Army Educational Outreach Program

Research & Engineering Apprenticeship Program

2013 Annual Program Evaluation Report

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U.S. Army Contacts

Jeffrey Singleton
Director, Basic Research and Educational Outreach
Office of the Assistant Secretary of the Army
Acquisition, Logistics, & Technology
(703) 617-0315
Jeffrey.d.singleton.civ@mail.mil

Andrea Simmons-Worthen
Army Educational Outreach Program Director on
behalf of the Office of the Deputy
Secretary of the Army for Research & Technology
(703) 617-0202
andrea.e.simmons.ctr@mail.mil

AEOP Cooperative Agreement Managers

Louie Lopez
AEOP Cooperative Agreement Manager
U.S. Army Research, Development, and
Engineering Command (RDECOM)
(410) 278-9858
louie.r.lopez.civ@mail.mil

Jennifer Carroll
AEOP Deputy Cooperative Agreement Manager
U.S. Army Research, Development, and
Engineering Command (RDECOM)
(410) 306-0009
jennifer.j.carroll2.civ@mail.mil

Research & Engineering Apprenticeship Program Administrators

Irene O'Mara
REAP Program Director
Academy of Applied Science
(603) 228-4530
renie@aas-world.org

Sheldon Apsell, Ph.D.
Principal Investigator
Academy of Applied Science
(603) 228-4530
sheldonapsell@gmail.com

VirginiaTech

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Virginia Tech Evaluation Contacts

Rebecca Kruse, Ph.D.
Evaluation Director, AEOP CA
Virginia Tech
(703) 336-7922
rkruse75@vt.edu

Donna Augustine Burnette
Program Director, AEOP CA
Virginia Tech
(540) 315-5807
donna.augustine@vt.edu

Virginia Tech Principal Investigators

Susan Short, Ph.D.
Associate Vice President for Engagement
Virginia Tech
(540) 231-9497
sshort@vt.edu

Scott Weimer
Director of Continuing and Professional Education
Virginia Tech
(540) 231-7887
weimers@vt.edu

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Executive Summary

The Research Engineering & Apprenticeship Program (REAP), managed by the Academy of Applied Science (AAS), is an Army Educational Outreach Program (AEOP) that places high school students from historically underserved and underrepresented populations in summer research apprenticeships at colleges and universities throughout the nation. Each REAP student (herein referred to as apprentice) works under the direct supervision of a university scientist or engineer (herein referred to as mentor) on a hands-on research project. Through the five to eight week REAP experience, apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM.

In 2013, REAP provided outreach to 101 participants at 54 hosting college or university laboratories. According to AAS, more than 1,500 applications were received from students interested in REAP.

This report documents the evaluation of the 2013 REAP 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 REAP included: in-person focus groups with apprentices and mentors at 4 REAP sites, phone interviews with apprentices and mentors representing 10 additional REAP sites, and online post-program questionnaires distributed to all apprentices and mentors.

Table 1. 2013 REAP Fast Facts	
Major Participant Group	High School Students
Participating Students	101
Participating University Faculty	95
Participating Universities	54
Total Cost	$349,690
Total Stipends	$216,400
Cost Per Student Participant	$3,462

