduate Mentoring Fellows)	61
Total Cost	$209,887
Cost Per Participant	**$3,440**
2013 URAP - Cost Breakdown	
Administrative Cost to ARO	$46,240
Participant Stipends	$163,647
Total Program Cost	**$209,887**

Evidence Based Program Change

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

1. Continue to streamline the application, proposal, and review process for URAP apprenticeships;
2. Provide online training to designated graduate student mentors (herein called Graduate Mentoring Fellows, GMF), 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 3 URAP sites;
2. Phone interviews conducted with apprentices and mentors at 10 URAP sites;
3. Enhanced Actionable Program Evaluation, including apprentice and mentor perceptions of:
    - Marketing and recruitment to the URAP program;
    - Motivation to participate in URAP;
    - Satisfaction with URAP activities;
    - Benefits of URAP; and
    - Suggestions for improvement to URAP.
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, including:
    - Perceptions of and learning from eWorkshop offerings; and
    - Use of eWorkshop material during mentorship of URAP apprentices.

2013 Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • ARO providing oversight of site programming • Operations conducted by 30 Army-funded university/ college labs • 47 students participating in URAP apprenticeships • 42 university/college S&Es and GMFs serving as URAP mentors • Apprenticeship funds administered to university/college research labs to support student participation • Centralized branding and comprehensive marketing • Centralized evaluation	• Students engage in authentic STEM research experiences through hands-on summer apprenticeships at Army-funded university/college labs • University/college S&Es supervise and mentor students' research	• Number and diversity of student participants engaged in URAP • Number and diversity of university/college S&Es engaged in URAP • Students, university/college S&Es, and ARO contributing to evaluation	• Increased student STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased student interest in future STEM engagement • Increased student awareness of and interest in other AEOP opportunities • Increased student awareness of and interest in STEM research and careers • Increased student awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve URAP programs	• Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of URAP

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

Key Evaluation Questions

- What aspects of URAP motivate participation?
- What aspects of URAP structure and processes are working well?
- What aspects of URAP could be improved?
- Did participation in URAP:
  - 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 URAP included onsite focus groups with apprentices and mentors at 3 URAP sites in the Northeast U.S., phone interviews with apprentices or mentors at 10 additional sites in the West, Southeast, Midwest and Northeast, U.S., a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubrics. Additionally, Graduate Mentoring Fellows completed a 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 URAP Apprentice Assessments

Category	Description
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education and Career Intentions: Intended degree, field, and confidence to achieve education goals; Confidence to achieve career goals
Satisfaction & Suggestions	Awareness of URAP, motivating factors for participation, satisfaction with and suggestions for improving URAP programs
AEOP Goal 1 Indicators of Program Achievement	**STEM Competencies:** Perceptions of opportunities to engage in STEM activities in URAP (as compared to in college courses and labs), self-reported change in confidence in their STEM competencies
	STEM Engagement: Interest in working as STEM mentors in the future
	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 URAP Mentor Assessments

Category	Description
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of URAP, motivating factors for participation, satisfaction with and suggestions for improving URAP programs, benefits to participants
AEOP Goal 1 Indicators of Program Achievement	**STEM Competencies:** Mentors' assessment of apprentices' STEM competencies after URAP 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

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data is summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and/or footnotes providing results from tests for significance.[4] Questionnaires and respective data summaries are provided in Appendix B (apprentice) and Appendix C (mentor). Focus group protocols are provided in Appendices D (apprentices) and E (mentors). Major trends in data and analyses are reported herein.

Study Sample

The post-URAP questionnaires were provided to ARO who distributed them to 2013 URAP sites in electronic format using the Qualtrics® survey system hosted by Virginia Tech. A total of 36 apprentices from 28 URAP sites responded to the apprentice questionnaire. In addition, 22 mentors from 20 URAP sites responded to the mentor questionnaire and rubrics.

Table 7 provides an analysis of apprentice and mentor participation in post-URAP 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 errors calculated for apprentices (±8.0%) and mentors (±14.5%) exceed acceptable levels and suggest limited representativeness of the respondent samples to the respective participant populations. However, a comparison of apprentice questionnaire respondents with apprentice participant demographics (obtained from ARO's registration data) shows no statistically significant differences on the key demographic factor of gender. In addition, apprentice questionnaire respondents represent 97% of the 30 URAP sites. Statistical reliabilities and alternative methods for establishing representativeness suggest findings from the apprentice questionnaire respondents may be sufficiently generalizable to the apprentice population. Similar demographic information is not available for the mentor participant population with which to make alternative determination of representativeness. Mentors contribute valuable perspective to URAP evaluation but should be cautiously generalized, with consideration given to the margin of error and to triangulation of findings with other data. Participation of apprentices and mentors are critical for establishing reliable evaluation and is a critical area for attention in future URAP programming.

Table 7. 2013 URAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[5]
Apprentices	36	47	77%	±8.0%
Mentors	22	42	52%	±14.5%

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

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

Focus groups were conducted at 3 URAP sites in the Northeast, U.S. Mentor focus groups included 6 HSAP and URAP mentors (1 female, 5 male). HSAP and URAP mentors were interviewed together (as they often worked with both HSAP and URAP apprentices simultaneously), but herein they will be referred to as URAP mentors. Apprentice focus groups included 5 apprentices (2 female, 3 male). Phone interviews were conducted with apprentices and mentors at ten additional sites in the West, Southeast, Midwest, and Northeast, U.S. Apprentice phone interviews included 8 apprentices (4 female, 4 male). Mentor Phone interviews included 7 mentors (3 female, 4 male) and 2 were Graduate Mentoring Fellows (GMFs). Focus groups and interviews are not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of questionnaire data. However, purposive sampling was successful at producing a sample representing nearly half of sites, all populations (apprentices, Graduate Mentoring Fellows, and university faculty mentors), and a range of demographic categories. All data collected contribute to the overall narrative of URAP'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 URAP apprentice questionnaire respondents are summarized in Table 8.

Table 8. 2012 and 2013 URAP Apprentice Questionnaire Respondent Demographics

Demographic Category	2012 (n = 16/69)	2013 (n = 29-36/45)	
Gender			
Female	38%	5	14%
Male	63%	31	86%
Choose not to report	0%	0	0%
Race/Ethnicity			
American Indian or Alaskan Native	6%	0	0%
Asian or Other Pacific Islander[6]	19%	5	14%
Black or African American	13%	1	3%
Hispanic or Latino	0%	3	8%
White or Caucasian	63%	26	72%
Other	0%	1	3%
Choose not to report	0%	0	0%
Age			
Average Age	21.69 years	21.66 years	
Age Range	18-30 years	18-31 years	
Year of Study			
1st year undergrad		1	3%
2nd year undergrad		7	19%
3rd year undergrad		6	17%
4th year undergrad		11	31%
5th year undergrad		6	17%
Other (specify)		5	14%

Note. Other = "7", "1st year grad.", "2nd year undergrad from transferring", "Finished", "recently graduated".

In 2012 and 2013, high proportions of apprentice questionnaire respondents were male, and, the proportion of male respondents is higher in 2013 than in 2012 (2012 = 63%, 2013 = 86%). In 2012 and 2013, similar proportions of respondents identified themselves with the race/ethnicity category of White or Caucasian (2012 = 63%, 2013 = 72%) and Asian or other Pacific Islander (2012 = 19%, 2013 = 14%). In 2012, 6% of responding apprentices identified themselves American Indian or Alaskan Native, 13% as Black or African American, and 0% as Hispanic or Latino. In 2013, 0% of respondents identified themselves as American Indian or Alaskan Native, 3% as Black or African American, and 8% as Hispanic or Latino. The average age of apprentices was similar in 2012 and 2013 (2012 = 21.69 years, 2013 = 21.66 years). The majority of URAP

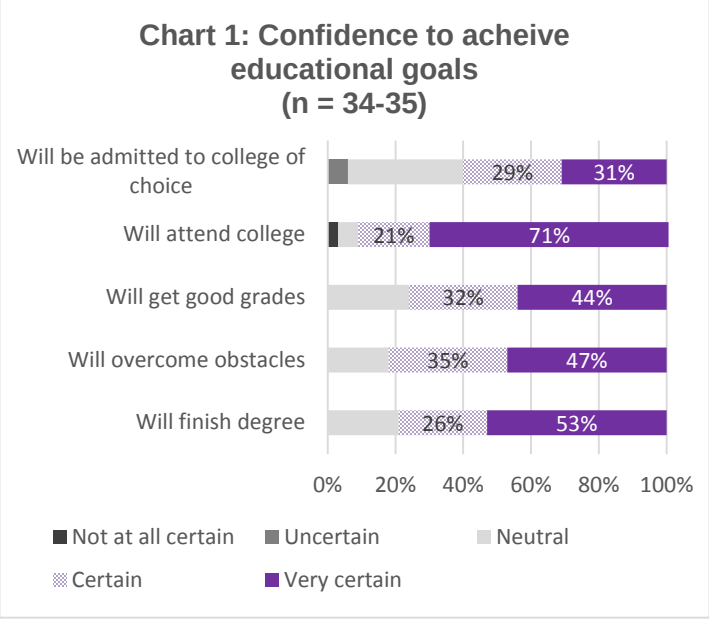
[6] The 2012 demographic category consisted of Asian-Pacific American, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations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

apprentices are advanced undergraduate students (3rd year or older), just graduated, or will be entering graduate school in the fall (78%).

One objective of all AEOPs is to involve a larger percentage of students from previously underrepresented and underserved segments of our population, such as women, American Indians, African Americans, and Hispanics, in pursuing science and engineering careers through participation in Army-sponsored programs. Comparison of 2012 and 2013 evaluation and registration data (obtained from ARO) suggests that URAP engaged a smaller proportion of female students—a population that is historically underrepresented in certain STEM field—than male students year to year. The same data suggests that URAP had limited success providing outreach to students from historically underserved minority race/ethnicity groups in 2012 and limiting success expanding that outreach in 2013 (19% of total sample in 2012, 11% of the total sample in 2013). While these findings are not conclusive (2012 evaluation data do not provide a reliable representation of the entire URAP population with a margin of error at 95% = ±23.6%), outreach to specific underrepresented and underserved populations of students remains an area of potential growth for URAP.

Apprentice education and career intentions. The apprentice questionnaire included items to elicit apprentices' education goals (highest degree sought, field of study), their confidence to achieve these goals, and career aspirations (STEM, Army/DoD STEM, field of career). 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 – 3 summarize these data.

All (100% of 35) URAP apprentices who responded to the item intended to pursue a college degree, with most apprentices (94%) planning to pursue a degree in a STEM field. Most apprentices intended to pursue an advanced degree (29% Master's, 57% Doctorate). Of the 6% intending to pursue non-STEM degrees, all 6% intended to pursue a doctoral degree outside of STEM.

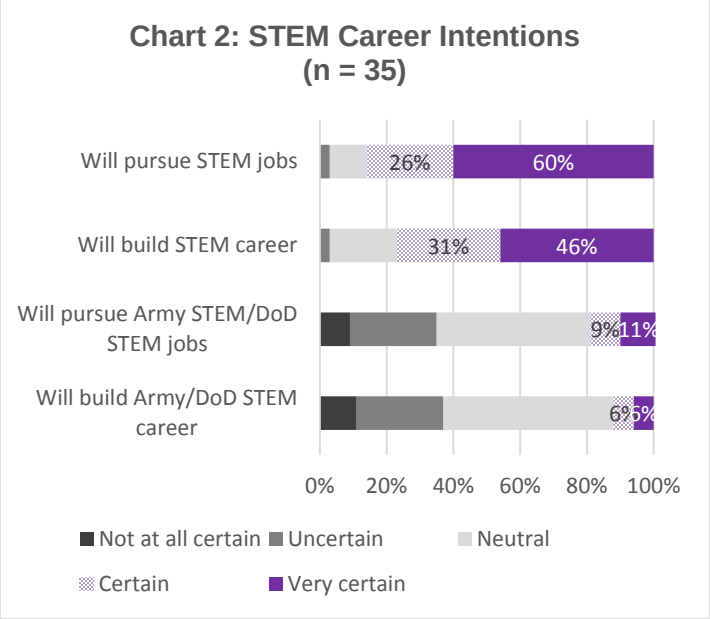


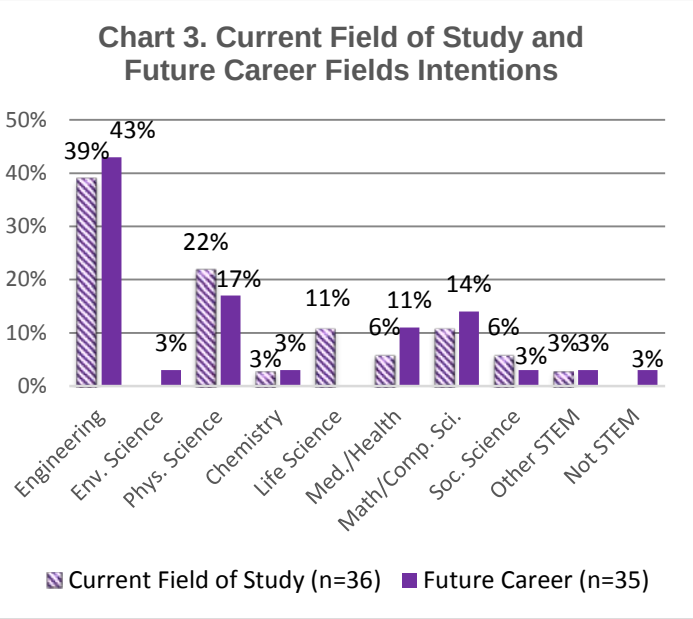
More than 60% of apprentices claimed to be certain or very certain they will achieve educational goals, as summarized in Chart 1. Apprentices were most certain (92%) that they will attend college to pursue their educational goal. Students were least certain (60%) they will be admitted to the college and their program of choice.

As illustrated by Chart 2 (next page), most URAP apprentices intended to pursue jobs in STEM (86%) or build STEM careers (77%). Significantly fewer apprentices intended to pursue

jobs or build careers with the Army/DoD (20% and 11%, respectively). Significance testing suggests the difference between apprentices' intent to pursue STEM jobs and careers and to pursue them with the Army/DoD is very large[7].

Chart 3 provides a visual comparison of apprentices' current field of study and their intended career field. Apprentices most frequently reported intent to engage in engineering (43%), physical science (17%), or math/computer science (14%) careers. There were no statistically significant differences in apprentices' current field of study and their intended future career fields.





These particular items pertaining to apprentices' educational and career intentions do not discern whether URAP apprentices' education and career goals are established prior to participation, or to what extent their participation in any way affects their pre-URAP goals. However, from these figures and other findings within this report, we can surmise that most URAP apprentices have well-established education and career goals for their STEM pathway and seek out URAP to advance in their STEM pathway. URAP clearly provides outreach to the Nation's future STEM workforce and, as demonstrated in the Outcomes Evaluation section, positively impacts many apprentices' attitudes toward Army/DoD STEM research.

Past AEOP experiences. Apprentices were asked about their past experiences in URAP and other AEOP programs. Only one (3%) respondent reported working as a URAP in the past and an additional 6 (18%) reported working in other college internships in the past such as CQL. Only one apprentice (3%) reported that they worked in a high school internship program such as REAP or SEAP. Similarly small proportions of URAP apprentices reported participating in other AEOP programs in the past; JSS (3%), JSHS (3%), UNITE (3%), West Point Bridge Design Contest (6%), or eCYBERMISSION (3%). Finally, 9% of URAP apprentice reported participating in the SMART scholarship program while none reported engaging in

[7] $p < 0.05$ with paired samples t-test (two tailed); STEM jobs vs. Army/DoD STEM jobs: Mean Diff = 2.029, t = 7.26, p = .000, d = 1.227, very strong effect; STEM career vs. Army/DoD STEM career: Mean Diff = 2.086, t = 7.17, p = .000, d = 1.212, very strong effect

the NDSEG fellowship program. Generally, data indicate that very few URAP participants have been active in AEOP programming prior to their current apprenticeship. As such, URAP may reach unique populations of students and serve as an entry-point into AEOP programming, rather than re-engaging HSAP apprentices and other AEOP alumni as the next step in a pipeline.

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

In 2013, URAP mentors were predominantly male (73%) and either White/Caucasian (50%) or Asian or Other Pacific Islander (38%). The 26 mentor questionnaire respondents have mentored 3 apprentices on average, ranging from 1 (the current apprentice) to 6 apprentices in total. Of the 26 mentors, 35% reported working as a URAP apprentice in the past. Given that most mentors are either returning URAP mentors or have worked as an apprentice in the past, data suggests that URAP relies on repeated engagement with the program as a primary mechanism for recruiting university or college personnel to serve as mentors.

Table 9. 2013 URAP Mentor Questionnaire Respondent Demographics

Demographic Category	2013 (n = 26/46)	
Gender		
Female	7	27%
Male	19	73%
Choose not to report	0	0%
Race/Ethnicity		
American Indian or Alaskan Native	0	0%
Asian or Other Pacific Islander[8]	10	38%
Black or African American	0	0%
Hispanic or Latino	1	4%
White or Caucasian	13	50%
Other	2	8%
Choose not to report	0	0%
Past Participation		
Worked as an URAP apprentice	9	35%
HSAP/URAP apprentices mentored historically	Avg. = 3, Range = 1-6	

As URAP, serving as part of the AEOP portfolio of programs, endeavors to expand participation of students from underserved and underrepresented populations, it may be beneficial to contemplate how to effectively expand inclusion of those same populations in its mentor participant pool. In pertinent research, having access to mentors that share the

[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.

same gender or race/ethnicity characteristics has been identified as a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.[9]

Mentor research. Mentors were asked to describe their field of research with the same broad fields provided in the apprentice questionnaire. The full data are provided in Appendix C.

All but three of the nine STEM-related disciplines listed were represented, those three being environmental science, medicine/health, and social science. Mentors most frequently reported conducting research in chemistry (38%), engineering (27%), and physical science (23%). The most frequently reported mentor field of research—chemistry—is not consistent with the field of study and career interest reported most frequently by apprentices. The inconsistencies could be due to any one or combination of reasons, including, low mentor participation in evaluation, apprentice intent to seek non-STEM professional degrees and careers (e.g., in medicine/health sciences, social science, or other non-STEM), or mismatches in interests of apprentices and mentors.

[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.