Summary of Findings

The 2013 evaluation of REAP 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 REAP Evaluation Findings	
Participant Profiles	
REAP apprentice and mentor participation in evaluation yielded sufficient confidence in the findings.	• The statistical reliability achieved for the REAP apprentice questionnaires allow us to sufficiently generalize findings of the evaluation sample to the population. Findings from mentor questionnaires can be cautiously generalized with consideration given to the margin of error and triangulation of findings with mentor focus group and interview data. Expanded participation in 2013 evaluation assessments is a success for REAP.
REAP had some success in serving historically underrepresented and underserved populations.	• REAP was successful in attracting participation of female students (60%)—a population that is historically underrepresented in engineering fields.
	• REAP had some success in providing outreach to students from historically underserved minority race/ethnicity and low-income groups. Questionnaire respondents included apprentices identifying as Black or African American (33%), American Indian or Alaskan Native (2%), and Hispanic or Latino (15%), as well as apprentices who qualify for free or reduced lunch (27%).
REAP's mentor diversity did not mirror the diversity of apprentices.	• Mentors identified as predominantly male (75%) and White or Caucasian (67%).
	• A comparison of apprentice and mentor demographics suggested that many apprentices of underserved or underrepresented populations are not likely to have mentors sharing the same gender or race/ethnicity characteristics—a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.
REAP provides outreach to the Nation's future STEM workforce.	• 91% of the 86 respondents indicated their intent to pursue a career in a STEM-related field. More respondents intended to pursue careers in Medicine/Health (36%) than any other field, with Engineering (26%), Chemistry (9%), and non-STEM fields (8%) being the next most frequently reported fields.
Actionable Program Evaluation	
REAP marketing and recruitment was largely a site-based endeavor.	• 54% of mentors reported actively recruiting apprentices through connections with local high schools, 13% through other programs for high school students, and 4% through on-campus recruiting events. University- and faculty-led advertising, social media, and word of mouth are also used to recruit apprentices.
	• Apprentices most frequently learned about REAP from high school personnel (25%) or through family or family friends (22%). 30% of apprentices reported having a family member or family friend at the university where the REAP apprenticeship took place.
	• 52% of mentors learned about REAP from a colleague and 33% from a superior, such as a Department Chair, Center Director, or Dean.
REAP apprentices participate to clarify and advance their STEM pathways.	• Apprentices received encouragement to participate from others, including friends, family members, and school staff, often who have current or past connections to the REAP program. Additionally, apprentices participated to clarify and advance their STEM pathways. A small number were motivated by their own positive experiences in REAP or other AEOPs.
REAP mentors participate to serve as university and STEM ambassadors.	• Mentors received encouragement to participate from other colleagues, including peers, more senior faculty, and superiors, often who have current or past connections to the REAP program. Additionally, mentors participated in REAP to serve as university and/or STEM ambassadors.
REAP mentors used a team-based approach to engaging their REAP	• Apprentices and mentors reported similar frequencies and types of mentor activities related to engaging apprentices in STEM research, with more focus on laboratory-based work than on academic or scientific writing.

apprentices in STEM research.	• Apprentices and mentors suggested that other students and laboratory personnel contributed significantly to the day-to-day mentoring and guidance about STEM educational and career pathways, sometimes more than the designated REAP faculty mentor.
	• Mentors suggested a number of ways that REAP can improve its impact on underserved students, including efforts to establish or expand site-based and REAP-wide community-building and support for post-REAP educational and career opportunities.
REAP mentors lacked awareness and resources for promoting AEOP opportunities and Army/STEM careers.	• Most mentors had limited awareness of or past participation in an AEOP initiative beyond REAP or the AEOP UNITE program on their campus. Most mentors suggested that more resources were necessary to educate apprentices about AEOP opportunities. A small number of mentors reported that educating apprentices about other AEOP opportunities is the responsibility of the AEOP and REAP administrator, AAS, and could be accomplished through an improved AEOP website.
	• Many mentors educated apprentices about STEM majors, programs, and funding sources for their educational pursuits. Some mentors educated apprentices about STEM careers, but few of those were Army/DoD STEM careers. Most mentors suggested that more resources are necessary to allow them to comfortably educate apprentices about Army/DoD STEM careers, in particular.
REAP benefited apprentices, mentors, and laboratories.	• Apprentices and mentors perceived that REAP benefits apprentices by providing authentic and deeper learning opportunities not available typical school settings. Mentors suggested establishing program features to engage apprentices in a larger community of REAP and AEOP alumni after during and after their apprenticeship.
	• Mentors also perceived benefit to their laboratories and to themselves, most notably that apprentices made meaningful contributions to the work of the lab.
Outcomes Evaluation	
REAP engaged apprentices in authentic STEM activities and improved their STEM competencies.	• Apprentices perceived that REAP provides significantly more opportunities to engage in authentic STEM activities as compared to their school setting, including academic (42%-68% in REAP, 17-42% in school) and hands-on (47%-75% in REAP, 12%-44% at school) research activities. Apprentice and mentor data suggested REAP has a larger effect with providing apprentices opportunities for hands-on research activities (using equipment safely, following procedures) than it does academic research activities (generating questions, designing experiments, analyzing and interpreting data, formulating conclusions).
	• Most apprentices (63%-87%) perceived growth in their confidence across 7 STEM skills and abilities. A majority of mentors (52%-72%) rated their apprentices at near expert or expert levels of the development continuum across 6 skills and abilities. The majority of mentors (64%-77%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels.
REAP apprentices were largely unaware of AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Apprentices (57%-96%) and mentors (50-66%) were largely unaware of other AEOP initiatives. Yet, substantial apprentice interest exists in AEOP opportunities: 27-29% of apprentices expressed interest in high school, college apprenticeship programs, and college scholarship program and 10% expressed interest in JSHS, a research competition program.

REAP had some success in increasing apprentices' awareness of, interest in, and attitudes toward Army/DoD STEM careers.	• Apprentice and mentor data suggested that a majority of apprentices had opportunities to learn about new STEM careers during REAP (54% apprentices, 57% mentors), but Army STEM careers received less attention (29% apprentices, 23% mentors).
	• REAP served to inspire interest in new STEM careers, with 21% of apprentices expressing new interest in Army/DoD STEM careers in particular.
	• 51% of apprentices credited REAP with improving their understanding Army/DoD STEM contributions, and 57% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society. 35% of mentors perceived their apprentices expressed a positive attitude toward the Army/DoD.

Recommendations

1. Based on the demographic data collected in evaluation assessments, REAP had some success in providing outreach to students from historically underserved minority race/ethnicity and low-income groups. Future evaluation and annual program reporting may provide a clearer picture of REAP's success in this area. However, additional program-level efforts and stronger collaboration between AAS and university sites may be required to fully realize this objective. For example, program level efforts such as AAS' competitive 2-year selection process, continued marketing to HBCUs and MSIs, and strengthening and expanding of the UNITE-REAP pipeline provide some assurance that universities receiving REAP awards are poised to serve minority and low-income populations. Further collaboration between AAS and universities are needed during the recruiting and selection processes for both apprentices and mentors. AAS and universities should consider
    a. How to mitigate underserved students' resource and educational gaps (identified by mentors), to ensure their participation is both feasible and successful;
    b. How to recruit and select apprentices in ways that do not unwittingly privilege certain students over others (e.g., those with personal connections to the university site, coordinator, or mentor); and
    c. How to recruit a more diverse yet highly qualified pool mentors that reflect the gender and race/ethnicity characteristics of apprentices. Access to mentors of the same gender and/or race/ethnicity have been suggested as a potential factor for reducing stereotypes and increasing students' performance and persistence in STEM.

2. Data suggests that REAP apprentices have more opportunities to do the *hands-on* aspects of research and fewer opportunities to contribute to the *minds-on* aspects. AAS, in collaboration with university sites, should explore creative strategies for supporting all apprentices in having opportunities to contribute to generating questions, designing experiments, analyzing and interpreting data, and formulating conclusions for research in which they are engaged. For example, sites may reproduce the daily written summary described in one of the REAP focus groups, or promising practices occurring at other sites or in the research literature pertaining to apprenticeship. In light of challenges expressed by mentors, including gaps in underserved students' education (lack of conceptual understanding and writing skills) and finding age- or ability-level appropriate projects for them to do, program level scaffolds may be needed, including any of the following: REAP apprentices participate in other AEOP

programs before REAP, REAP apprenticeships extend beyond 5-8 weeks and include an apprentice-directed research project (though not necessarily paid beyond summer months), and/or REAP apprenticeships are awarded with a commitment of two summers from each apprentice.