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

Marketing and Recruiting Underserved Populations

The URAP manager, ARO, conducts two relatively independent marketing and recruitment efforts. First, distribution of email and print advertising to Army-funded university and college research laboratories nationwide are intended to reach ARO-funded personnel who then submit proposals requesting funds for URAP apprenticeships. Second, for students, URAP is 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. URAP's marketing and advertising campaigns target the very specific population of Army-funded university and college researchers. 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 URAP, including any personal connections that led them to URAP (or to a specific site or mentor), any past experience participating in URAP or other AEOPs, and how they were recruited to URAP. Their responses revealed a variety of ways in which they became aware of and involved in URAP, which help identify how URAP ultimately attracts apprentices. In focus groups, interviews, and in questionnaires mentors were asked why they chose to participate in URAP this year, to explain how they became connected with their apprentice, and to describe the recruiting process that they employed to attract apprentices. This helps us to understand how mentors became involved in URAP and how apprentices are ultimately recruited and/or selected at the site level.

Most apprentice interviewees and respondents learned about URAP through university personnel, advertisements, classes, or other acquaintances associated with the URAP site. Many apprentices were encouraged by their mentor, selected by their mentor, or already having a working relationship with their mentor prior to application. Others heard about URAP in their classes (e.g., professor announcement or email) or reported that they heard about the program because they were already working at the URAP site. Only 10% of URAP apprentices found out about the program using

independent means (e.g., search for summer internships) and 12% contacted the mentor directly to inquire about research opportunities. Generally, apprentices became aware of the program because they are affiliated with URAP host sites which expose them to highly localized marketing of the program. Additionally, most apprentices had an existing relationship with their mentor prior to the URAP apprenticeship.

Fourteen mentor respondents and interviewees spoke about recruiting apprentices for URAP apprenticeships. Most of who reported recruiting participants within classes or by advertising at the university or local level. Others had students recommended to them by colleagues. The majority of mentor respondents reported that they selected apprentices from the AEOP applicant pool while others selected apprentices through a previous association with the student or selected a student that had contacted them directly about the apprenticeship. The apparently conflicting information – that most mentors selected apprentices from the AEOP applicant pool but that apprentices and mentors reported previous associations with one another prior to program participation – makes it is unclear how recruitment, application, and selection processes occurred in 2013. Given the pattern of results described above, evaluators suspect that most apprentices are recruited and selected by mentors and subsequently directed to the AEOP application pool as a formality. What is clear from mentor and apprentice accounts contained herein is that apprentice recruitment and selection occurs at the site-level.

Twelve mentor interviewees spoke about their own recruitment to participate in URAP: 67% became involved after receiving site-communications directly from ARO, 25% were encouraged to participate by a colleague or advisor, and 8% heard about URAP through university advertisements or communications. Although most mentors heard about URAP after direct contact from ARO, it is clear that that they would not receive any communications about URAP if not for their affiliation with a university or college that conducts Army-sponsored research. Similar to recruitment of apprentices, URAP sites are the critical avenue through which mentors became aware the URAP program. Therefore, URAP's ability to reach populations of potential apprentices and mentors from historically underserved or underrepresented populations depends upon the breadth of outreach that university or college sites employ.

Motivating Factors for Participation

Focus groups and phone interviews elicited apprentices' and mentors' motivation to participate in URAP. The following trends emerged from their responses.

Motivating factors for apprentices. The majority of apprentice interviewees were motivated by opportunities to experience research in a lab setting (e.g., working in a biology lab) and by opportunities to develop academically (enhancing graduate school application, opportunity to publish, etc.). In a similar theme, some apprentices were motivated by the prospect of more in-depth knowledge in their field of study. Other apprentices were motivated simply by the prospect of summer work at the university or college that they attend. Generally, apprentices anticipated that URAP would help them progress in their intended STEM pathways, including: experiencing research first hand, academic development, building applications or resumes, and gaining new knowledge in their field of study. Only one apprentice (3%) respondent reported past participation in the URAP program motivated participation this year.

Motivating factors for mentors. Mentors also expressed a variety of factors that motivated their participation. Most often, mentors became involved in URAP because it satisfied an internal desire to mentor students and/or perform community service that benefited youth. Other mentors reported that URAP offered them an opportunity to develop in a professional capacity as a teacher, mentor, or lab director. Some mentors found that URAP expanded funding for their research programs in the form of funded apprentices. Less often, mentors mentioned that a colleague in their university or college encouraged them to participate.

In sum, qualitative data suggests that apprentices were exposed to URAP because they attend a university or college URAP site. After learning of the program, apprentices are most often motivated to participate because URAP offers unique educational experiences, and opportunities to enhance their academic credentials. Mentors are typically motivated to pursue URAP through their own ambitions to outreach to undergraduate students. Additionally, mentors are motivated by the opportunity to develop professionally and expand their research laboratories with extra funding for undergraduate personnel, or by colleagues who encourage them to begin mentoring URAP apprentices.

Mentor Capacity

URAP's fifth and sixth priorities are to develop students' research skills with the intent of preparing them for graduate school and careers in science and engineering and benefit from the expertise of a scientist or engineer as a mentor. The nature and quality of mentoring provided is a critical factor to maximizing students' participation in these opportunities and sustaining or inspiring their interest in future STEM work. Understanding mentor activities from the perspectives of apprentices and mentors can inform programmatic improvement for sustaining apprentices' interest and participation in STEM.

All of the apprentice and mentor assessments included a number of closed-scale and open-ended items addressing mentor activities. The next section summarizes some of these data, including apprentice and mentor perceptions of general mentor activities and apprentice and mentor perceptions of academic and professional advising activities.

General mentor activities. Mentor and apprentice questionnaires included five items to elicit perceptions of general mentor activities related to productively engaging apprentices in STEM research. Eight additional items addressed mentor activities related to supporting apprentices' educational and career pathways. For all items, mentors and apprentices responded on a 6-point scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree." Charts 4 and 5 summarize 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.

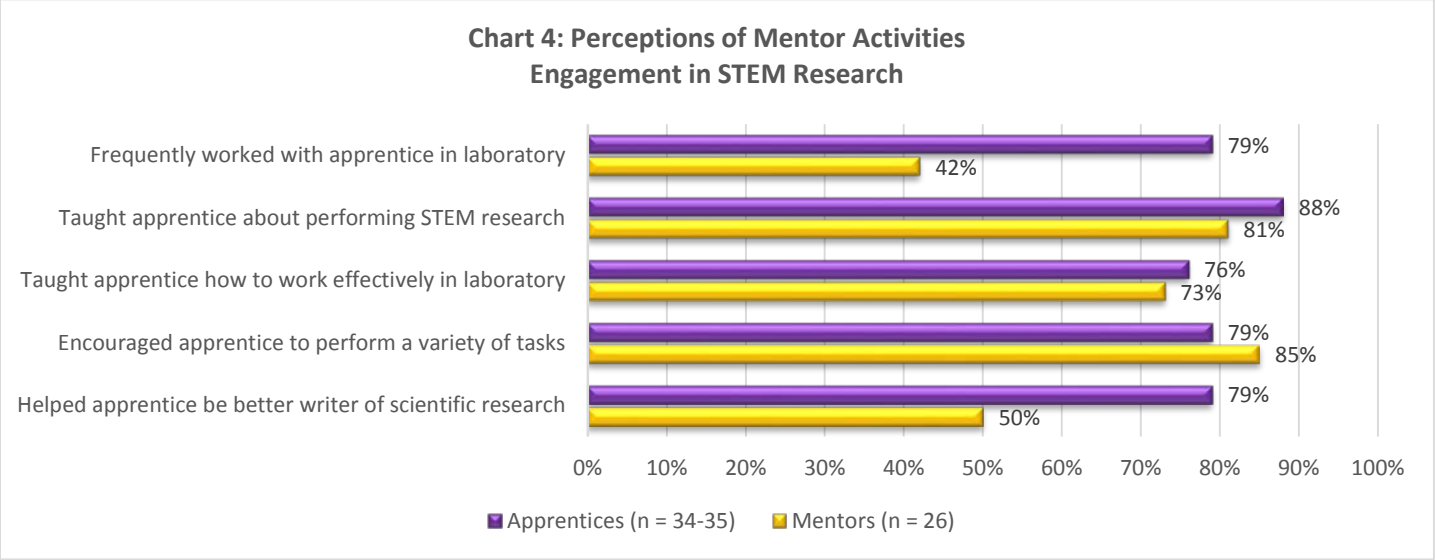
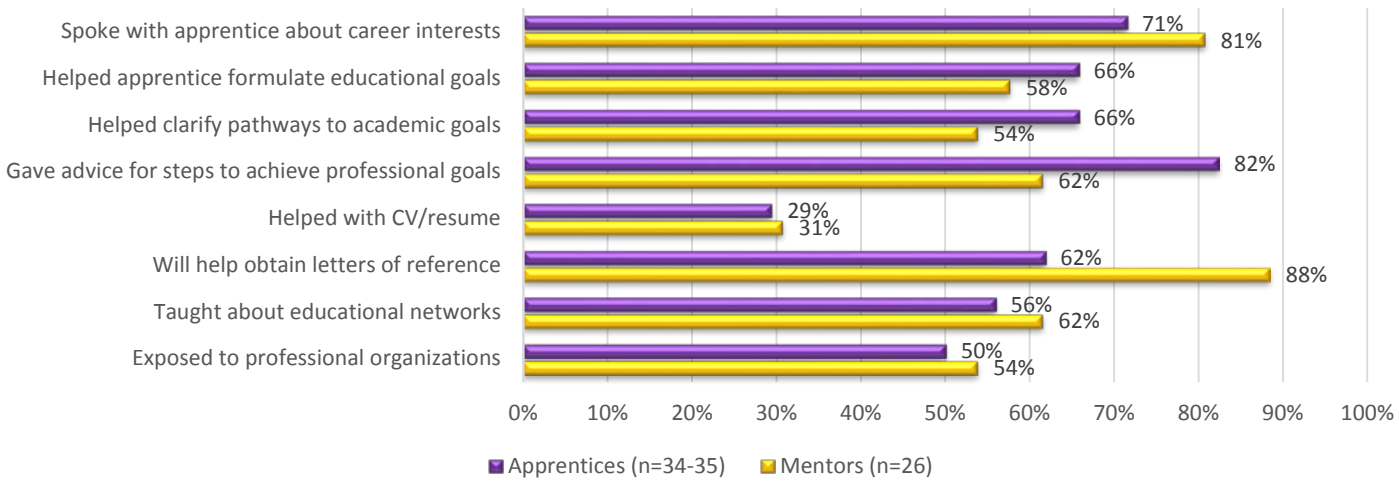


Chart 4 illustrates that the majority of apprentices (76%-88%) and mentors (42%-85%) reported that each of these basic mentor activities relating to engagement in STEM research occurred. Only a small proportion of apprentices (0%-3%) and mentors (0%-15%) strongly disagreed or disagreed that any of these mentor activities occurred. One statistically significant difference was detected in apprentice and mentor perceptions: apprentices had significantly stronger perceptions than mentors that they frequently worked with their mentors in the laboratory, an effect that is moderate in magnitude.[10] Apprentice interviewees, who frequently described working with more than one researcher in the lab, may have answered this question in relation to all lab personnel that they work with. As a result, apprentices' responses would yield stronger perceptions of working frequently in the lab with any of several mentors whereas mentors answered the question in reference to the frequency of their own work with a single apprentice in the lab.

From Chart 5, the majority of apprentices (50%-82%) and mentors (54%-88%) reported experiencing or engaging in mentor activities related to supporting apprentices' educational and career pathways. The lone exception is the extent to which mentors helped apprentices with their CV or resume where 38% of apprentices and 39% of mentors strongly disagreed or disagreed that they experienced or engaged in that specific mentor activity. Statistical comparisons confirm that mentors and apprentices perceive experiencing or engaging in educational and career pathway mentorship similarly. For only one activity, writing or helping obtain letters of reference, mentors reported significantly higher levels of engagement than apprentices.[11] It is likely that mentors responded to this item in reference to their intentions to help apprentices obtain letters of reference in the future while apprentices simply did not engage in that activity during their apprenticeship experience. However, apprentices generally perceive less support for their educational and career pathways (Avg. 60% agreement) than support for productively engaging in STEM research (Avg. 80% agreement).

[10] $p < 0.05$ with independent samples t-test (two tailed); apprentices vs. mentors: Mean Diff = .66, $p = .04$, $d = .592$, moderate effect.
[11] $p < 0.05$ with independent samples t-test (two tailed); apprentices vs. mentors: Mean Diff = .726, $p = .012$, $d = .634$, moderate effect

Chart 5: Perceptions of Mentor Activities Supporting Educational and Career Pathways



When asked in focus group to describe the mentoring received or provided in a typical day, apprentice and mentor interviewees most frequently described efforts to engage apprentices in the research, including:

- Regular meetings, training, introduction to research projects, and explanations of research project;
- Answering research questions and providing feedback; and,
- Regular presentations by the apprentices to mentors about the work done.

Roughly equal numbers of apprentices and mentors spoke about working closely together during research as those who spoke about apprentices working with many different researchers in the lab simultaneously. One apprentice spoke to the mentor about educational pathways. Another apprentice said that the mentor was not on the appropriate mailing list (from ARO) and as a result the mentor did know to speak to the apprentice about future education or career aspirations.

Generally, URAP mentors used many mechanisms to engage in research mentorship with their apprentices. Equal numbers of mentors used a team-based approach to engaging their apprentices in STEM research and supporting their educational and career pathways as those who did so in a one-on-one basis. Data suggest that URAP mentors are more focused on engaging and training apprentices about the research to be accomplished (whether they use a team of researchers or not) while less focus is given to supporting apprentices' educational and career pathways. Improved reliability of mentor data and matched mentee-mentor data could be used to test this explanation in future evaluations.

Mentoring about AEOP opportunities. The mentor questionnaires asked about strategies used, challenges faced, and ways in which URAP could support mentors in educating apprentices about AEOP opportunities. Most mentors (n = 14-17/26) responded to these questionnaire items. Mentors reported discussing AEOP programming with apprentices during the program, providing information to apprentices about the SMART scholarship or NDSEG fellowship program, directing apprentices to the AEOP website, and passing out AEOP brochures to apprentices. Some mentors reported they were not familiar with other AEOP programs. Half of mentor interviewees reported passing out AEOP brochures to their apprentices

during the program; however, the remaining half of interviewees reported that they did not engage in any mentorship about AEOP programs, even when AEOP brochures were available. Mentors generally cited a lack of awareness of AEOPs, lack of resources and knowledge of existing expectations to educate apprentices about AEOPs, and a lack of time in the program to approach AEOP mentorship as the primary challenges that prevented them from addressing this objective.

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

- more and better resources about AEOP initiatives for mentors to pass to apprentices;
- improved communication from ARO to mentors about the expectation and deadlines for delivering AEOP information to apprentices;
- information that can be provided directly to apprentices by ARO via electronic media or videos; and
- information that apprentices can pass along to peers after completion of the URAP program.

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

Mentoring about Army/DoD STEM careers. In questionnaires, interviews, and focus groups mentors were asked about strategies used, challenges faced, and ways in which URAP could better support mentors in educating apprentices about STEM and specifically Army/DoD STEM careers. Mentor respondents and interviewees used different strategies in mentoring students about STEM careers, including: discussions about various STEM and Army/DoD STEM careers, relying on the hands-on training or experiences within the apprenticeship to expose apprentices to STEM careers, encouraging apprentices to publish within the STEM field that they want to pursue, and encouraging apprentices to learn more about STEM career options. One mentor took the apprentice to a DoD research laboratory in an effort to educate him about possible careers. Three mentors reported that they did not discuss STEM or Army/DoD STEM careers with their apprentice.

Mentors cited a few challenges in educating apprentices about STEM and Army/DoD STEM careers, including: mentors are unfamiliar with aspects of Army/DoD STEM careers, mentors were not provided with information to pass along to mentors about STEM or Army/DoD STEM careers, and the duration of the program is too short to engage in career mentorship.

In questionnaires, interviews, and focus groups the most frequent recommendation was made for URAP to provide mentors with informational resources about Army/DoD STEM for distribution to apprentices. Other recommendations provided by mentor respondents and interviewees include: connecting with URAP alumni who are in Army/DoD STEM careers and using them to distribute the message across the program; facilitating tours of Army/DoD facilities to enhance exposure; providing workshops or webinars for apprentices and delivering Army/DoD STEM information, and; online training for mentors to highlight the information that ARO would like them to pass to apprentices.

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: a single 45-minute eWorkshop provided GMFs with information about AEOP programs and strategies for effective mentoring. Evaluators attended the eWorkshop.

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 URAP 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 URAP

Assessments elicited apprentice and mentor perceptions of URAP, including perceived value of URAP, contributions to educational and professional pursuits (apprentices only), successes and challenges of the URAP experience (mentors only), overall satisfaction with program activities, and areas for improvement.

Value of URAP. Apprentice and mentor interviewees were asked what they perceive as the value of the URAP program. The apprentice questionnaire also asked what they perceived as the most valuable part of the research project or final presentation.

Apprentices described a range of benefits to them, including:

- Authentic, real-world research experiences within a professional research setting and unlike typical school experiences;
- Expanding STEM competencies and confidence;
- Opportunities to explore and advance their STEM pathways; and
- Access to effective mentorship in STEM.

Mentor interviewees most frequently described the ways in which URAP benefitted participants. Mentors reported that this program:

- Engages apprentices in authentic research experiences and opportunities to develop hands-on and academic research skills in a professional laboratory setting, which are not possible in school;
- Helps apprentices clarify, advance, and increases motivation for them to pursue their STEM pathway;
- Improved apprentices' confidence in research skills and abilities; and
- Provides exposure to civilian Army research.

Evaluators also elicited URAP's value in terms of its benefit to mentors or to their laboratories. Mentors reported that URAP provides mentors with:

- Opportunities to develop professionally (e.g., Learning mentorship through experience and taking a leadership role in a laboratory setting);
- Opportunities to contribute to their community in a significant way; and
- Opportunities to expand the impact of mentors' research lab.

Contributions to educational and professional pursuits. The apprentice questionnaire asked apprentices to describe the ways in which URAP contributed to their educational or professional pursuits. The major trends in their responses are provided below, listed from the most to the least cited responses. A summary of narrow themes and example responses from the questionnaire related to each broad theme is provided in Appendix B.

- Developing and expanding a range of both hands-on and academic knowledge, skills, and abilities needed to conduct, think about, and communicate about authentic STEM research;
- Exploring, clarifying, or advancing apprentices STEM pathway;
- Providing important and meaningful funding opportunities for summer research; and
- Enhancing confidence to pursue future STEM endeavors.