3. REAP appears to serve as largely an entry and exit point to participation in AEOP. Only a small percentage of apprentices reported past participation in other AEOP initiatives before REAP, and data from REAP and other AEOP evaluations suggest few REAP apprentices participate in other AEOP initiatives after REAP. Subsequently, REAP apprentices and mentors were largely unaware of other AEOP initiatives. In light of these findings, we first recommend that both training and resources be provided to mentors to educate them about AEOPs, with clear expectations that they educate apprentices about and encourage participation in other AEOP initiatives. Every REAP apprentice should at least know possible next steps to take in AEOP at the conclusion of their REAP apprenticeship. Second, we recommend that AAS be strategic in its cross-marketing of other AEOP initiatives to mentors and apprentices to better position itself within a pipeline and to support successful participation of underserved populations. For example, REAP will benefit from strengthening and expanding the UNITE-REAP bridge, ensuring readiness of REAP apprentices by mitigating any educational gaps before they arrive in REAP. REAP will also benefit from establishing a REAP-JSHS bridge, ensuring that REAP apprentices have opportunities to network and build community with other REAP apprentices (and non-REAP students), to present their research in a STEM-supportive environment, and to compete for college scholarships through their research.

4. Most apprentices had opportunities to learn about STEM careers during REAP. Army/DoD STEM careers received less attention than STEM careers in general. Apprentices are interested in an array of career fields that are of potential interest to the Army/DoD, but perhaps they do not recognize them as such. The majority of mentors interviewed cited their lack of awareness of Army/DoD STEM careers as the primary reason for not educating apprentices about them. AAS might consider a requirement, similar to that of the UNITE program, that REAP sites connect (either virtually or in-person) with local Army scientists, engineer, and/or research facilities. In addition, REAP and/or AEOP should consider developing a resource that profiles the research, educational pathway, and on-the-job training of one or more Army/DoD STEM professionals (or Army/DoD-sponsored researchers in private industry and academia) engaged in the fields of interest listed by apprentices. This evolving resource can assist mentors and apprentices in learning about Army/DoD STEM interests more broadly without the need for firsthand experience or professional connections with Army/DoD scientists and engineers.

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 Research & Engineering Apprenticeship Program (REAP). REAP is managed by the Academy of Applied Science (AAS). 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

REAP is a paid, summer internship program that focuses on developing STEM competencies among high school students from groups historically underrepresented and underserved in STEM. For more than 30 years REAP has placed talented high school students in research apprenticeships at colleges and universities throughout the nation. Each REAP student (herein referred to as apprentice) works a minimum of 200 hours (5 to 8 weeks in length) under the direct supervision of a university scientist or engineer on a hands-on research project. REAP apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM, through a challenging STEM experience that is not readily available in high schools. Both REAP apprentices and mentors receive a $1,300 stipend for their participation in the program.

REAP is guided by the following objectives:

1. Provide high school students from groups historically under-represented and underserved in STEM, including alumni of AEOP's UNITE program, with an authentic science and engineering research experience;

2. Introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP;
3. Provide participants with mentorship from a scientist or engineer for professional and academic development purposes; and,
4. Develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.

More than 1500 applications were received for 2013 REAP. In 2013 REAP provided funding for 101 apprenticeships under the supervision of 95 university faculty. Apprenticeships were completed at 54 colleges and universities in 39 states (shown in Table 3), including 7 institutions identified as historically black colleges and universities (HBCUs) or minority serving institutions (MSIs). As part of a pipeline pilot program, REAP funded 17 apprenticeships for UNITE alumni at 8 universities. UNITE is an AEOP-sponsored pre-collegiate summer program for talented high school students from historically underrepresented and underserved groups. The 101 apprenticeships in 2013 represent a 23% decline from the 131 apprenticeships in 2012.

Table 3. 2013 REAP Sites

Ball State University	New Mexico State	University of Colorado Colorado Springs*
Christian Brothers University	Norfolk State University	University of Houston
City College of New York*	North Carolina Central University	University of Illinois Urbana-Champaign
Clark Atlanta University	Oakland University	University of Iowa
Colorado State University	Polytechnic University of New York	University of Maryland Baltimore
Delaware State University	Portland State University	University of Maryland College Park
East Central University	South Dakota School of Mines and Technology*	University of Massachusetts Lowell
Florida Atlantic University	State University of New York	University of South Florida
Georgia State University	Stony Brook University	University of Missouri
Iowa State	Tennessee State University	University of New Hampshire
Jackson State University*	Texas Southern University*	University of New Hampshire
Le Moyne College	Texas Technological University	University of North Carolina Pembroke
Loyola University	University of Alabama Huntsville	University of New Hampshire
Miami Dade University*	University of Arkansas Pine Bluff	University of South Carolina Upstate
Michigan Technological University*	University of California Irvine	University of South Florida
Minnesota Academy of Science	University of Central Florida	University of Texas Arlington
Montana State University	University of Cincinnati	University of Texas El Paso
New Jersey Institute of Technology*	University of Colorado Boulder	Washington State University

NOTE: ** = 2013 UNITE site*

The total cost of 2013 REAP was $349,690. The average cost per apprentice was $3,462. Table 4 summarizes these and other 2013 REAP program costs.

Table 4. 2013 REAP Program Costs	
2013 REAP – Cost Per Participant	
Total Participants	101
Total Cost	$349,690
Cost Per Participant	**$3,462**
2013 REAP - Cost Breakdown Per Participant	
Average Administrative Cost to AAS	$1,320
Average Student Stipend	$1,300
Average Mentor Stipend	$842*
Cost Per Participant	**$3,462**

NOTE: *Universities that host REAP students are provided with $1,300. Often this funding goes to support the mentor. In some cases this funding is reallocated to afford an additional REAP apprenticeship. In 2013, 86 grants were originally provided and 15 additional apprenticeships were supported through this process.*

Evidence Based Program Change

In response to the FY12 evaluation AAS made the following changes or additions to its administration of REAP in 2013 in the effort to effectively and efficiently meet AEOP and program objectives:

1. Recruitment and selection efforts focused on expanding REAP's reach geographically and on bringing the population of students served by REAP back to its originally intended population—students from groups historically underrepresented and underserved in STEM;
2. Collaboration with the UNITE program manager, focused on developing a pipeline for participants between the two programs;
3. Encouragement that apprentices and mentors at all university sites will participate in evaluation efforts; and
4. Development of a new format for competitively selecting mentors for REAP for implementation in the FY14 funding cycle.

The 2013 evaluation also incorporated FY12 evaluation recommendations that were relevant to REAP's evidence-based changes and other changes that were made to assessments AEOP-wide, including:

1. Focus groups conducted with apprentices and mentors at 4 REAP sites and phone interviews were conducted with apprentices and mentors representing 10 additional sites;
2. Enhanced Actionable Program Evaluation, including:
    - Marketing and recruitment to the REAP program;
    - Motivation to participate in REAP;
    - Perceptions of and satisfaction with REAP activities;
    - Perceived benefits of REAP; and
    - Suggestions for improvement to REAP.
3. Baseline data collection from mentors on current activities, challenges, and additional support needed related to
    - Mentoring historically underrepresented and underserved populations;
    - Educating students about AEOP opportunities; and
    - Educating students about AEOP opportunities STEM jobs, and specifically Army/DoD STEM jobs.