Successes and challenges of URAP. The questionnaire asked mentors to report successes and challenges they or their apprentices experienced during URAP. Of the 15 respondents, 100% reported that the URAP program was successful in some way. Specific successes include:

- Mentors perceived that the apprentice had a positive experience,
- Mentors perceived that the apprentice developed as a researcher,
- Mentors report that apprentices' will be co-authoring published manuscripts as a result of their apprenticeship, and
- Mentor perceived that they developed or expanded their own mentor skills and abilities through the program.

A few mentors described challenges that they faced. Three mentors found that URAP is a significant time commitment, two of who also claimed that funding was either insufficient or hard to track down from ARO to the university. One mentor considered an 8-week duration too short and reported difficulty matching student expectations with the reality a short research experience.

Overall satisfaction and areas for improvement. Apprentices and mentors were asked several items to gauge their overall satisfaction with URAP. These items also provided opportunity for participants to voice concerns and identify areas for improvement. Table 10 summarizes these items.

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 URAP, what would you say?
Apprentice and Mentor Phone Interviews	Would you recommend participating in the program as an apprentice/mentor to others? If so, why? If not, why not?
Apprentice Questionnaire	Given the opportunity, would you participate in URAP again? Why or why not?

Mentor interviewees wanted to share with Army decision makers that URAP is an excellent program that benefits apprentices, mentors, laboratories, and the nation. Mentors also wanted to reinforce that URAP prepares apprentices for their future and helps mentors develop professionally. In addition to the benefits already listed by mentors as the value of URAP (see above section), mentors reported that:

- Apprentices grow during URAP through exposure to STEM topics, exposure to STEM careers, and through experience working directly with mentors;
- Mentors develop as role models for young STEM learners;
- Apprentices make significant contributions to the work of the laboratory;
- The program changes that have been enacted are well-received; and
- URAP is important for the nation and national security in the future.

Mentors also shared some recommendations for improving URAPs impact, including:

- Increasing program funding to expand URAP;
- Coordinating a conference for apprentices at the end of the program to share research, and providing longer-term mechanisms for establishing a URAP community (e.g., news board for scholarships and Army job openings); and
- Increasing the visibility of the program.

Apprentice interviewees and respondents nearly unanimously spoke highly of their URAP experience or the URAP program, most of which have already been explained in the value of URAP section above. Apprentices would share a breadth of benefits that URAP has on participants and society with Army decision makers. Many apprentices felt that URAP, and programs like it, are needed to train the future STEM workforce and that it is good for the nation as a whole. Others suggested that additional students could benefit from URAP if the program was expanded, and that underserved minorities are especially in need of opportunities like URAP. One apprentice found that URAP is a higher-quality experience in comparison to other internships programs that they have participated in. In addition, apprentices spoke about areas for potential improvement, all of which were focused in increasing the capacity of URAP to reach more students by improving outreach, and/or improving the visibility of the URAP program.

Outcomes Evaluation

The evaluation of URAP 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 URAP; apprentices' and mentors' post-URAP 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 students' 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 URAP priorities 1, 3, and 5: Provide hands-on science and engineering research experience to undergraduates in science or engineering majors; Provide participants with experience in developing and presenting scientific research; and Develop students' research skills with the intent of preparing them for graduate school and careers in science and engineering.

Engagement in authentic STEM activities. Twelve items measured apprentices' perceptions of opportunities to engage in STEM activities in URAP as compared to in school. Six of the items included minds-on or academic research activities, such synthesizing and evaluating information. Six of the items included hands-on research activities, such as using equipment and procedures. Apprentices responded on a 6-point frequency scale of 1 = "Never," 2 = Once per week," 3 = "2-3 times per week," 4 = 4-5 times per week," 5 = "Every day," and 6 = "Multiple times per day". Mentors responded to a similar battery of 9 items using the same response scale. Additionally, apprentice focus groups asked what URAP provides to students that they cannot get from studying in their classes.

Charts 6 and 7 on the next page summarize the proportions of apprentices who reported engaging in each activity 4-5 or more times per week or more in URAP and at school, in their undergraduate or graduate STEM lecture and laboratory courses. More detailed data summaries are provided in Appendix B. A statistical comparison of the frequency with which students reported engaging in STEM activities in URAP and at school, is provided in Table 11.

As illustrated in Charts 6 and 7, the proportion of apprentices who reported engaging in these activities 4-5 or more times per week during URAP (24-68%) is larger than those who reported engaging in these activities 4-5 or more times per week in their undergraduate classes (9-39%). In URAP, apprentices most frequently reported working on a project team (68%), using advanced science or engineering equipment (63%), safely handling equipment and materials (60%), and using advanced measurement techniques (57%). On average, students engaged in minds-on and hands-on activities more than

2-3 per week in URAP (Avg.~3.44/6.0) and less than 2-3 times per week in their undergraduate classes and labs (Avg.~2.49/6.0).

Chart 6: Apprentice Perceptions of Academic Research Activities (4-5 times or more per week)

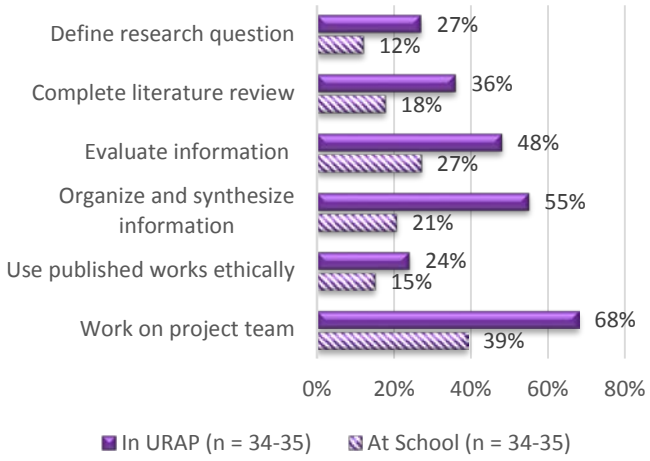


Chart 7: Apprentice Perceptions of Hands-on Research Activities (4-5 times or more per week)

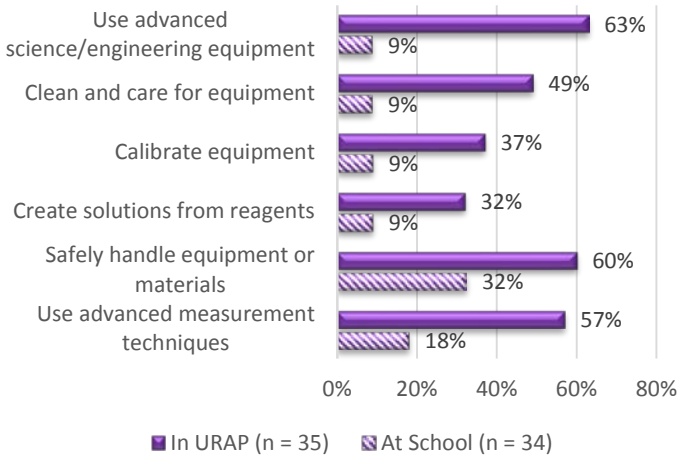


Table 11 reveals that observed differences between URAP and school apprentice engagement in three minds-on and all hands-on activities are statistically significant ($p < .05$). The magnitude of significant differences range from small ($d = .356$) to large ($d = .948$). For example, the difference in critically evaluating information from academic sources is significant but relatively small ($d = .356$) while the difference in using advanced science or engineering equipment in URAP versus in undergraduate class or lab is large ($d = .948$).

Apprentice interviewees most frequently reported that URAP offered more opportunities to engage in authentic research experiences than regular classes (e.g., exploratory research, learning from doing, and working in unique research contexts). While only one student mentioned that URAP offers minds-on opportunities that are unavailable in regular classes (specifically, the opportunity to contribute meaningfully to the body of scientific knowledge) statistical comparisons in Table 11, evidence suggests that URAP had a large effect in providing apprentices with enhanced opportunities to engage a variety of hands-on research activities and a smaller effect on specific academic (minds-on) research activities over undergraduate classes. Additionally, the magnitude of observed differences between URAP and undergraduate classes was generally larger for hands-on activities than for academic research activities. [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

Table 11. Engagement in STEM Activities, Matched Cases Comparison At school vs. In URAP							
Item	**At school Avg. (SD)**	**In URAP Avg. (SD)**	**n**	**Mean Diff.**	***t***	***p***	***d***
I had to define a research question or thesis and determine its critical concepts	2.06 (1.35)	2.94 (1.41)	34	**.882***	3.36	.002	.576
I had to use academic search strategies (e.g., databases and journals) to complete a literature review	2.71 (1.62)	3.26 (1.52)	34	**.559**	1.68	.103	.288
I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	2.88 (1.65)	3.56 (1.37)	34	**.676***	2.07	.046	.356
I had to organize and synthesize information across academic sources	2.88 (1.55)	3.50 (1.44)	34	**.618**	1.76	.088	.302
I had to determine appropriate ethical and legal uses of published academic research for my own work	2.29 (1.45)	2.50 (1.42)	34	**.206**	0.76	.451	.131
I had to work as part of a team on research projects	2.97 (1.59)	4.15 (1.67)	34	**1.176***	3.30	.002	.565
I used advanced science or engineering equipment	2.35 (1.18)	4.09 (1.99)	34	**1.735***	5.53	.000	.948
I cleaned and cared for the equipment in a science or engineering laboratory	2.21 (1.25)	3.50 (2.05)	34	**1.294***	3.33	.002	.572
I calibrated laboratory equipment for experimentation	2.12 (1.09)	2.97 (1.85)	34	**.853***	2.36	.024	.405
I created solutions from reagents in preparation for experimental procedures	1.91 (1.11)	2.65 (2.01)	34	**.735***	2.03	.050	.349
I used proper safety procedures when handling equipment and material in the lab	2.94 (1.63)	3.88 (2.11)	34	**.941***	3.19	.003	.546
I employed advanced measurement techniques in science or engineering procedures	2.47 (1.38)	3.79 (2.06)	34	**1.324***	3.58	.001	.614

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

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 URAP program. In addition, six rubrics in the URAP mentor

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.

questionnaire leveraged mentors' expertise as researchers and observations of apprentices during the program to provide expert ratings of apprentices' academic and hands-on research skills and abilities. The STEM skills and abilities assessed by 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 I am more confident in my ability to perform equipment calibration and perform complex laboratory techniques	**Laboratory skills/abilities:** Uses, adjusts and/or calibrates equipment skillfully and innovatively. Safety and equipment care is impeccable. Could teach equipment skills to other students if needed. **Data Collection Techniques:** Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques.
I am more confident that I can analyze data and understand the results of an experiment I am more confident that I can identify and account for limitations and assumptions when formulating conclusions	**Quantitative literacy skills/abilities:** Expertly converts and interprets quantitative information into an accurate set of results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation.

Apprentices responded to items on a 6-point scale of 1 = "Not at all like me" to 6 = "Just like me" while mentor rubrics defined a developmental 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 mentor rubrics are provided in Appendix C. For ease of visualizing mentor rubric responses here, we assigned a more condensed scale across for rubrics of 1 = "Novice," 2 = "Near novice," 3-4 = "Developing expertise/supervision needed", 5 = "Near expert," 6 = "Expert." Additionally, 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 8 and 9 summarize apprentices' and mentors' responses to the STEM Competency items.

From Chart 8, the majority of apprentices (63%-80%) perceived growth in their confidence across the range of skills and abilities. Larger proportions of apprentices' perceived gains in their confidence to contribute to a research team (80%), to

analyze data and understand results (77%), to safely and effectively use the laboratory (71%), to perform literature reviews (71%).

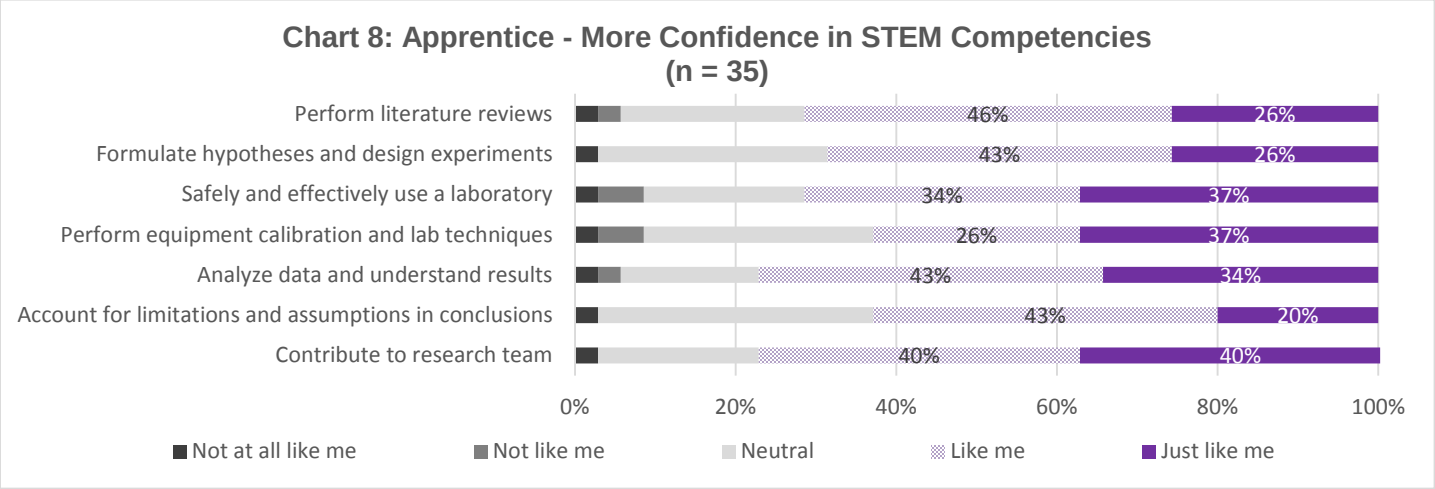
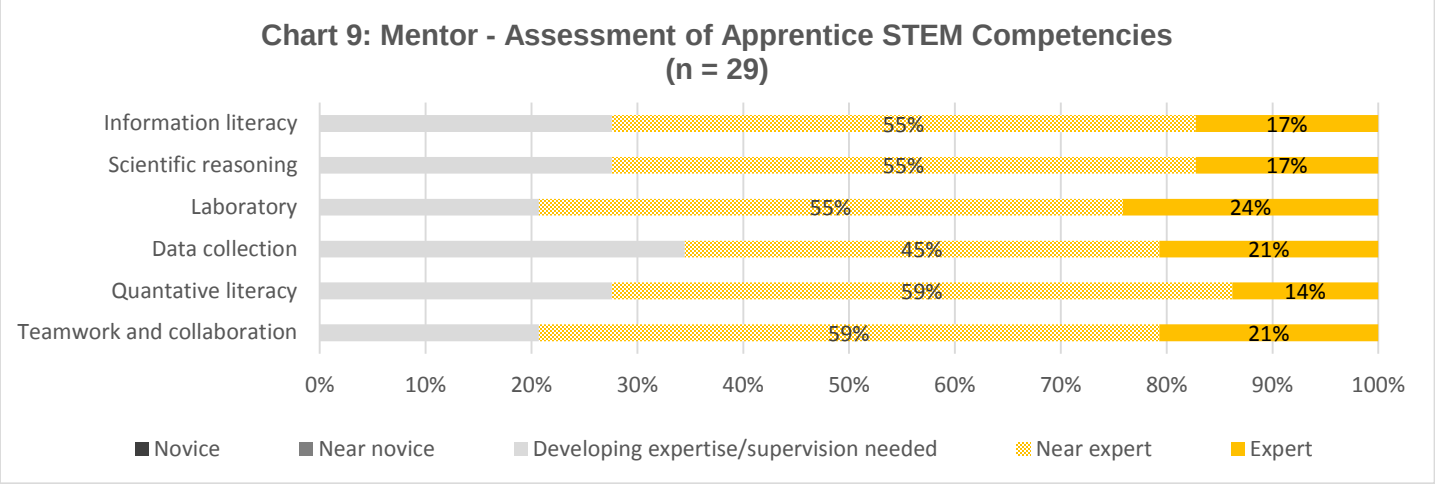


Chart 9 shows that the majority of mentors rated their apprentice's skills and abilities in the near expert or expert levels of the development continuum for all skills and abilities (66%-79%). Mentors gave higher proportions of near expert and expert ratings for apprentices' teamwork and collaboration (79%) and laboratory (79%) skills and abilities. Average ratings approached near expert across all skills and abilities (4.86-5.03/6.0).



There is considerable agreement between perceptions of apprentice growth in confidence and mentor assessment of STEM skills and abilities. For example, using the alignment of apprentice and mentor items provided in Table 13, we observe that the highest and the lowest rated items by each participant group align (those associated with teamwork and collaboration and advanced data collection techniques, respectively). Taken together, we would conclude that students perceived growth in their STEM skills, and mentors' assessment of their performance corroborates those perceptions. Apprentices' perceived growth and mentor rubric ratings are also consistent with what we might expect given the frequency with which students reported conducting hands-on activities during URAP in the previous section. For example,

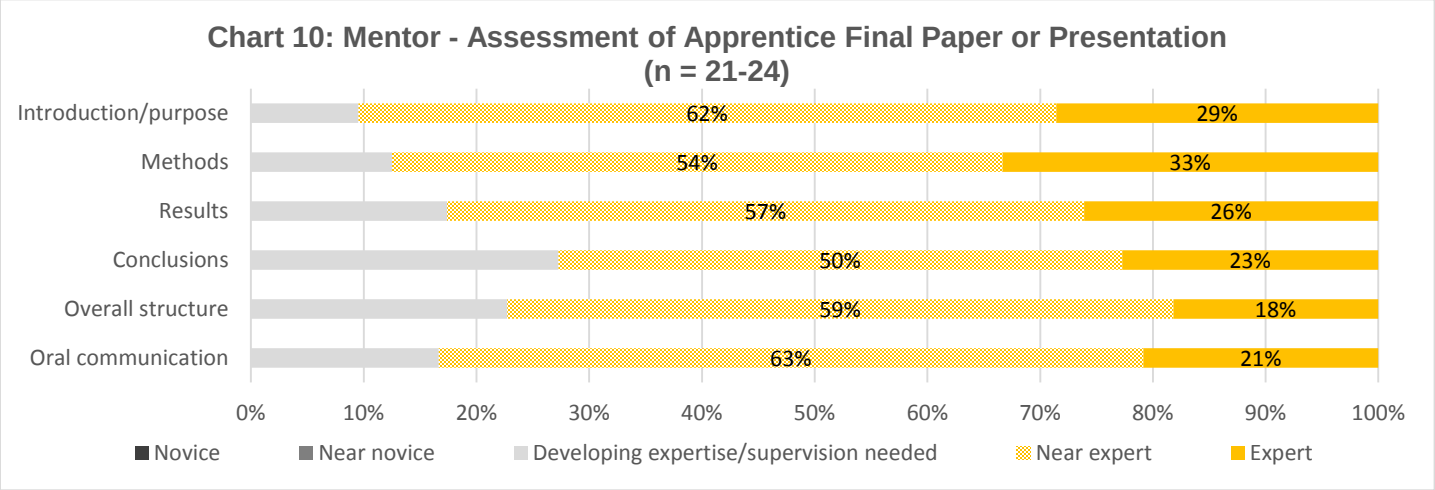
teamwork and collaboration occurred most frequently according to apprentices; subsequently, it was perceived as the largest growth area according to apprentices and the highest performance area according to mentors.

Final paper or presentation. Additionally, six rubrics were given to mentors to rate the quality of their apprentice's final research paper or presentation. Each rubric represents one of six dimensions of typical STEM research papers or presentations. Much like the aforementioned mentor rubrics, each rubric defined a developmental 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 10 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.

Chart 10 shows that these mentors rated all six components of their apprentices' final research project very highly, with 77%-90% providing near expert or expert ratings for each component. The average apprentice received a rating exceeding near expert (5.0/6.0) for all components of their research program (Avg. 4.95-5.21/6.0). These data suggest that most URAP apprentices not only conduct research, but are also capable of producing high level research papers and presentations within the university or college laboratories where they worked.



Future STEM Engagement

The ideology of exposing students to different real-world applications and careers employing STEM early in a students' academic career is rooted in the belief that exposing students might unearth hidden curiosity and passion that students never knew existed. Separate studies from University of Indiana[13] and University of Virginia[14] found that exposure to STEM as adolescents piqued immediate interest in near-term STEM-related pursuits and had a significant effect on future pursuit of STEM degrees and careers, respectively. Not only does URAP aim to provide research experiences and develop students' research skills, they aim to prepare them for graduate school and careers in science and engineering research. In their future science and engineering research careers current apprentices may, themselves, serve as mentors for young STEM researchers.

In focus groups, apprentice interviewees were asked if they are interested in becoming a mentor one day. Five apprentices responded to this question, four of who (80%) responded in the affirmative and one (20%) reported that they were open to the experience. Most respondents were interested in mentoring students in the future because it is an important part of the career of a STEM researcher. Other apprentices have already taken the role of mentor for younger students and that they would like to continue to do so. One apprentice was inspired to mentor students because of the positive influence that mentors had on their life. Another felt that mentorship is a good way to expose new people to STEM

> *"That is what Ph.D.'s do. I want to be teaching people how to be doing this stuff."*
>
> *"You can do two things in STEM; do great work or inspire great minds."*

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

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

research which is good for the apprentice and the researcher. Keeping in mind that only five apprentices responded to this item, evidence suggests that apprentices associate mentorship with STEM research careers. Additionally, apprentices are motivated to pursue mentorship through the positive influence that their mentors have had on their lives and by the prospect of positively impacting new people by performing as a mentor themselves.

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 the 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

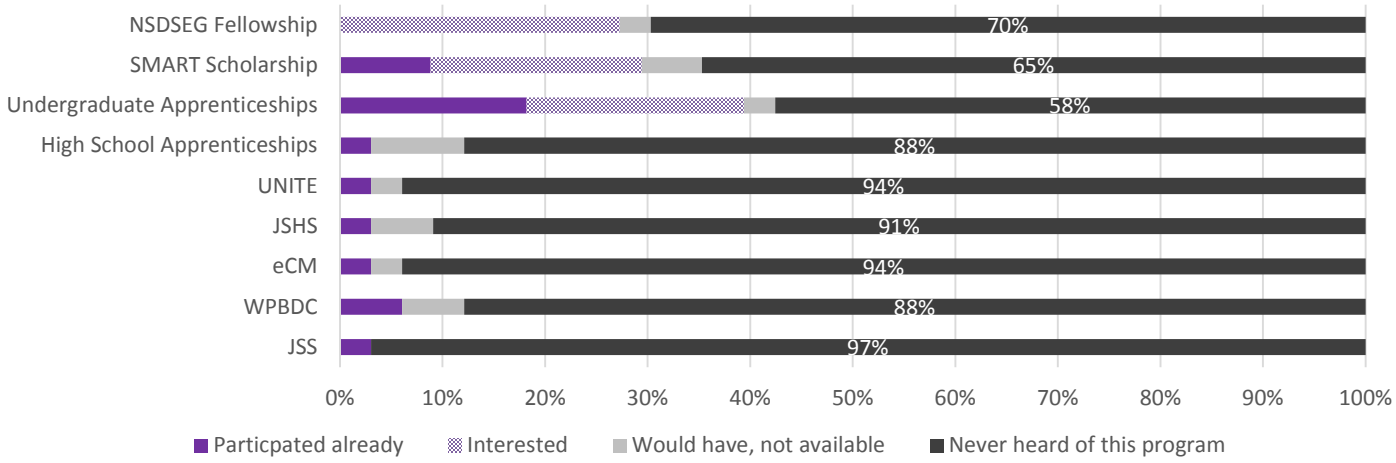
- Junior Solar Sprint (JSS)
- Gains in Mathematics and Science Education (GEMS)
- West Point Bridge Design Competition (WPBDC)
- eCYBERMISSION (eCM)
- High School Apprenticeship Program (HSAP)
- Research and Engineering Apprenticeship Program (REAP)
- Science and Engineering Apprentices Program (SEAP)
- 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 questionnaire 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 URAP's priority to educate students about the Army's interest and investment in science and engineering research and the associated educational and career opportunities available to students through the Army and the Department of Defense.

AEOP Opportunities. Apprentice questionnaires simultaneously elicited past participation in, awareness of, and interest in other AEOP opportunities outside of URAP. Item choices included "Participated already," "Want to Participate," "Would have participated but not available in my area," and "Have never heard about this program". These data are reported together in Chart 11 on the next page.

According to these items, small proportions (0%-18%) of apprentices have participated in AEOPs outside of URAP. Small proportions of apprentices (21% - 27%) expressed interest in participating in programs that they may still qualify for (i.e., college internships with CQL and REAP, SMART, and NDSEG). The most ubiquitous finding is that at the time of questionnaire administration (near or after the conclusion of URAP apprenticeships), the majority of apprentices (58%-97%) have never heard about AEOP programs outside of URAP. Apprentice interviewees corroborate these findings; no interviewees reported participated in other AEOP programs. Of nine apprentice phone interviewees, four reported receiving no information about the AEOP, four others reported receiving the AEOP brochure but cannot name any AEOP programs. The only program named spontaneously by interviewees was the SMART scholarship program.

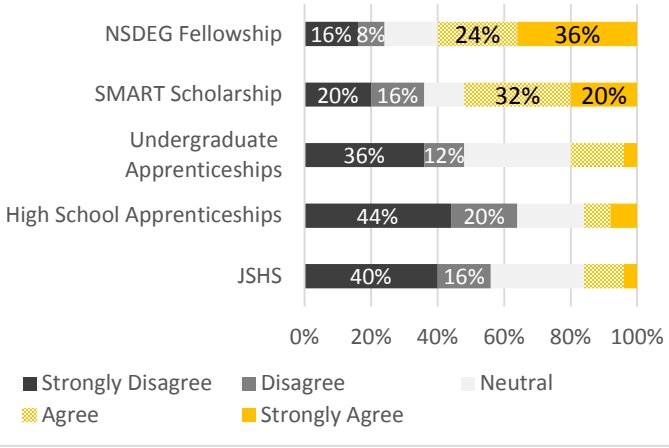
Chart 11: Apprentice - AEOP past participation, awareness, and future interest (n=33-34)



Mentors were asked to report their level of awareness of AEOP and DoD opportunities to assess the extent to which mentors are prepared to inform apprentices and younger students about future STEM engagement through the AEOP. Items asked mentors to respond on a scale of 1 = "Strongly Disagree" (reflecting lack of awareness) to 6 = "Strongly Agree" (reflecting awareness) and are reported in Chart 14.

From Chart 12, many mentors (48-64%) were unaware of various AEOP undergraduate apprenticeships, high school apprenticeships, and JSHS. The majority of mentors were aware of the SMART scholarship and NDSEG fellowship opportunities. When asked whether they provided information to their apprentices about AEOP and DoD

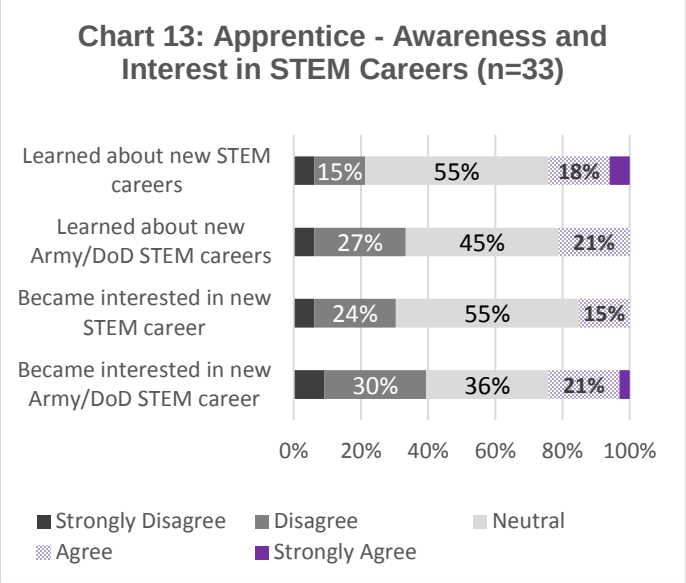
Chart 12: Mentor - AEOP Awareness (n=25)

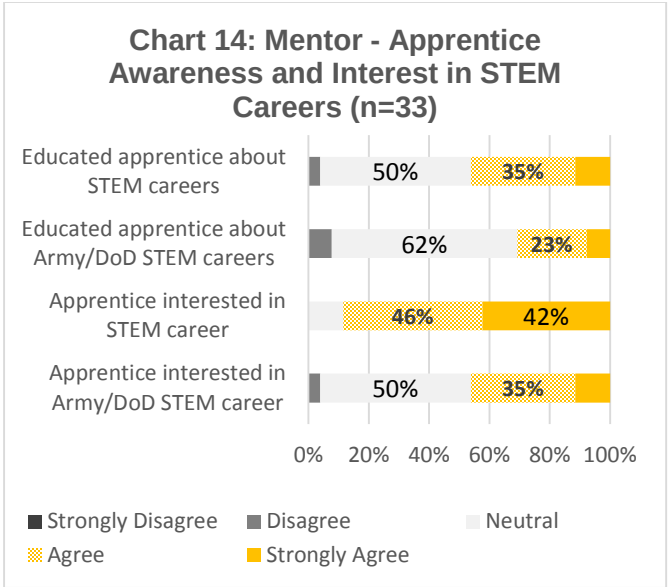


educational programs, only 20% of mentors answered affirmatively with “agree” or “strongly agree” (Appendix C).

In summary, these data suggest that URAP mentors have limited knowledge and limited success in educating apprentices about AEOP programming, even programming that apprentices may qualify for directly after URAP. Specifically, the majority of mentors reported that they are aware of NDSEG and SMART yet the majority of apprentices reported that they are unaware of these opportunities. This pattern of responses suggests that mentors are generally not engaging in discussions with apprentices about AEOP or DoD educational opportunities. Given that 21-27% of apprentices reported interest in NDSEG and SMART, apprentice interest could be leveraged for targeted cross-promotion of programs by URAP mentors.

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





Charts 13 and 14 and Table 14 all illustrate that mentors and apprentices perceived education/learning about STEM and Army/DoD STEM careers in a significantly different manner. Apprentices did not generally perceived high or low levels of learning or interest in new STEM or Army/DoD STEM careers, as a result, large proportions of apprentices endorsed the neutral category for these items (36% - 55%). In contrast, and summarized in Table 14, mentors held significantly higher perceptions of educating apprentices about STEM careers, Army/DoD STEM careers, apprentice interest in STEM careers, and apprentice interest in Army/DoD STEM careers, the magnitude of these differences are moderate to very large.

Table 14. Engagement in STEM Activities, Matched Cases Comparison At school vs. In URAP								
Item	**Mentor**	**n**	**Apprentice**	**n**	**Mean Diff.**	***t***	***p***	***d***
Apprentice was educated about/learned about new STEM careers	4.42 (0.94)	26	3.64 (1.30)	33	**.787***	2.60	.012	.686
Apprentice was educated about/learned about new Army/DoD STEM careers	4.00 (1.06)	26	3.21 (1.24)	33	**.788***	2.58	.013	.690
Apprentice expressed interest/was interested in new STEM careers	5.27 (0.78)	26	3.21 (1.17)	33	**2.057***	8.10	.000	2.06
Apprentice expressed interest/was interested in new Army/DoD STEM careers	4.35 (1.02)	26	3.18 (1.40)	33	**1.164***	3.69	.000	.954

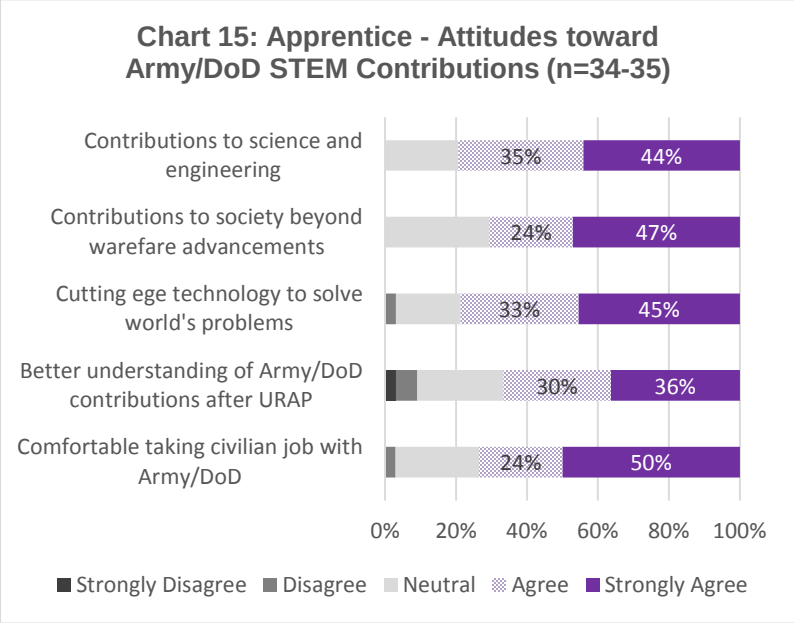
Two explanations of mentor and apprentice divergence are plausible. First, given that most URAP apprentices are advanced undergraduate students (61% are 4th year or greater, Appendix B) it is likely that many have already established or chosen their desired career path. As such, apprentices may be less likely to attend to their mentors' attempts to educate them about STEM or Army/DoD STEM careers and or to consider alternative STEM or Army/DoD STEM careers. Mentor interviewees corroborate this phenomenon: mentors reported that many URAP apprentices did not need education about STEM or Army/DoD STEM careers because they had already set their career path. Apprentice patterns of responses to other questionnaire items also corroborate this finding: 14 of 35 (40%) apprentices responded to a questionnaire item asking them the three new STEM jobs/careers that they learned about and found the most interesting. In contrast, 35 of 35 (100%) apprentices responded to an item asking them which field of study that they want to build their career around. Clearly, apprentices already have established career paths in mind and that they are not very interested in new careers.

Second, it is likely that URAP does not have any systematic, program wide, approach for educating apprentices or attempting to increase their interest in STEM or Army/DoD STEM careers. The result is that the extent to which mentors attempt to educate their apprentices about STEM or Army/DoD STEM careers varies substantially from site to site. Further, mentors' employ idiosyncratic strategies when they attempt to educate apprentices about STEM or Army/DoD STEM careers. Many mentor interviewees did not explicitly discuss careers with their apprentices; others felt that the nature of the research experience implicitly exposes apprentices to STEM careers. Another mentor took the apprentice to a DoD research laboratory to educate him about DoD STEM careers. It is obvious that exposure to STEM careers and especially Army/DoD STEM careers through mentors is inconsistent across URAP. The lack of exposure to Army STEM careers is particularly concerning given that mentors are Army-funded S&Es. As URAP endeavors to impact apprentice education in interest in STEM and Army/DoD STEM careers, it may consider taking delivering program-wide, systematic efforts to do so.

When asked which three new STEM jobs they found most interesting, 14 of 35 apprentices listed 34 different jobs or careers, summarized in Appendix B. Apprentices were interested in a range of careers or research areas across one or more basic or applied fields of science (e.g., engineering, technology, medicine/health, etc.). Most often, URAP apprentices named or described very specific careers within a field of science: in the technology field apprentices listed "quantum computing" and "Information systems"; in the engineering field apprentices listed "aerodynamicist" and

"Alternative Energy Research"; in the physical science field apprentices listed "chemistry research scientist" and "quantitative biology". Very few apprentices were interested in positions that require application of STEM knowledge and skills in a government setting, they include: Army research and weapon research. Although less than half of URAP respondents wrote anything for this item, from these examples the reader can see that URAP apprentices are interested in a wide range of specific positions requiring STEM competencies.

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



Most apprentices (71-79%) expressed agreement that Army research and researchers have made valuable contributions to science and engineering fields and to society. A majority of URAP apprentices (66%) credited URAP with improving their understandings of Army/DoD STEM contributions. In contrast to the 24% of apprentices who became interested in a job or career with the Army/DoD during URAP, 74% expressed they would be comfortable taking a civilian position in STEM with the Army/DoD. This difference suggests that URAP served to inspire new interest and sustained existing interest in Army/DoD STEM careers. Subsequently, 69% of the 26 mentor respondents agreed or strongly agreed that their apprentices expressed a positive attitude toward the Army/DoD and STEM careers it offers.

URAP apprentice focus groups and interviews provide elaboration of these data. Of 14 apprentice interviewees, 10 suggested that they would consider STEM jobs or careers with Army or other DoD agencies. Apprentices' reasons for considering careers in Army/DoD STEM included apprentice perceptions that the Army/DoD conducts research that aligns with their interests (e.g., nuclear energy), apprentice curiosity about cutting edge technology that is only available in the Army/DoD, and apprentice family connections with the Army/DoD. Those apprentice interviewees that declared they were not interested in Army/DoD STEM positions cited that they were unaware of or had not spoken to their mentor about Army/DoD career options.