2013 Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • AAS providing oversight of site programming • Operations conducted by 54 universities • Students participating in 101 REAP apprenticeships • STEM professionals and educators serving as REAP mentors • Stipends for students to support meals and travel • Stipends for faculty to support administrative costs • Centralized branding and comprehensive marketing • Centralized evaluation	• Students engage in authentic science and engineering research experiences through hands-on summer apprenticeships at REAP-sponsored colleges and universities • STEM professionals supervise and mentor students' research	• Number and diversity of student participants engaged in programs • Number and diversity of STEM professionals serving as mentors for programs • Number and diversity of Army/DoD scientists and engineers and other military personnel engaged in programs • Number and Title 1 status of high schools served through participant engagement • Students, STEM professionals, site coordinators, and AAS contributing to evaluation	• Increased participation in authentic STEM activities • Increased participant STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in STEM research and careers • Increased participant awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve REAP programs	• Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased student pursuit of STEM coursework in secondary and post-secondary schooling • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of REAP

The REAP evaluation gathered information from apprentice and mentor participants about REAP 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 REAP program objectives.

Key Evaluation Questions

- What aspects of REAP motivate participation?
- What aspects of REAP structure and processes are working well?
- What aspects of REAP could be improved?
- Did participation in REAP:
  - 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?

The assessment strategy for REAP included onsite focus groups with apprentices and mentors at 4 REAP sites, phone interviews with apprentices and mentors representing 10 additional sites, a post-program apprentice questionnaire, and a post-program mentor questionnaire and rubric.

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

Table 5. 2013 Apprentice Assessments	
Category	**Description**
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level and degree field sought
Satisfaction & Suggestions	Awareness of REAP, motivating factors for participation, satisfaction with and suggestions for improving REAP programs
AEOP Goal 1- Indicators of Program Achievement	**STEM Competencies:** Perceptions of opportunities to engage in STEM activities in REAP (as compared to at school), self-reported change in confidence in their STEM competencies
	Army STEM: AEOP Opportunities –Past participation, exposure to, and interest in participating in other AEOP programs
	Army STEM: Army/DoD STEM Careers –Exposure to STEM and Army/DoD STEM jobs, change in interest for STEM and Army/DoD STEM jobs, attitudes toward Army/DoD STEM research
AEOP Goal 2 Program Efforts	**Mentor Capacity:** Apprentices' perceptions of day-to-day mentor activities

Table 6. 2013 Mentor Assessments	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of REAP, motivating factors for participation, satisfaction with and suggestions for improving REAP programs, benefits to participants
AEOP Goal 1- Indicators of Program Achievement	**STEM Competencies:** Perception of apprentices' opportunities to engage in STEM activities in REAP, assessment of apprentices' STEM competencies after REAP
AEOP Goal 1 & 2 Program Efforts	**Army STEM: AEOP Opportunities –** Mentor awareness and efforts to expose apprentices to AEOP opportunities, perceptions of apprentice interest in AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Mentor efforts to expose students to STEM and Army/DoD STEM careers, perceptions of apprentice interest in STEM and Army/DoD STEM jobs
	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 footnotes providing results from tests for significance.[1] Questionnaires and respective data summaries are provided in Appendix B (apprentice) and Appendix C (mentor). Focus group and phone interview protocols are provided in Appendices D (apprentices) and F (mentors). Major trends in data and analyses are reported herein.

Study Sample

The post-REAP questionnaires were provided to the 2013 REAP sites in electronic format using the Qualtrics® survey system hosted by Virginia Tech. A total of 93 apprentices from 49 sites responded to the apprentice questionnaire. In addition, 46 mentors from 35 sites responded to the mentor questionnaire and rubrics.

Table 7 provides an analysis of apprentice and mentor participation in post-REAP 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 statistical reliability achieved for REAP apprentices suggest high representativeness of the population. The larger margin of error for REAP mentors suggests less representativeness, however the mentor sample does represent more than two thirds of all REAP university sites. The mentor questionnaire data contributes valuable perspective to REAP evaluation and can be cautiously generalized with consideration given to the margin of error and triangulation of findings with mentor focus group and interview data. Expanded participation in 2013 evaluation assessments is a success for REAP.