We can conclude from apprentice data that URAP potentially impacted apprentices' awareness of and attitude toward Army/DoD STEM. Again, apprentice data suggests that URAP did not systematically impact apprentice interest in new STEM careers or Army/DoD STEM careers. Yet, 74% would consider a civilian position in STEM with the Army/DoD, meaning that URAP sustained pre-program attitudes toward Army/DoD STEM careers. Furthermore, 66% of apprentices credited URAP with improving their understanding Army/DoD STEM contributions. Focus group data suggests that URAP

provided apprentices with realistic previews of work at Army-sponsored university or college research labs, including potential benefits and challenges of the work and work environment.

What Participants are Saying

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

URAP contributes to apprentices' educational and professional development:

- URAP greatly prepared me for graduate school. I now know how to perform various experiments, operate many different kinds of equipment, and write technical reports at a higher level.
- The URAP Program has exposed me to the procedures and nuances of engineering research. I feel that this experience places me ahead of others with similar resumes because of the type of research performed. I also feel that I would be able to assimilate into a professional career much more quickly because of this experience.
- This URAP gave me the knowledge and confidence to pursue future research positions in any of the STEM disciplines especially Math. I think this experience gave me a better idea of what to expect from graduate school.
- I feel as if my time in the URAP has helped to expose me to more of what research and academia is all about. At this point in my career having participated in research also gives me something of an advantage over peers who have not. This in and of itself is incredibly valuable. I have enjoyed my time researching, and would see it as a very good career path.
- URAP provided me with the experience to work in a lab where I was able to get first-hand experience of what research is all about. Working in a research environment confirmed my career goal of pursuing a doctoral degree and becoming a professor in academia.
- URAP provided me with lab experience that will help further my knowledge and academic goals. In addition it opened my eyes to other academic and career opportunities I would not have likely envisioned myself going into.
- "I've learned that hands-on is very important. When you touch something…that is where you learn. So just writing problems is good for theory but if you want to see what is going on in nature you have to start using instruments and do experiments. This [program] give you that…"
- "When he took me in that was quite surprising because I didn't know anything. Before I came in, I just read the text book but he sat down with me and he taught me."
- "There are very few moments that you are…thinking that I am the only person in the entire world who could have found this thing for the first time. That is the kind of thing we look for and we dream for. Someday we will come to a point and say I contributed to science and that will be my legacy."

URAP apprentices would participate again:

- "Yes because it was a valuable experience that reinforced my skills necessary for independent learning and synthesizing information for a research project."
- "Given the opportunity I would participate in URAP again. It was a great opportunity for me to grow as a student and as a person. It tested my critical thinking skills and furthered my knowledge of new academic pursuits. I enjoyed the experience and look forward to learning about more URAP programs in the future."

URAP apprentices value the experience:

- "I am very satisfied with the research project I am doing. The most valuable part of the experience was becoming trained in the operation of various machinery inside and outside the lab. I feel I have many more skills now to offer my current and future labs."
- "The program was an excellent way to become exposed to and acquainted to research. It was a valuable way to learn how to perform experiments, literature surveys, and academic writing. I have no doubt that it will have a strong influence on the rest of my academic career (I now know substantially more about aero dynamics than I did earlier this summer). I am glad to have been able to participate."
- "It should continue for student experiences…we have to prepare our younger generation to be ready for the next challenge so they need this type of exposure. It has enhanced my skills and it will continue to enhance other peoples' skills."
- "I worked on things like the terahertz super continuum, I'm doing things like spectroscopy of cancer cells, telecommunication, and second-harmonic generation…in one year I learned all of these things. I want other undergrads or HS students who were like me before, who didn't have this opportunity, they should get this opportunity. I want them to get this type of experience. I believe that if they do it they will really do something great in life."

URAP mentors value the experience:

- "Exposing good laboratory skills and discussion with graduate students made him fully understand what the next step needed to do in STEM research is critically important. I fully believe in this effort and need to grow to help US training and guidance on students toward STEM. STEM program is a building block for US students for international competitiveness in addition to Army/DoD. Overall, I am very excited about the program and looking forward to see more opportunity."

Summary of Findings

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

Table 15. 2013 URAP Evaluation Findings	
Participant Profiles	
All evaluation data contribute to the overall narrative of URAP's efforts and impact, and highlight areas for future exploration in programming and evaluation. However, confidence in evaluation findings varies by participant group.	• Statistical reliability calculated for the apprentice questionnaire (margin of error = ±8.0% at 95% confidence level) and alternative methods for establishing representativeness (statistical comparison of apprentice respondents' and participants' demographic information revealed no significant differences) suggest findings from the apprentice questionnaire may be sufficiently generalizable to the apprentice population.
	• Statistical reliability calculated for the mentor questionnaire (margin of error = ±14.5% at 95% confidence level) and lack of available demographic information with which to make alternative determinations suggest mentor respondents may not be representative of the mentor population. Mentors contribute valuable perspective to URAP evaluation and any findings from mentor questionnaires should be cautiously generalized with consideration given to the margin of error and with triangulation of findings with other data.
URAP had difficulty providing outreach to participants from historically underrepresented and underserved populations.	• Apprentice participants included a small proportion of female students (14%)—a population that is historically underrepresented in some STEM fields.
	• 11% of apprentices identified as populations among those historically considered underserved and underrepresented in STEM education; Black or African American (3%), Hispanic or Latino (8%), and American Indian or Alaskan Native (0%).
	• Mentors identified as predominantly male (73%), White or Caucasian (50%), or Asian or Other Pacific Islander 38%). Of the 26 mentor respondents, 0% identified as Black or African American, 0% as American Indian or Alaskan Native, and 4% as Hispanic or Latino.
URAP serves the Nation's future STEM workforce.	• Most URAP apprentices (94%) planned to pursue a degree in a STEM field (14% Bachelors, 29% Master's, 57% Doctorate).
	• Most URAP apprentices intended to pursue STEM careers. Most frequently, apprentices reported currently working on an engineering degree (39%) and having similar intentions to pursue an engineering career (43%). Physical science was the second most frequently listed career field (17%). Apprentices also intended to pursue careers in math or computer science (14%), medicine or health (11%), environmental science (3%), chemistry (3%), social science (3%), or another STEM field (3%).
Actionable Program Evaluation	
Marketing and recruitment of URAP apprentices and mentors depends almost entirely on the universities or colleges that host URAP	• ARO successfully marketed and recruited URAP mentors from university or college laboratories that conduct Army-sponsored research. Subsequently, university or college researchers marketed and recruited URAP apprentices using university or college channels.
	• Apprentices learned about URAP through university personnel, advertisements, classes, or other acquaintances associated with URAP site. Many apprentices had previous associations with their mentor prior to working as a URAP apprentice. Only 10% of URAP apprentices found out about the program through their own searches.
	• Most mentors reported recruiting apprentices within the university or college context. Some mentors had a previous association with the apprentice prior to URAP through a course or previous research.

	• Although many apprentices and mentors had previous associations prior to URAP, most mentors selected apprentices from the AEOP applicant pool. This pattern of responses suggests that apprentices are first recruited within universities and colleges and subsequently directed to the AEOP application as a formality.
URAP apprentices desired opportunities to engage in authentic research experiences and advance their STEM pathways.	• Apprentices were motivated to participate in URAP because the program offered opportunities to experience research in a lab setting and to advance their STEM pathways: experiencing research first hand, developing academically, building applications or resumes, and gaining new knowledge in their desired field of study.
URAP mentors sought an opportunity to outreach to STEM learners or develop professionally.	• Most mentors participated in URAP to satisfy their desire to mentor students and/or perform community service that benefitted youth. Less often, mentors mentioned that URAP offered them the opportunity to develop their mentorship or supervisory skills and abilities. A few mentors used URAP to expand their research laboratories with extra funding for undergraduate apprenticeships.
URAP mentors used team-based and one-on-one approaches to engage apprentices in STEM research activities but supported their educational and career pathways to a lesser extent.	• Apprentice and mentor questionnaire respondents reported similar frequencies of mentor activities related to engaging apprentices in hands-on STEM research and academic and career advising. Apprentices and mentors also generally agreed that mentorship focused more on productively engaging in STEM research and less on educational and career pathways.
	• Approximately the same proportions of mentors used team-based approaches as used one-on-one approaches to engage apprentices in STEM research activities. Data also suggests that mentors focus more on engaging and training apprentices about STEM research than on supporting educational and career pathways.
URAP mentors lacked awareness of or directives to promote AEOP opportunities and STEM careers during the program.	• Most mentor interviewees had limited awareness of AEOP initiatives and did not receive or perceive any direction from ARO to educate apprentices about AEOP. Subsequently, mentors did not consistently educate their apprentices about AEOPs or encourage apprentices to participate in them.
	• Mentors suggested that informational resources provided to mentors or apprentices, mentor training, and clear expectations for promoting other AEOPs were necessary to accomplish this objective.
	• Mentors reported using a variety of strategies for mentoring apprentices about STEM careers, some with an implied emphasis on Army/DoD STEM careers. In other words, most mentors believe that the experience itself educated apprentices about STEM research and working within Army-funded laboratories.
	• Mentors cited a lack of necessary knowledge about Army/DoD STEM careers and that the duration of the program was too short to facilitate career mentorship. Suggestions for improving included the provision of information resources for distribution to apprentices and facilitation of visits or tours to Army/DoD research laboratories.
URAP benefited apprentices as well as Army S&E mentors and their laboratories.	• Apprentices and mentors perceived that URAP benefits apprentices by providing authentic research opportunities not typically available in school settings, opportunities to expand their STEM competencies and confidence, opportunities to advance their STEM pathway, and access to effective mentorship in a civilian Army research setting.
	• Mentors also perceived benefits to their own professional development, an opportunity to engage in community service, and an opportunity to expand the impact of their research laboratory through funded apprenticeships.

URAP funding is not transparent and the 8-week duration presents challenges to apprentices and mentors.	• Some mentors had a difficult time tracking funding coming from ARO to their university and felt that funding is not sufficient for the time commitment involved for apprentices and mentors.
	• Mentors suggested that URAP's 8-week duration is too short, making it difficult to meet apprentice expectations while trying to complete research project in a compressed time period.
Outcomes Evaluation	
URAP engaged apprentices in authentic STEM activities more frequently than their undergraduate courses.	• Apprentices reported that URAP provided more frequent opportunities to engage in authentic STEM activities as compared to their undergraduate courses, including academic research activities (24%-68% in URAP, 12%-39% in classes) and hands-on research activities (32%-63% in URAP, 9%-32% it classes). Small to large, significant differences were found between in-URAP and in-school engagement for 9 of 12 STEM activities.
	• Apprentice and mentor data suggested URAP had a slightly larger effect with respect to providing apprentices opportunities for hands-on research activities than it had providing opportunities for academic (minds-on) research activities.
URAP apprentices became more confident in STEM, and mentors rated their research and reporting skills highly.	• A majority of apprentices (63%-80%) perceived growth in their confidence across 7 key STEM skills and abilities: performing literature reviews, formulating hypotheses and designing experiments, using laboratory safely, using laboratory equipment and techniques, analyzing data, generating conclusions, and contributing to a research team.
	• Many mentors (66%-79%) 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 (77-90%) also rated all 6 components of their apprentices' final research project or presentation as near expert or expert level.
URAP apprentices believe that serving as STEM mentor is an implicit part of STEM careers.	• Apprentice interviewees were interested in mentoring students in the future because it is an important part of the career of a STEM researcher. Others cited positive impacts that mentors have played in their STEM pursuits which motivates them to pursue opportunities to mentor other students in the future.
URAP apprentices were unaware of the many AEOP initiatives, but showed interest in future AEOP opportunities.	• Many apprentices (58-97%) and mentors (48-64%) were unaware of other AEOP initiatives.
	• URAP apprentices are interested in participating in other AEOP opportunities: college apprenticeships (21%), college scholarship programs (21%), and graduate fellowships (27%) offered by AEOP or DoD. This interest could be leveraged for targeted cross-promotion of programs and repeated engagement of apprentices in the AEOP pipeline.
URAP improved and sustained apprentices' positive attitudes toward the defense community but does not systematically impact their interest or intent to pursue STEM or Army/DoD STEM careers.	• Apprentices and mentors disagree about the extent to which apprentices were given opportunities to learn about new STEM careers (apprentice=24%, mentor=46%) and Army/DoD STEM careers (apprentice=21%, mentor=31%).
	• URAP had limited success inspiring interest in new STEM careers (15%) or in Army/DoD STEM careers (24%). Data suggest that URAP apprentices enter URAP with well-established career intentions that do not change over the course of the program. However, 74% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society, suggesting that URAP sustained any existing interest in Army/DoD civilian careers.
	• Most apprentices (66%) credited URAP with improving their understanding Army/DoD STEM contributions. Most mentors (69%) reported that their apprentices expressed a positive attitude toward Army/DoD STEM.

Recommendations

1. Coordinated efforts should be made by the Army, ARO, and selected URAP PIs to encourage and improve apprentice and mentor participation in evaluation efforts. Low response rates to evaluation assessments, especially for programs that reach small populations, pose the most significant threat to the validity of findings from those assessments. Furthermore, low response rates prevent reliable comparisons of data year to year. While evaluators can assess representativeness of samples through alternative means, accurate demographic data must be available for the population in order to accomplish these determinations. With respect to the outcomes evaluation, mentors' assessment of apprentice performance are important for triangulating apprentices' perceptions of growing confidence in their STEM competencies. Future evaluation will continue to rely on mentors to provide an authoritative, albeit subjective, assessment of apprentices' performance and *growth* in apprentices' STEM competencies. Mentor-reported awareness of and efforts to promote AEOP and Army STEM are important for understanding related apprentice outcomes and identifying site-level programming needs (e.g., resources and/or training for mentors). Evaluators will endeavor to streamline instruments and appropriately incentivize participation in evaluation assessments; however, evaluators necessarily rely on assistance from Army, ARO, and selected URAP PIs to promote a culture of evaluation among URAP apprentices and mentors.

2. AEOP objectives include expanding participation of historically underrepresented and underserved populations. In URAP, 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. As a result, the ability of URAP to recruit underserved or underrepresented populations of students depends upon the diversity of the universities or colleges in which recruitment takes place. Indications are that many URAP apprentices are informally selected by mentors and subsequently sent to the AEOP application site as a mere formality. Guidance ensuring 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 Army and ARO may need to consider practical solutions to the challenge posed by URAP locations, as the student population of some universities and colleges is likely to advantage some groups of students more than others.

3. Apprentice and mentor data suggested that URAP 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. At the undergraduate level, students are more capable of and should have frequent opportunities to make conceptual contributions to their research: generate research questions, design experiments, analyze and interpret data, formulate conclusions, and contribute to technical writing about the research in which they are engaged. ARO should encourage mentors to use strategies that productively engage apprentices in these critical aspects of work, ensuring that apprentices are more than simply laboratory assistants. 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 and mentors share the responsibility for exposing apprentices to other AEOP initiatives and for encouraging continued participation (even as a mentor or volunteer) in programs which are available. Evaluation data suggests that URAP apprentices and mentors were largely unaware of other AEOP initiatives and that URAP served 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 URAP 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 URAP with an idea of their next steps in AEOP and/or the capability to serve as an AEOP ambassador.

5. Depending upon the university or college site and/or mentor for which they worked, apprentices had varying opportunities to learn about STEM research and careers during URAP, 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. In an effort to standardize the information provided to apprentices we strongly recommend a URAP- or AEOP-wide effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public, web-based, resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[15]

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

Appendices

Appendix A:
2013 URAP Evaluation Plan

Key Evaluation Questions

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

- What aspects of URAP motivate participation?
- What aspects of URAP structure and processes are working well?
- What aspects of URAP could be improved?
- Did participation in URAP:
  - 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 URAP included onsite focus groups with apprentices and mentors at three URAP 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 6 HSAP and URAP mentors (1 female, 5 males). Apprentice focus groups included 5 apprentices (2 females, 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. URAP and HSAP apprenticeships often occurred at the same site. In these cases, URAP and URAP mentors (no more than two) were interviewed together due to scheduling constraints and to acknowledge that some mentors served both URAP and HSAP programs. When necessary to interview

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

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

Phone interviews were conducted with apprentices or mentors at ten 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 7 mentors (3 females, 4 males), 2 of which were Graduate Mentoring Fellows Apprentice phone interviews included 8 apprentices (4 females, 4 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 URAP 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 URAP 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 URAP 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 URAP Apprentice Questionnaire and Data Summary

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

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 URAP valuable information for improvement.

By completing this assessment, you are providing your consent to participate in the URAP research/evaluation study

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

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

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
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Cooperative Agreement Manager, AEOPCA
(919) 549-4205, ahsley.wade@us.army.mil

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2013 URAP Apprentice Questionnaire and Data Summary

Provide your personal information below (optional):

First Name: _____
Last Name: _____
Email Address: _____
Age (in years): _____, years.

What year of study will you begin this fall?

- ❍ 1st year undergrad
- ❍ 2nd year undergrad
- ❍ 3rd year undergrad
- ❍ 4th year undergrad
- ❍ 5th year undergrad
- ❍ Other (specify): _____

Who is your URAP mentor?

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

At which University are you and your mentor working?

_____.

Have you ever worked as a URAP apprentice before?

- ❍ No
- ❍ Yes: How many times? _____

Briefly describe the process by which you were recruited and became an URAP apprentice:

Prior to becoming a URAP apprentice, did you already know someone who works at the university where you got your URAP 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 URAP 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 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 the STEM field you are currently pursuing?

- ❍ 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 B:
2013 URAP Apprentice Questionnaire and Data Summary

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

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
My URAP mentor helped me clarify my pathways to achieve my academic goals	❍	❍	❍	❍	❍	❍
My URAP mentor gave me advice about the steps I need to take to achieve my professional goals	❍	❍	❍	❍	❍	❍
My URAP mentor helped me with my CV/Résumé	❍	❍	❍	❍	❍	❍
My URAP mentor will write or help me obtain letters of reference	❍	❍	❍	❍	❍	❍
My URAP mentor taught me about professional and educational networks that will help me in the future	❍	❍	❍	❍	❍	❍
My URAP mentor exposed me to professional organizations that can help me with my career/educational goals	❍	❍	❍	❍	❍	❍
I would recommend my URAP mentor to other students	❍	❍	❍	❍	❍	❍

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your UNDERGRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:

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

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

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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

Please take a moment to consider your UNDERGRADUATE Science, Technology, Engineering, and Math lectures and laboratory courses. Use the scale provided to indicate how often you performed each of the following activities IN THOSE COURSES:

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

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

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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

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

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

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

❍ 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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

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	❍	❍	❍	❍	❍	❍

Use the scale provided to tell us how certain you are that you will do each of the following activities in the future?

	Not at all Certain	Uncertain	Relatively Uncertain	Relatively Certain	Certain	Very Certain
I will apply for jobs in a STEM-related field	❍	❍	❍	❍	❍	❍
I will get a job in a STEM field	❍	❍	❍	❍	❍	❍
I will build a career around my STEM skills	❍	❍	❍	❍	❍	❍
I will pursue STEM jobs with the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
I will build a STEM career with the Army/DoD	❍	❍	❍	❍	❍	❍

Which of the following categories best describes the STEM field that you want to build your career around?

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

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

Job #1:

Job #2:

Job #3:

Appendix B:
2013 URAP 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):

	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 URAP, I have a better understanding of the important contributions that Army/DoD researchers have made every day civilian life	❍	❍	❍	❍	❍	❍

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

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

	Yes, I participated	I would have participated but it was not available in my area / I did not qualify for this program	I am interested in participating in this program	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	❍	❍	❍	❍
High School Internships : Internships in laboratories at colleges throughout the country (SEAP and REAP)	❍	❍	❍	❍
College Internships: At laboratories at colleges throughout the country (CQL)	❍	❍	❍	❍
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	❍	❍	❍	❍

How did URAP contribute to your educational and professional experiences and/or pursuits?

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

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

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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

What is your age (in years)?		
Age	**Freq.**	**%**
18 years	2	7%
19 years	3	10%
20 years	6	21%
21 years	5	17%
22 years	6	21%
23 years	4	14%
24 years	0	0%
25 years	1	3%
26 years	0	0%
27 years	0	0%
28 years	0	0%
29 years	0	0%
30 years	1	3%
31 years	1	3%
Total	**29**	**100%**

Note. Average age = 21.66 years, SD = 2.94 years.

What year of study will you begin this fall?		
	Freq.	**%**
1st year undergrad	1	3%
2nd year undergrad	7	19%
3rd year undergrad	6	17%
4th year undergrad	11	31%
5th year undergrad	6	17%
Other (specify)	5	14%
Total	**36**	**100%**

Note. Other = "7", "1st year grad.", "2nd year undergrad from transferring", "Finished", "recently graduated".

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

At which University are you and your mentor working?						
URAP Site	**Freq.**	**%**		**URAP Site**	**Freq.**	**%**
Indiana University	2	6%		**Marshall University**	1	3%
Mississippi State University	2	6%		**Oakland University**	1	3%
Princeton University	2	6%		**Polytechnic Institute of NYU**	1	3%
University at Buffalo	2	6%		**Tennessee State University**	1	3%
University of California Santa Barbara	2	6%		**Texas Tech University**	1	3%
University of Puerto Rico, Mayaguez campus	2	6%		**UCF**	1	3%
University of South Florida	2	6%		**UCLA**	1	3%
University of Southern Mississippi	2	6%		**UMASS Amherst**	1	3%
Arizona State University	1	3%		**University Michigan- Ann Arbor**	1	3%
Auburn University	1	3%		**University of California at Berkeley**	1	3%
City College - CUNY	1	3%		**University of Chicago**	1	3%
Colorado School of Mines	1	3%		**University of Missouri**	1	3%
Georgia State University	1	3%		**University of Rochester**	1	3%
Harvard University	1	3%		**University of Texas at Austin**	1	3%
				Total	**36**	**100%**

Have you ever worked as a URAP apprentice before?		
	Freq.	**%**
No	35	97%
Yes- this is my 2nd year in URAP	1	3%
Total	**16**	**100%**

Appendix B:
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Briefly describe the process by which you were recruited and became an URAP apprentice? (n = 37)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP Awareness – becoming aware of URAP		**28**	
	Mentor informed apprentice about the URAP program	11	• "I asked him about work for this summer and he told me about this program."
	URAP positions were advertised in class or by the university	10	• "A broad appeal was made to the students in at least two of the classes I attended." • "I received an email with a promotional flyer attached from one of my professors at the university I attend."
	A colleague told the apprentice about the program	4	• "Peter was an alum of the college I attend. He also was a football player like me and reached out to the chemistry and other science people on the team about this opportunity."
	Apprentice found the program	2	• "I heard about the application. I applied. Afterwards, I had a phone interview and sent in my resume."
	URAP was recommended by the apprentice's employer	1	• "I was recommended to the position by my current employer."
AEOP Participation – getting involved in URAP		**34**	
	Apprentice used the general application process	13	• "I was asking for positions in a lab and the URAP program was shown to me. I applied to work at the university I was attending."
	Mentor selected apprentices to apply for URAP	7	• "I already knew the professor who was participating in the URAP program and he asked if I was interested in working with him over the summer."
	Mentor had previously worked with the apprentice	6	• "I helped [my mentor] set up his lab and constructed a few circuits. I asked him about work for this summer and he told me about this program. From there, I just had to fill out the application on the USAEOP website."
	Apprentice contacted the mentor	4	• "I emailed professors whose research interested me and asked if I could join their labs.
	Mentor encouraged the apprentice to apply	3	• "My professor told me that I was eligible and encouraged me to apply."
	Other connections	1	• "I was given this opportunity through connections."

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Prior to becoming a URAP apprentice, did you already know someone who works at the university where you got your URAP apprenticeship?		
	Freq.	**%**
Yes – a family member that works at this university	1	3%
Yes – a family friend that works at this university	9	25%
No – I did not know anyone that works at this university	26	72%
Total	**36**	**100%**

Which of the following best describes you?		
	Freq.	**%**
Male	31	86%
Female	5	14%
Choose not to report	0	0%
Total	**36**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	5	14%
Black or African American	1	3%
Hispanic or Latino	3	8%
White or Caucasian	26	72%
Some other ethnicity/race	1	3%
Choose not to report	0	0%
Total	**36**	**100%**

Note. Other = “White and Hispanic”.

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

Which of the following categories best describes the STEM field you are currently pursuing?		
	Freq.	**%**
Engineering (e.g., technology, robotics, computers, etc.)	14	39%
Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)	0	0%
Physical Science (e.g., physics, astronomy, etc.)	8	22%
Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)	1	3%
Life Science (e.g., biology, animal science, ecology, etc.)	4	11%
Medicine / Health (e.g., behavioral science, medicine, public health, etc.)	2	6%
Mathematics / Computer Science	4	11%
Social Science (e.g., sociology, psychology, economics, etc.)	2	6%
Other STEM Field	1	3%
A field unrelated to STEM	0	0%
Total	**36**	**100%**

Note. Other = "Biotechnology".

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

Please take a moment to think about your URAP 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 URAP mentor frequently worked with me in the laboratory	0 (0%)	1 (3%)	2 (6%)	4 (12%)	17 (50%)	10 (29%)	34	**4.97**	0.97
I learned a lot from my URAP mentor about performing STEM research	0 (0%)	0 (0%)	0 (0%)	4 (12%)	12 (35%)	18 (53%)	34	**5.41**	0.70
My URAP mentor encouraged me to perform a variety of tasks in the laboratory	0 (0%)	0 (0%)	1 (3%)	7 (20%)	5 (14%)	22 (63%)	35	**5.37**	0.91
My URAP mentor helped me to formulate my educational goals	0 (0%)	2 (6%)	1 (3%)	9 (26%)	10 (29%)	13 (37%)	35	**4.89**	1.13
My URAP mentor taught me how to work more effectively in a laboratory	0 (0%)	0 (0%)	2 (6%)	6 (18%)	10 (29%)	16 (47%)	34	**5.18**	0.94
MY URAP mentor spoke with me about my career interests	0 (0%)	1 (3%)	2 (6%)	7 (20%)	15 (43%)	10 (29%)	35	**4.89**	0.99
My URAP mentor helped me become a better writer of scientific research	0 (0%)	1 (3%)	6 (18%)	11 (32%)	11 (32%)	5 (15%)	34	**4.38**	1.04
I would like to work with my URAP mentor again	0 (0%)	0 (0%)	1 (3%)	4 (11%)	8 (23%)	22 (63%)	35	**5.46**	0.82

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

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 URAP mentor helped me clarify my pathways to achieve my academic goals	0 (0%)	0 (0%)	3 (9%)	9 (26%)	12 (34%)	11 (31%)	35	**4.89**	0.96
My URAP mentor gave me advice about the steps I need to take to achieve my professional goals	0 (0%)	0 (0%)	4 (12%)	2 (6%)	17 (50%)	11 (32%)	34	**5.03**	0.94
My URAP mentor helped me with my CV/Résumé	1 (3%)	12 (35%)	6 (18%)	5 (15%)	4 (12%)	6 (18%)	34	**3.50**	1.58
My URAP mentor will write or help me obtain letters of reference	1 (3%)	2 (6%)	3 (9%)	7 (21%)	7 (21%)	14 (41%)	34	**4.74**	1.40
My URAP mentor taught me about professional and educational networks that will help me in the future	1 (3%)	2 (6%)	3 (9%)	9 (26%)	11 (32%)	8 (24%)	34	**4.50**	1.29
My URAP mentor exposed me to professional organizations that can help me with my career/educational goals	0 (0%)	2 (6%)	4 (12%)	11 (32%)	10 (29%)	7 (21%)	34	**4.47**	1.13
I would recommend my URAP mentor to other students	0 (0%)	0 (0%)	1 (3%)	2 (6%)	9 (26%)	23 (66%)	35	**5.54**	0.74

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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

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

	1	2	3	4	5	6	n	Avg.	SD
In school, I had to define a research question or thesis and determine its critical concepts	13 (37%)	15 (43%)	3 (9%)	1 (3%)	1 (3%)	2 (6%)	35	**2.09**	1.34
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	7 (21%)	13 (38%)	8 (24%)	0 (0%)	1 (3%)	5 (15%)	34	**2.71**	1.62
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	8 (24%)	8 (24%)	9 (26%)	2 (6%)	3 (9%)	4 (12%)	34	**2.88**	1.65
In school, I had to organize and synthesize information across academic sources	5 (15%)	12 (35%)	10 (29%)	0 (0%)	3 (9%)	4 (12%)	34	**2.88**	1.55
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	12 (35%)	11 (32%)	6 (18%)	1 (3%)	2 (6%)	2 (6%)	34	**2.29**	1.45
In school, I had to work as part of a team on research projects	8 (24%)	7 (21%)	6 (18%)	6 (18%)	5 (15%)	2 (6%)	34	**2.97**	1.59

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

	1	2	3	4	5	6	n	Avg.	SD
In URAP, I had to define a research question or thesis and determine its critical concepts	2 (6%)	16 (47%)	7 (21%)	3 (9%)	3 (9%)	3 (9%)	34	**2.94**	1.41
In URAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	3 (9%)	9 (26%)	10 (29%)	5 (15%)	2 (6%)	5 (15%)	34	**3.26**	1.52
In URAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	0 (0%)	10 (29%)	8 (24%)	7 (21%)	5 (15%)	4 (12%)	34	**3.56**	1.37
In URAP, I had to organize and synthesize information across academic sources	2 (6%)	7 (21%)	10 (29%)	6 (18%)	5 (15%)	4 (12%)	34	**3.50**	1.44
In URAP, I had to determine appropriate ethical and legal uses of published academic research for my own work	9 (26%)	13 (38%)	4 (12%)	2 (6%)	6 (18%)	0 (0%)	34	**2.50**	1.42
In URAP, I had to work as part of a team on research projects	3 (9%)	5 (14%)	3 (9%)	4 (11%)	11 (31%)	9 (26%)	35	**4.20**	1.68

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 URAP Apprentice Questionnaire and Data Summary

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

	1	2	3	4	5	6	n	Avg.	SD
In school, I used advanced science or engineering equipment	10 (29%)	8 (24%)	13 (38%)	0 (0%)	3 (9%)	0 (0%)	34	**2.35**	1.18
In school, I cleaned and cared for the equipment in a science or engineering laboratory	11 (32%)	12 (35%)	8 (24%)	0 (0%)	2 (6%)	1 (3%)	34	**2.21**	1.25
In school, I calibrated laboratory equipment for experimentation	11 (32%)	13 (38%)	7 (21%)	1 (3%)	2 (6%)	0 (0%)	34	**2.12**	1.09
In school, I created solutions from reagents in preparation for experimental procedures	15 (44%)	12 (35%)	4 (12%)	1 (3%)	2 (6%)	0 (0%)	34	**1.91**	1.11
In school, I used proper safety procedures when handling equipment and material in the lab	7 (21%)	11 (32%)	5 (15%)	0 (0%)	10 (29%)	1 (3%)	34	**2.94**	1.63
In school, I employed advanced measurement techniques in science or engineering procedures	10 (29%)	9 (26%)	9 (26%)	2 (6%)	3 (9%)	1 (3%)	34	**2.47**	1.38

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*".

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

	1	2	3	4	5	6	n	Avg.	SD
In URAP, I used advanced science or engineering equipment	7 (20%)	2 (6%)	4 (11%)	1 (3%)	8 (23%)	13 (37%)	35	**4.14**	1.99
In URAP, I cleaned and cared for the equipment in a science or engineering laboratory	9 (26%)	5 (14%)	4 (11%)	1 (3%)	6 (17%)	10 (29%)	35	**3.57**	2.06
In URAP, I calibrated laboratory equipment for experimentation	11 (31%)	5 (14%)	6 (17%)	3 (9%)	4 (11%)	6 (17%)	35	**3.06**	1.89
In URAP, I created solutions from reagents in preparation for experimental procedures	17 (49%)	3 (9%)	4 (11%)	1 (3%)	3 (9%)	7 (20%)	35	**2.74**	2.06
In URAP, I used proper safety procedures when handling equipment and material in the lab	9 (26%)	3 (9%)	2 (6%)	0 (0%)	9 (26%)	12 (34%)	35	**3.94**	2.11
In URAP, I employed advanced measurement techniques in science or engineering procedures	9 (26%)	2 (6%)	4 (11%)	1 (3%)	8 (23%)	11 (31%)	35	**3.86**	2.06

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:
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Use the scale provided to tell us how accurately each statement describes you AFTER URAP:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
After URAP, I am more confident in my ability to formulate hypotheses and design experiments to test them	1 (3%)	0 (0%)	1 (3%)	9 (26%)	15 (43%)	9 (26%)	35	**4.83**	1.04
After URAP, I am more confident that I can analyze data and understand the results of an experiment	1 (3%)	1 (3%)	0 (0%)	6 (17%)	15 (43%)	12 (34%)	35	**4.97**	1.12
After URAP, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	1 (3%)	2 (6%)	0 (0%)	7 (20%)	12 (34%)	13 (37%)	35	**4.89**	1.25
After URAP, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	1 (3%)	0 (0%)	3 (9%)	9 (26%)	15 (43%)	7 (20%)	35	**4.66**	1.08
After URAP, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	1 (3%)	2 (6%)	2 (6%)	8 (23%)	9 (26%)	13 (37%)	35	**4.74**	1.34
After URAP, I am more confident in my ability to complete academic literature reviews for my own research projects	1 (3%)	1 (3%)	1 (3%)	7 (20%)	16 (46%)	9 (26%)	35	**4.80**	1.13
After URAP, I am more confident that I can make significant research contributions as an effective part of a research team	0 (0%)	0 (0%)	1 (3%)	6 (17%)	14 (40%)	14 (40%)	35	**5.17**	0.82

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 URAP Apprentice Questionnaire and Data Summary

Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?		
	Freq.	**%**
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.	5	14%
Bachelor's degree in something other than a STEM-related field.	0	0%
Master's degree in a STEM-related field.	10	29%
Master's degree in something other than a STEM-related field.	0	0%
Doctoral degree in a STEM-related field.	18	51%
Doctoral degree in something other than a STEM-related field.	2	6%
Total	**35**	**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	0 (0%)	2 (6%)	3 (9%)	9 (26%)	10 (29%)	11 (31%)	35	**4.71**	1.18
I will attend college to pursue this educational degree	1 (3%)	0 (0%)	0 (0%)	2 (6%)	7 (21%)	24 (71%)	34	**5.53**	0.99
I will get good grades in my classes	0 (0%)	0 (0%)	0 (0%)	8 (24%)	11 (32%)	15 (44%)	34	**5.21**	0.81
I will be able to overcome any obstacle between me and this educational degree	0 (0%)	0 (0%)	0 (0%)	6 (18%)	12 (35%)	16 (47%)	34	**5.29**	0.76
I will finish this degree	0 (0%)	0 (0%)	1 (3%)	6 (18%)	9 (26%)	18 (53%)	34	**5.29**	0.87

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

Appendix B:
2013 URAP Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how certain you are that you will do each of the following activities in the future?									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I will apply for jobs in a STEM-related field	0 (0%)	1 (3%)	1 (3%)	3 (9%)	9 (26%)	21 (60%)	35	**5.37**	0.97
I will get a job in a STEM field	0 (0%)	1 (3%)	2 (6%)	7 (20%)	10 (29%)	15 (43%)	35	**5.03**	1.07
I will build a career around my STEM skills	0 (0%)	1 (3%)	2 (6%)	5 (14%)	11 (31%)	16 (46%)	35	**5.11**	1.05
I will pursue STEM jobs with the Army/Department of Defense (DoD)	3 (9%)	9 (26%)	7 (20%)	9 (26%)	3 (9%)	4 (11%)	35	**3.34**	1.47
I will build a STEM career with the Army/DoD	4 (11%)	9 (26%)	10 (29%)	8 (23%)	2 (6%)	2 (6%)	35	**3.03**	1.32

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

Which of the following categories best describes the STEM field that you want to build your career around?		
	Freq.	**%**
Engineering (e.g., technology, robotics, computers, etc.)	15	43%
Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)	1	3%
Physical Science (e.g., physics, astronomy, etc.)	6	17%
Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)	1	3%
Life Science (e.g., biology, animal science, ecology, etc.)	0	0%
Medicine / Health (e.g., behavioral science, medicine, public health, etc.)	4	11%
Mathematics / Computer Science	5	14%
Social Science (e.g., sociology, psychology, economics, etc.)	1	3%
Other STEM Field	1	3%
A field unrelated to STEM	1	3%
Total	**35**	**100%**

Appendix B:
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Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
In URAP, I learned about new STEM-related jobs/careers.	2 (6%)	5 (15%)	6 (18%)	12 (36%)	6 (18%)	2 (6%)	33	**3.64**	1.29
In URAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	2 (6%)	9 (27%)	9 (27%)	6 (18%)	7 (21%)	0 (0%)	33	**3.21**	1.24
In URAP, I became interested in a STEM job/career I did not know about before.	2 (6%)	8 (24%)	9 (27%)	9 (27%)	5 (15%)	0 (0%)	33	**3.21**	1.17
In URAP, I became interested in a new STEM-related job/career with the Army/DoD	3 (9%)	10 (30%)	7 (21%)	5 (15%)	7 (21%)	1 (3%)	33	**3.18**	1.40