Table 7. 2013 REAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[2]
Apprentices	93	101	92%	±2.9%
Mentors	46	95	48%	±10.4%

Focus groups were conducted at 4 REAP sites in the West, Southwest, and Northeast, U.S. Mentor focus groups included 9 mentors (5 females, 4 males). Apprentice focus groups included 22 apprentices (13 females, 9 males). Females, a targeted population of REAP, were incidentally overrepresented in focus groups at the sites selected. Phone interviews were conducted with evaluator-selected apprentices or mentors at 10 additional sites in the Northwest, Southeast, Midwest, and Northeast, U.S. Mentor phone interviews included 6 mentors (3 females, 3 males). Apprentice phone interviews included 6 apprentices (4 females, 2 males). Female apprentices were more responsive to individualized interview requests than their male counterparts. Focus groups and phone interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of

[1] 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.

[2] "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.

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

Respondent Profiles

Apprentice demographics. Demographic information collected from 2012 and 2013 REAP apprentice questionnaire respondents are summarized in Table 8.

Table 8. 2012 and 2013 REAP Apprentice Questionnaire Respondent Demographics

Demographic Category	2012 (n = 14-16/131)		2013 (n = 88-89/101)	
Gender				
Female	6	43%	53	60%
Male	8	57%	34	38%
Choose not to report	0	0%	2	2%
Race/Ethnicity				
American Indian or Alaskan Native	0	0%	2	2%
Asian or Other Pacific Islander[3]	7	50%	16	18%
Black or African American	1	7%	29	33%
Hispanic or Latino	2	14%	13	15%
White or Caucasian	3	22%	19	22%
Other[4]	0	0%	3	3%
Choose not to report	1	7%	6	2%
Socioeconomic Indicators (most frequent responses given)				
Public School Type	12	86%	81	92%
Suburban School Setting	11	79%	58	65%
Do Not Qualify for Free or Reduced Lunch	12	86%	53	60%
Grade Level and Age				
Rising Grade 9	0	0%	1	1%
Rising Grade 10	0	0%	5	5%
Rising Grade 11	5	39%	25	27%
Rising Grade 12	6	46%	42	45%
Rising College Freshman	2	15%	19	20%
Rising College Sophomore	0	0%	1	1%
Average Age	N/A		16.7 years	

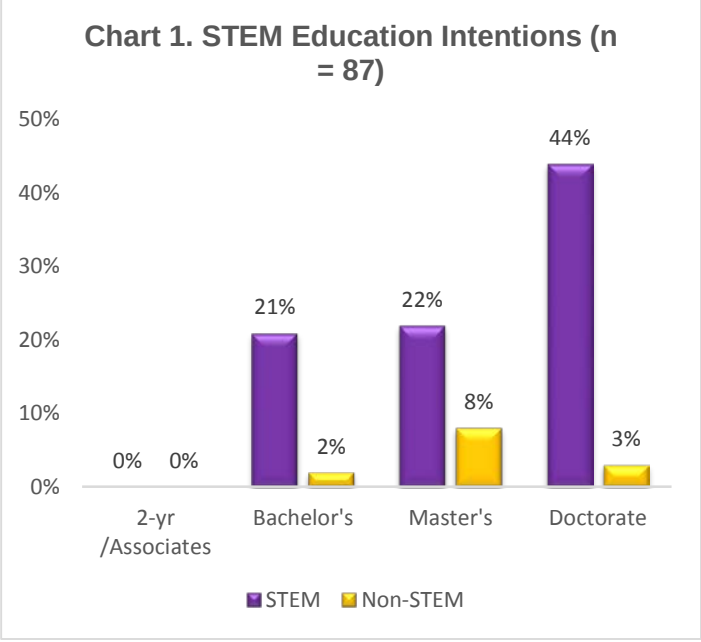
[3] The 2012 demographic category consisted only of Asian, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate Asian and Native Hawaiian and Other Pacific Islander categories in 2014 evaluations to reflect OSTP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