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 = 14)					
List	**Freq.**	**%**	**List**	**Freq.**	**%**
Physicist	4	29%	**Computer Science**	1	7%
Professor	4	29%	**Electrical Engineer**	1	7%
Chemical Engineer	2	14%	**Engineer (general)**	1	7%
Consultant	2	14%	**Information Systems**	1	7%
Doctor	2	14%	**Material Scientist**	1	7%
Mechanical Engineer	2	14%	**Mathematician**	1	7%
Aerodynamicist	1	7%	**Power Generation**	1	7%
Alternative Energy Research	1	7%	**Quantitative Biology**	1	7%
Army research	1	7%	**Quantum Computing**	1	7%
Biochemistry	1	7%	**Research (general)**	1	7%
Biomedical Engineer	1	7%	**SMART Fellowship**	1	7%
Chemistry Research Scientist	1	7%	**Weapon Research**	1	7%
			Total	**34**	**100%**

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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%)	7 (21%)	12 (35%)	15 (44%)	34	**5.24**	0.78
Army/DoD researchers contribute much more to society than just "warfare" advancements	0 (0%)	0 (0%)	0 (0%)	10 (29%)	8 (24%)	16 (47%)	34	**5.18**	0.87
Army/DoD researchers use cutting-edge technology to solve the world's problems	0 (0%)	1 (3%)	1 (3%)	5 (15%)	11 (33%)	15 (45%)	33	**5.15**	1.00
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	0 (0%)	1 (3%)	1 (3%)	7 (21%)	8 (24%)	17 (50%)	34	**5.15**	1.05
After URAP, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life	1 (3%)	2 (6%)	1 (3%)	7 (21%)	10 (30%)	12 (36%)	33	**4.79**	1.32

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

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

	Yes, I participated	I would have participated but it was not available in my area / I did not qualify for this program	I am interested in participating in this program	I have never heard about this program
Junior Solar Sprint (JSS): A solar-car building and race for 6th – 8th grade	1 (3%)	0 (0%)	0 (0%)	32 (97%)
Junior Science and Humanities Symposium (JSHS): A high school STEM research competition	1 (3%)	2 (6%)	0 (0%)	30 (91%)
UNITE: An engineering summer program for high school students from underserved groups	1 (3%)	1 (3%)	0 (0%)	31 (94%)
West Point Bridge Design Contest: A computer-based engineering design competition for 6th – 12th grade	2 (6%)	2 (6%)	0 (0%)	29 (88%)
eCYBERMISSION: A web-based STEM competition for 6th – 9th grade	1 (3%)	1 (3%)	0 (0%)	31 (94%)
High School Internships (REAP and SEAP):	1 (3%)	3 (9%)	0 (0%)	29 (88%)
College Internships (CQL and URAP):	6 (18%)	1 (3%)	7 (21%)	19 (58%)
The Science, Mathematics And Research for Transformation (SMART) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	3 (9%)	2 (6%)	7 (21%)	22 (65%)
The National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	0 (0%)	1 (3%)	9 (27%)	23 (70%)

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How did URAP contribute to your educational and professional experiences and/or pursuits? (n = 26)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Academic Research Activities		**17**	
	Provided valuable insight into researching	9	• "It has given me a valuable view into how research in my field is done." • "I learned a lot of valuable information about the research and development field."
	Learned a lot of information / Positive learning experience	4	• "URAP gave me valuable additional exposure to the cutting-edge field of semiconductor optoelectronics."
	Developing research skills/techniques	3	• "…this opportunity provides me with experience to further pursue other research opportunities and advance my critical thinking skills."
	Pursue personal research interest	1	• "URAP allowed me to pursue a research interest which I had previously not been able to explore."
STEM Pathway		**15**	
	Exposed student to potential careers and education opportunities	7	• "It opened my eyes to other academic and career opportunities I would not have likely envisioned myself going into." • "This exposure has helped me narrow my career plans."
	Prepares student for the future	5	• "URAP greatly prepared me for graduate school." • "URAP has provided me an opportunity to work on scientific research which will bolster my resume and make it easier to get into programs in the future.".
	Provides an advantage over peers	2	• "At this point in my career having participated in research also gives me something of an advantage over peers who have not."
	Solidified student's choice of career	1	• "Working in a research environment confirmed my career goal of pursuing a doctoral degree and becoming a professor in academia."
Hands-On Research Activities		**7**	
	Getting hands-on experience in the lab	4	• "URAP provided me with lab experience that will help further my knowledge and academic goals."
	Developing lab skills/techniques	3	• "I've learned a variety of lab techniques that microbiologists use every day."
Other		**3**	
	Provided funding or opportunity	2	• "Without the funding from URAP, I would not have been able to afford to participate in the research I am doing right now over the summer." •
	Improved confidence	1	• "This URAP gave me…confidence to pursue future research positions in any of the STEM disciplines especially Math."

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Given the opportunity, would you participate in this URAP program again? Why or why not? (n = 28)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Yes		**23**	
Academic Research Activities		**14**	
	Learned a lot of information / Positive learning experience	10	• "It tested my critical thinking skills and furthered my knowledge of new academic pursuits." • "It was a valuable learning opportunity."
	Developing research skills/techniques	4	• "It was a valuable experience that reinforced my skills necessary for independent learning and synthesizing information for a research project."
General Satisfaction		**13**	
	Great / fun experience	7	• "I had a great time this summer." • "Working in laboratories is a great experience."
	Invaluable opportunity	4	• "The program provides invaluable experience to the research world that is often inaccessible to undergraduates."
	Liked / loved the program	2	• "It's a great program in which I developed research skills and got paid for, so I'm very satisfied."
Hands-On Research Activities		**9**	
	Getting hands-on experience in the lab	4	• "I see it as a great opportunity to get hands on experience in cutting edge research."
	Program provides access to a lab	1	• "The access to laboratory resources as an undergrad is very valuable."
No		**5**	
	Student is graduating	3	• "Probably not, because I'm about to graduate and seek a job in the private sector."
	Not enough time to participate	1	• "No, not enough time."
	Too old to participate	1	• "I would probably not because I'll be too old for the program next year."
STEM Pathway		**1**	
	Helped student with STEM career choice	1	• "I learned that I would like to pursue a field that is not so heavily dependent upon intricately understanding coding and computer technology."
Other		**1**	
	Work with high quality faculty	1	• "[I] had the opportunity to work with some high quality faculty members."

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2013 URAP Apprentice Questionnaire and Data Summary

In a couple of sentences, tell us about your overall satisfaction with the URAP research project/final presentation: What was the most valuable part of that experience? (n = 26)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Academic Research Activities		**18**	
	Gained knowledge from URAP participation	6	• "I have been working on this program for weeks, learning everything there is to know about my topic."
	Valued gains in scientific reasoning	4	• "The most valuable part was that I learned how to put different existing ideas together to solve real world problems which can aid us in many different ways."
	Valued gains in academic writing acumen	4	• "It was a valuable way to learn how to perform experiments, literature surveys, and academic writing."
	Valued independent research opportunities	4	• "I was given an entirely independent research project. While it was rewarding in its own difficulty, the level of responsibility I had and have to assume in order to successfully complete it and work with other group members was foundational."
Satisfaction with program		**13**	
	General satisfaction	11	• "I have really enjoyed the opportunity to participate in the URAP project in [URAP site's] lab."
	Dissatisfaction	3	• "I wish that more of the work was in the laboratory and less just running computer simulations."
Hands-on/Laboratory research activities		**9**	
	Valued the laboratory research experiences	8	• "I built a lot of skills relating to my knowledge of, and ability to simulate, laser and light based experiments." • "It was a satisfying experience to be able to fine tune a process for making chips as I felt I was able to help the lab in a tangible way."
	Valued the application of class material	1	• "I thought my research was a good application of the material that I learned this year in my fields and waves class."
Effective Mentorship		**4**	
	Valued learning and working with mentors	4	• "Getting to work side-by-side with a professor has been a valuable learning experience for me."
Confidence		**3**	
	Feeling accomplished	2	• "Seeing how the whole poster came together and was finished made me feel accomplished on what I did over the summer."
	Gained confidence with	1	• "The most valuable part was learning how to work in a

	research techniques		lab and the confidence I gained in my own experimental techniques."
STEM Pathway		**2**	
	Valued the preview of graduate research	1	• "[URAP] gave me a good idea of what graduate research would be like."
	Valued skills that will be applied to future research	1	• **"**I feel I have many more skills now to offer my current and future labs."
STEM Ambassadorship		**2**	
	Benefiting of other researchers	1	• "My final presentation was also satisfying as I was able to explain the process, so that other members of the lab can benefit from the work I did in the future."
	Can enter competitions	1	• "The most valuable part of my experience is… that I can enter competitions with what I've learned from this program."

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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:

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Ashley Wade, U.S. Army Research Office
Cooperative Agreement Manager, AEOPCA
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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)? _____

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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: _____

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***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	❍	❍	❍	❍	❍	❍

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***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	❍	❍	❍	❍	❍	❍

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

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

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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	❍	❍	❍	❍	❍	❍

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:

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	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	❍	❍	❍	❍	❍	❍

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

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	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	❍	❍	❍	❍	❍	❍

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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	❍	❍	❍	❍	❍	❍

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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.

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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:

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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.

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?

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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

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

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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

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

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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

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

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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

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

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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

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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:
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At which University are you and your apprentice working?

URAP Site	Freq.	%		URAP Site	Freq.	%
Colorado School of Mines	2	9%		Texas Tech University	1	5%
University of Michigan	2	9%		UC Berkeley	1	5%
Oakland University, Rochester, Michigan	1	5%		UC Riverside	1	5%
Auburn University	1	5%		University of Central Florida	1	5%
CCNY	1	5%		University of Chicago	1	5%
Marshall U	1	5%		University of Illinois @ Urbana-Champaign	1	5%
Mississippi State University	1	5%		University of Massachusetts Amherst	1	5%
Polytechnic Institute of New York University	1	5%		University of Missouri, Columbia	1	5%
Princeton University	1	5%		University of Puerto Rico	1	5%
Tennessee State University	1	5%		University of South Florida	1	5%
				Total	**22**	**100%**

In total, how many HSAP and URAP apprentices have you mentored through the years? (Avg. = 2.58 Apprentices, SD = 1.58)

# of Apprentices	Freq.	%
6 apprentices	8	31%
5 apprentices	8	31%
4 apprentices	2	8%
3 apprentices	5	19%
2 apprentices	1	4%
1 apprentices	2	8%
Total	**26**	**100%**

Including 2013, for how many consecutive years have you mentored HSAP/URAP apprentice(s)? (Avg. = 1.46 years, SD = 0.95)

# of Consecutive Years	Freq.	%
3 consecutive years	3	12%
2 consecutive years	13	50%
1 consecutive years	5	19%
0 consecutive years	5	19%
Total	**26**	**100%**

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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)	0	0%
One or more URAP apprentice(s)	17	65%
Both HSAP and URAP apprentices	9	35%
Total	**26**	**100%**

In the past, have you ever worked as an HSAP/URAP apprentice?		
	Freq.	**%**
No	17	65%
Yes – for how many years?	9	35%
Total	**26**	**100%**

CONTINUED - In the past, have you ever worked as an HSAP/URAP apprentice? (n = 9 mentors who have worked as HSAP/URAP apprentices previously)		
Yes – for how many years?	**Freq.**	**%**
6 years	1	4%
5 years	1	4%
4 years	0	0%
3 years	0	0%
2 years	1	4%
1 year	6	23%

Note. % = proportion of the total number of URAP mentor respondents (n = 26).

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Do you serve as a mentor for apprentices or students in programs other than HSAP/URAP?		
	Freq.	**%**
No	5	19%
Yes – which program(s)?	21	81%
Total	**26**	**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	9	41%
Departmental undergraduate mentoring program (e.g., chemistry department research course)	6	27%
NSF	2	9%
NASA	1	5%
NASA URC	1	5%
NASA NSTRF	1	5%
STEP	1	5%
ACS Project SEED	1	5%
GOALI Girls Camp/Intrepid Museum	1	5%
Mentoring Summer Research Internship Program	1	5%
NYU-Poly's SURP	1	5%

Note. % = proportion of the total number of URAP mentor respondents (n = 21).

Which of the following best describes you?		
	Freq.	**%**
Male	19	73%
Female	7	27%
Choose not to report	0	0%
Total	**26**	**100%**

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Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	10	38%
Black or African American	0	0%
Hispanic or Latino	1	4%
White or Caucasian	13	50%
Some other ethnicity/race	2	8%
Choose not to report	0	0%
Total	**26**	**100%**

Note. Other = "Indian/Asian" & "Middle Eastern".

Which of the following categories best describes your research field?		
	Freq.	**%**
Engineering (e.g., technology, robotics, computers, etc.)	7	27%
Environmental Science (e.g., pollution, ecosystems, bioremediation, climatology, meteorology, etc.)	0	0%
Physical Science (e.g., physics, astronomy, etc.)	6	23%
Chemistry (e.g., geochemistry, material science, alternative fuels, etc.)	10	38%
Life Science (e.g., biology, animal science, ecology, etc.)	1	4%
Medicine / Health (e.g., behavioral science, medicine, public health, etc.)	0	0%
Mathematics / Computer Science	1	4%
Social Science (e.g., sociology, psychology, economics, etc.)	0	0%
Other STEM Field	1	4%
Total	**26**	**100%**

Note. Other = "Multidisciplinary: Mathematical Sciences"

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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 (4%)	2 (8%)	5 (20%)	3 (12%)	5 (20%)	9 (36%)	25	**4.44**	1.56
Used a workbook or a pre-defined set of procedures to conduct an experiment	1 (4%)	4 (16%)	5 (20%)	3 (12%)	7 (28%)	5 (20%)	25	**4.04**	1.54
Created their own hypotheses and conclusions after witnessing an experiment	1 (4%)	8 (33%)	3 (13%)	3 (13%)	8 (33%)	1 (4%)	24	**3.50**	1.47
Designed their own experiment to answer a set of their own hypotheses	1 (4%)	10 (40%)	4 (16%)	4 (16%)	5 (20%)	1 (4%)	25	**3.20**	1.38
Used advanced laboratory equipment including necessary adjustments	3 (12%)	2 (8%)	3 (12%)	5 (20%)	8 (32%)	4 (16%)	25	**4.00**	1.61
Cleaned, handled, and cared for laboratory equipment	4 (16%)	0 (0%)	3 (12%)	4 (16%)	8 (32%)	6 (24%)	25	**4.20**	1.71
Organized and handled experimental data	1 (4%)	1 (4%)	4 (16%)	6 (24%)	10 (40%)	3 (12%)	25	**4.28**	1.24
Analyzed experimental data	1 (4%)	4 (15%)	6 (23%)	6 (23%)	6 (23%)	3 (12%)	26	**3.81**	1.39
Interpreted the results of an experiment and drew their own conclusions	2 (8%)	5 (19%)	5 (19%)	5 (19%)	6 (23%)	3 (12%)	26	**3.65**	1.52

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

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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	0 (0%)	4 (15%)	1 (4%)	10 (38%)	5 (19%)	6 (23%)	26	**4.31**	1.32
I taught my HSAP/URAP apprentice(s) about performing STEM research	0 (0%)	0 (0%)	0 (0%)	5 (19%)	14 (54%)	7 (27%)	26	**5.08**	0.69
I encouraged my HSAP/URAP apprentice(s) to perform a variety of tasks in the laboratory	0 (0%)	0 (0%)	0 (0%)	4 (15%)	11 (42%)	11 (42%)	26	**5.27**	0.72
I helped my HSAP/URAP apprentice(s) formulate their educational goals	0 (0%)	1 (4%)	0 (0%)	10 (38%)	9 (35%)	6 (23%)	26	**4.73**	0.96
I taught my HSAP/URAP apprentice(s) how to work more effectively in a laboratory	0 (0%)	0 (0%)	0 (0%)	7 (27%)	15 (58%)	4 (15%)	26	**4.88**	0.65
I spoke with my HSAP/URAP apprentice(s) about their career interests	0 (0%)	0 (0%)	0 (0%)	5 (19%)	13 (50%)	8 (31%)	26	**5.12**	0.71
I helped my HSAP/URAP apprentice(s) be better writers of scientific research	0 (0%)	0 (0%)	1 (4%)	12 (46%)	9 (35%)	4 (15%)	26	**4.62**	0.80
I would like to work with my HSAP/URAP apprentice(s) again	0 (0%)	0 (0%)	0 (0%)	2 (8%)	6 (23%)	18 (69%)	26	**5.62**	0.64

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

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Use the scale provided to tell us how much you agree or disagree with each of the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I helped my HSAP/URAP apprentice(s) clarify their educational goals and pathways	0 (0%)	0 (0%)	0 (0%)	12 (46%)	6 (23%)	8 (31%)	26	**4.85**	0.88
I provided guidance to my HSAP/URAP apprentice(s) about the steps they will need to achieve their professional and educational goals	0 (0%)	0 (0%)	1 (4%)	9 (35%)	8 (31%)	8 (31%)	26	**4.88**	0.91
I helped my HSAP/URAP apprentice(s) draft their CV/Résumé	2 (8%)	8 (31%)	4 (15%)	4 (15%)	3 (12%)	5 (19%)	26	**3.50**	1.68
I will write or help my HSAP/URAP apprentice(s) obtain letters of reference	0 (0%)	0 (0%)	0 (0%)	3 (12%)	8 (31%)	15 (58%)	26	**5.46**	0.71
I introduced my HSAP/URAP apprentice(s) to professional and educational networks that will help them in the future	0 (0%)	1 (4%)	1 (4%)	8 (31%)	11 (42%)	5 (19%)	26	**4.69**	0.97
I exposed my HSAP/URAP apprentice(s) to professional organizations that can help them pursue their career/educational goals	0 (0%)	1 (4%)	2 (8%)	9 (35%)	10 (38%)	4 (15%)	26	**4.54**	0.99
My HSAP/URAP apprentice(s) were interested in pursuing AEOP programs in the future	0 (0%)	1 (4%)	1 (4%)	8 (31%)	10 (38%)	6 (23%)	26	**4.73**	1.00
I am interested in mentoring more HSAP/URAP apprentices in the future	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8 (31%)	18 (69%)	26	**5.69**	0.47
I would recommend my HSAP/URAP apprentice(s) for future Army internships	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9 (35%)	17 (65%)	26	**5.65**	0.49

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

Appendix C:
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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 (4%)	2 (8%)	11 (42%)	9 (35%)	3 (12%)	26	**4.42**	0.95
I educated my HSAP/URAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	0 (0%)	2 (8%)	6 (23%)	10 (38%)	6 (23%)	2 (8%)	26	**4.00**	1.06
During HSAP/URAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	0 (0%)	1 (4%)	4 (15%)	14 (54%)	4 (15%)	3 (12%)	26	**4.15**	0.97
My HSAP/URAP apprentice(s) expressed a lot of interest about pursuing a STEM career	0 (0%)	0 (0%)	1 (4%)	2 (8%)	12 (46%)	11 (42%)	26	**5.27**	0.78
My HSAP/URAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	0 (0%)	1 (4%)	4 (15%)	9 (35%)	9 (35%)	3 (12%)	26	**4.35**	1.02
My HSAP/URAP apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	0 (0%)	0 (0%)	3 (12%)	5 (19%)	11 (42%)	7 (27%)	26	**4.85**	0.97

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

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Please describe the ways in which you educated your URAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=19)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
STEM Pathway		**8**	
	Hands-on nature of the material introduced apprentices to careers	6	• "Direct hands-on training on multiple short-term research assignments." • "My research group provided hands on research experience for the URAP students."
	Encouraged further education	2	• "…most of them are really lack of experimental experience. I help them to use the advanced equipment […] and discuss results weekly... By doing so, he was able to know his weakness and plan to take courses useful to his future research."
Awareness of Army/DoD careers		**7**	
	Discussed various Army/DoD careers	7	• "I share with them my 25 years' industrial experience of working with DOD including Army on exciting leading-edge technology innovation." • "I constantly talked to them about some of the technical challenges needed for the Army/DoD."
Awareness of STEM Careers		**6**	
	Discussed various STEM careers	5	• "I had a career-focused discussion with him the first week he was in the lab and I plan on doing one before he leaves."
	Did not yet discuss STEM careers	1	• "I plan to do it... this survey is in the middle of their internship."

Please describe any challenges you faced when educating your URAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=17)

List of Suggestions	Freq.	Example Response(s)
Unfamiliar with aspects of Army/DoD careers	4	• "I am not sure about many of the STEM-related careers that are offered with the Army/DoD." • "I have somewhat limited experience myself in other career options since I have been in a university my whole career."
No Challenges	3	• "No challenges to report." • "He is an outstanding student and work well with graduate student without much problem. He is a harder worker."
Duration of program is too short to get students involved	2	• "My apprentice was exposed to the research material in only on semester in the junior year. It provided barely enough background to perform the research."
Generate/keep interest in STEM	2	• "Aligning their interests with the needs of the project."
ARO should provide more information regarding Army/DoD careers	2	• "ARO could do more to advertise career opportunities within Army and related DoD departments." • "I was expecting more information from the ARO on these career pathways."
More daily support is needed	1	• "Need support for the trainers to oversee the students on daily basis."
Not familiar with student's interest	1	• "…my student's main focus was somewhat outside my area of research I didn't have too much experience with his desired career path."
Students were distracted	1	• "During the first 2-3 days, students showed multi-media distraction."
Too busy to discuss careers	1	• "Very busy with research, we spent most of our time working through the data collected and the issues in the lab."

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Please describe how URAP could better support you in your efforts to educate your apprentice(s) about STEM-related careers, especially those within the Army/DoD. (n = 17		
List of Suggestions	**Freq.**	**Example Response(s)**
Provide mentors a packet of information to distribute to apprentices	8	• "A document to summarize STEM-related careers within the Army/DoD can be very useful." • "I would welcome any type of information book about what kind of careers are possible within Army/DoD and could pass along this information." • "Provide more reading materials specifically on STEM related careers in the army."
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."
Increase funding for students and/or the lab	2	• "Give funds to paid trainers (post doc and Graduate students) per HS/UG students." • "Some summer salary support would be very helpful."
Suggest a teleconference / workshop for apprentices during the program	1	• "In August plan a mandatory workshop for all URAP/URAP participants and highlight these points in an engaging way. NSF does this for their undergraduate research fellows and the students love it!"
Provide information to apprentices using electronic media	1	• "If there was some information about Army/DoD jobs and a website/link to such jobs."
Support more students	1	• "Support more number of HSAP/URAP students."
Create webinars to help educate apprentices	1	• "Webinars, especially those about Army personnel in technical fields of the Army/DOD and about careers within the military."
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."

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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	10 (40%)	4 (16%)	4 (16%)	3 (12%)	3 (12%)	1 (4%)	25	**2.52**	1.61
I encouraged my apprentice(s) to submit his/her research project/final report to JSHS	8 (32%)	7 (28%)	4 (16%)	2 (8%)	3 (12%)	1 (4%)	25	**2.52**	1.53
My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS	9 (36%)	7 (28%)	3 (12%)	2 (8%)	3 (12%)	1 (4%)	25	**2.44**	1.56
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)	11 (44%)	5 (20%)	4 (16%)	1 (4%)	2 (8%)	2 (8%)	25	**2.36**	1.66
I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL)	9 (36%)	3 (12%)	4 (16%)	4 (16%)	4 (16%)	1 (4%)	25	**2.76**	1.67
I provided information to my apprentice(s) about one or more AEOP program(s)	9 (36%)	3 (12%)	4 (16%)	4 (16%)	4 (16%)	1 (4%)	25	**2.76**	1.67
My apprentice(s) expressed interest in pursuing AEOP programs in the future	5 (20%)	2 (8%)	4 (16%)	5 (20%)	7 (28%)	2 (8%)	25	**3.52**	1.66
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	4 (16%)	2 (8%)	0 (0%)	4 (16%)	6 (24%)	9 (36%)	25	**4.32**	1.86
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	5 (20%)	4 (16%)	0 (0%)	3 (12%)	8 (32%)	5 (20%)	25	**3.80**	1.91

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

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Please describe the ways in which you educated your URAP apprentice(s) about AEOP programs. (n = 15)		
List of Suggestions	**Freq.**	**Example Response(s)**
Discussed with apprentices during the program	4	• "Discussed at weekly group meetings." • "We spoke about the programs that he would be eligible for based on his level of education and career path."
Could not discuss because programs were unknown/not familiar	3	• "I was not aware of any of these programs." • "I do not know about NDSEG or SMART programs."
Discussed the SMART/NDSEG program	3	• "The only AEOP program I have discussed with my students is the NDSEG and she had applied." • "We only discussed the NDSEG because that was all I knew about."
Sent students towards the website	3	• "I passed online information and website of AEOP programs to my apprentice."
Gave apprentices fliers or brochures	1	• "Brochures."
Unsure	1	• "Not sure."

Please describe any challenges you faced when educating your URAP apprentice(s) about AEOP programs. (n = 14)		
List of Suggestions	**Freq.**	**Example Response(s)**
Need more information about other AEOP Programs	7	• "The challenge is that I am not really aware of all the AEOP programs." • "Need materials about each program and funding available." • "I don't' know these programs in depth."
No challenges	4	• "No challenges." • "None, they were outstanding!"
Education should be addressed by AEOP website	1	• "Present a web seminar about AEOP during summer time so that URAP/URAP attending research can participate and learn about AEOP educational mission and research opportunities."
Not enough time to discuss programs	1	• "We spent most of our time working on the summer research."
Unsure	1	• "Not sure."

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Please describe how URAP could better support you in your efforts to educate your apprentice(s) about AEOP programs. (n = 17)		
List of Suggestions	**Freq.**	**Example Response(s)**
Provide print information about the AEOP	6	• "Provide information/brochures either to the students directly or to me." • "It seems ARO could start by making the PIs aware of the above programs."
Satisfied with the program	3	• "I am completely pleased and satisfied by the manner in which this program is managed."
Deliver information via electronic media	2	• "Just a simple email alert from AEOP with a PDF brochure attachment would be a great way to publicize the programs better."
Improve communications	2	• "Better communication before, during and after the program."
Provide deadlines	2	• "Send material and application with deadlines to hand out to graduate and undergraduate students for support by Army." • "We could be sent links to each AEOP program with deadlines."
Create a video	1	• "Some sort of Youtube video about each of the programs would be a great introduction to them."
Increase funding for students and/or the lab	1	• "Since we are involved in experiment work, we hope the program can cover more expense in laboratory user fee and cost."
Suggest improving the brochure	1	• "The brochure materials are a bit thin."

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How was your URAP apprentice recruited and selected for this apprenticeship? (n = 34)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP participation: Application & Selection		**22**	
	Selected from AEOP applicant pool	15	• "He applied through the gateway "spontaneously", selected as most competitive candidate." • "Selected from a pool of undergrads that applied to the lab for summer research positions."
	Student made direct contact	3	• "[He] contacted me about a position." • "[He] contacted me about opportunities."
	Students were participating in lab already	3	• "I spoke to her of the opportunity as she was working in my lab."
	Aware of student before application	1	• "Met him in Orlando."
AEOP Awareness: Recruiting & Marketing		**12**	
	Recruit students through course	7	• "He was in a course I taught that was related to the apprenticeship topic." • "He was one of my students and [I] informed all my students about URAP research opportunity and he applied first for this position."
	Recommended by others	3	• "One of colleagues recommended [this student]. He was well-qualified candidate with very good credentials."
	Recruit using other events / programs / organizations	2	• "The opportunity was advertised in the engineering and science departments of Oakland University."

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

Please rate [your apprentice]'s laboratory skill level. (Avg. = 5.03, SD = 0.68)		
	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	6	21%
(5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision	16	55%
(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	24%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **23 (79%)**; 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. = 4.86, SD = 0.74)		
	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	0	0%
(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	10	34%
(5): Understands and uses techniques competently without supervision. Yielded results are useful	13	45%
(6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques	6	21%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **19 (66%)**; 1&2 = **0 (0%).**

Appendix C:
2013 URAP 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. = 5.00, SD = 0.65)		
	Freq.	**%**
(1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions	0	0%
(2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates	0	0%
(3): Attempts but rarely offers unique ideas to the team or manages to retain information from teammates. Occasionally late with task completion. Congenial but sometimes indifferent toward teammates	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	6	21%
(5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates	17	59%
(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	6	21%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **23 (79%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes [your apprentice]'s scientific reasoning skills/abilities? (Avg. = 4.90, SD = 0.67)		
	Freq.	**%**
(1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles	0	0%
(2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles	0	0%
(3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles	0	0%
(4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles	8	28%
(5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research	16	55%
(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	5	17%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **21 (72%)**; 1&2 = **0 (0%).**

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

Which of the following categories most accurately describes [your apprentice]'s information literacy skills/abilities? (Avg. = 4.90, SD = 0.67)		
	Freq.	**%**
(1): Information searches are not connected to research needs and search is done entirely via web search engines. No information from sources is included nor consideration for sources	0	0%
(2): Information searches are vaguely tied to research needs and search is not systematic in nature. Sources are often not credible, plagiarism is evident, and ethical uses are not considered	0	0%
(3): Sometimes does not discern needed information and how or where to search for it. Sources are sometimes not credible and ethical uses of information are compromised occasionally	0	0%
(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	8	28%
(5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses	16	55%
(6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner	5	17%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **21 (72%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes [your apprentice]'s quantitative literacy skills/abilities? (Avg. = 4.86, SD = 0.64)		
	Freq.	**%**
(1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation	0	0%
(2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation	0	0%
(3): Sometimes misunderstands quantitative information which results in inaccurate sets of findings. Judgments are occasionally not based on results and may not consider some limitations	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	8	28%
(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	17	59%
(6): Expertly converts and interprets quantitative information into a comprehensive set of accurate results. Skillfully applies the results of analysis to thoughtful judgments and conclusions while integrating assumptions and limitations during their derivation	4	14%
Total	**29**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **21 (72%)**; 1&2 = **0 (0%).**

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

Which of the following categories best describes [your apprentice]'s Introduction/Purpose? (Avg. = 5.19, SD = 0.60)		
	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	10%
(5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague	13	62%
(6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research	6	29%
Total	**21**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **19 (90%)**; 1&2 = **0 (0%).**

Which of the following categories best describes [your apprentice]'s Methods (e.g., description of equipment & procedures)? (Avg. = 5.21, SD = 0.66)		
	Freq.	**%**
(1): The student provides no list or description of the equipment or procedures for this study	0	0%
(2): Equipment and procedures are inaccurately listed and described. Replication would be impossible	0	0%
(3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult	0	0%
(4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information	3	13%
(5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification	13	54%
(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	8	33%
Total	**24**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **21 (88%)**; 1&2 = **0 (0%).**

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

Which of the following categories best describes [your apprentice]'s Results (e.g., data analysis, interpretation & findings) (Avg. = 5.09, SD = 0.67)		
	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	4	17%
(5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear	13	57%
(6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts	6	26%
Total	**23**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **19 (83%)**; 1&2 = **0 (0%).**

Which of the following categories best describes [your apprentice]'s Conclusions? (Avg. = 4.95, SD = 0.72)		
	Freq.	**%**
(1): No conclusions, limitations, or future directions are offered	0	0%
(2): Discussion of findings is unstructured and does not tie back to the research question very well. Barely touches on limitations	0	0%
(3): Vaguely ties the findings back to the research questions. Limitations are only touched on. No future directions are offered	0	0%
(4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed	6	27%
(5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus	11	50%
(6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research	5	23%
Total	**22**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **16 (73%)**; 1&2 = **0 (0%).**

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

Which of the following categories best describes [your apprentice]'s Structure? (Avg. = 4.95, SD = 0.65)		
	Freq.	**%**
(1): Does not include or distinguish between an abstract, body, appendix, or bibliography	0	0%
(2): Missing two or more components (abstract, body, appendix, or bibliography). Ordering, labeling, and grammar are not acceptable	0	0%
(3): Missing one component (abstract, body, appendix, or bibliography). Order of sections is disjointed or mislabeled. Grammar is minimally acceptable	0	0%
(4): Abstract, body, appendices, citations, and bibliography are included with mistakes. Order and labeling of sections is present but not always clear. Grammar is adequate	5	23%
(5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality	13	59%
(6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable	4	18%
Total	**22**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **17 (77%)**; 1&2 = **0 (0%).**

Which of the following categories best describes [your apprentice]'s Oral Communication? (Avg. = 5.04, SD = 0.62)		
	Freq.	**%**
(1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)	0	0%
(2): Fails to present one intro, purpose, and/or conclusion. Very few and non-credible supporting materials are used	0	0%
(3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best	0	0%
(4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question	4	17%
(5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility	15	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	5	21%
Total	**24**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **20 (83%)**; 1&2 = **0 (0%).**

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

Do you have any other comments or input to provide us regarding your URAP apprentice's final project? (n = 16)		
List of Comments	**Freq.**	**Example Response(s)**
Apprentice has not finished the project yet	10	• "Project is not finished at date of this submission, two weeks to go." • "[My apprentice] has done excellent work in this summer."
Apprentice has excellent work	6	• "He will be an outstanding student for advance research in science and engineering." • "…her work is stellar."
Project may turn into publication	2	• "I encourage him to publish their results as a paper." • "I expect we will write a paper on her research."
Apprentice is very motivated	1	• "[He] is a self-motivated student. He is very interested in this project and has worked very hard in this program."
Mentor is pleased to have the apprentice	1	• "It is a pleasure to have [him] in my group this summer."

Do you have any other comments or input to provide us regarding your URAP apprentice? (n = 16)		
List of Comments	**Freq.**	**Example Response(s)**
Apprentice is an excellent student	6	• "He is an excellent student." • "[My apprentice] is a very solid student."
Apprentice has learned/developed due to the program	4	• "[My apprentice] has benefited tremendously from the HSAP/URAP program." • "He undertook a methodical approach to problem solving, and it paid dividends by the end of his time here."
Apprentice is intelligent	2	• "A very bright and skillful student."
Apprentice demonstrates interest for the material	2	• "[My apprentice is] a very good student interested in his work." • "We always discover the strengths of the students after they have been in the lab for a while, Zachary is very interested and capable in 3D printing."
Apprentice exceeded expectations	2	• "[My apprentice performed] beyond my expectations." • "He is best and gifted "APPRENTICE" that [I] have met so far."
No issues	1	• "Everything is going well."

Appendix C:
2013 URAP 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 URAP this year. (n = 15)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
General Satisfaction		**6**	
	Mentors enjoyed working with apprentices	3	• "I am enjoying working with them." • "I enjoyed working with my HSAP/URAP apprentices this summer."
	Apprentices enjoyed a positive experience with others	2	• "They also enjoyed working as a team, particularly having the opportunity to present their research progress to our technical monitor at ARL."
	Apprentices seem satisfied with URAP	1	• "[The apprentices] seem to be enjoying the experience."
STEM pathway		**5**	
	Apprentices did/will benefit from URAP	3	• "Both apprentices benefited tremendously from the research experience." • "[She] has been an apprentice for 2 years and has really developed as a scientist."
	Apprentice will be a co-author on a paper	2	• "He will be a co-author on a manuscript that is under preparation."
Hands-on / Laboratory Research Experiences		**4**	
	Apprentices performed well in the program	4	• "[My apprentice] worked on a project on nanowire composites and was able to perform very well." • "The data [they] obtained was of a high quality."
Other		**3**	
	Increase funding for students and/or the lab	2	• "The funding was difficult to track down. ARO says the money was sent, the folks at UM still have not located it and so I used different funds to pay the student & mentor."
	Duration of program is too short to get students involved	1	• "8 weeks is a short period of time. The largest difficulty is matching student expectations with reality. Research takes time."
Effective Mentorship		**1**	
	Mentors developed their own mentoring skills/abilities	1	• "I learned how to better express and stress proper techniques as part of a larger conversation, so that my suggestions were also paired with positive feedback."
Academic Research Activities		**1**	
	Apprentice gained knowledge through the program	1	• "They have learned a lot in shock/boundary-layer flow control."

Appendix D:
2013 URAP 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 URAP 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 URAP 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 URAP?
    - What specific ways has it benefited you?
    - What does URAP 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 URAP, 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 URAP 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 URAP.

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 URAP 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 URAP?
    - What specific ways has it benefited you?
    - What does URAP offer that you don't get at school/college?

3. Have you learned about other Army Educational Outreach Programs while participating in the URAP 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 URAP 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 URAP 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 URAP 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 URAP?
    - 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 URAP, 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 URAP 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 URAP.

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 URAP 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 URAP?
   - 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

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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."*** • ***"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."