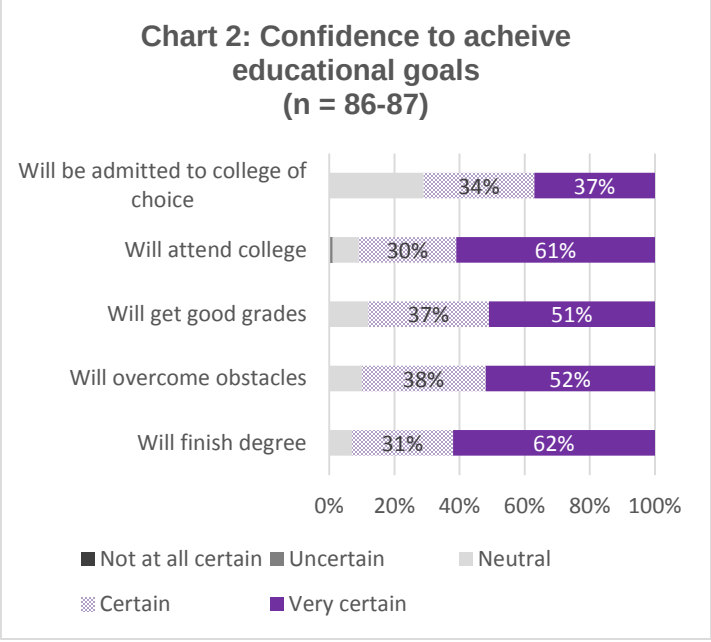
[4] "Other" category Included three responses of "multiracial"

In 2013 more females (60%) than males (38%) completed the questionnaire. More respondents identified with race/ethnicity category of Black or African American (33%) than any other single race/ethnic category. Respondents also included American Indian or Alaskan Native (2%) and Hispanic or Latino (15%) apprentices. Respondents most frequently reported they do not qualify for free or reduced lunch (60%)—a common indicator of low income status. Most respondents attended public schools (85%). School settings reported were predominantly suburban settings (65%). The average age of students was 16.7 years old, and most students (79%) had one or more years of high school left.

A comparison of 2012 and 2013 data may suggest progress was made in 2013 efforts to expand the participation of underrepresented and underserved populations in REAP. However, the poor statistical reliability of 2012 evaluation data (associated with the extremely low response rates), does not allow for conclusive determinations that REAP has progressed toward the objective. In 2013 REAP had success in attracting participation from female students—a population that is historically underrepresented in certain STEM fields. In 2013 REAP had some success in providing outreach to students from historically underserved minority race/ethnicity groups (50%) and low-income groups as determined by free or reduced lunch status (27%). This remains an area for growth.

Apprentice education intentions. All REAP apprentices (100%) expressed intent to pursue a college degree. Chart 1 summarizes students' intentions to pursue STEM and Non-STEM degrees in. Of the 89 respondents, 87% planned to pursue a degree in a STEM field. The majority of apprentices (66%) intend to pursue advanced degrees in STEM, included the most frequently selected doctorate (44%). Less than 15% of REAP apprentices intend to pursue non-STEM degrees.





REAP apprentices were asked how certain they are that they will achieve their education goals on a 6-point scale of 1 = "Not at all Certain" to 6 = "Very Certain." Chart 2 summarizes their responses. On all items more than 60% of students

claimed to be certain or very certain. Students are most certain (93%) that they will attain their ultimate education goal—a degree. Students are least certain (71%) they will be admitted to the college and program of choice.

The apprentice questionnaires asked which STEM field apprentices would like to pursue. Of the 86 respondents, 91% indicated their intent to pursue a career in a STEM-related field. More respondents intended to pursue careers in Medicine/Health (36%) than any other field, with Engineering (26%), Chemistry (9%), and non-STEM (8%) fields being the next most frequently reported fields.

The assessment items and resulting data regarding apprentice educational intentions do not discern whether REAP have established education and career goals prior to participation, or to what extent their REAP participation in any way affects their pre-REAP goals. However, from these figures and other findings within this report, we can surmise that most REAP apprentices had established, if not well-established, education goals for their STEM pathway upon. REAP clearly provides outreach to the Nation's future STEM workforce, but almost 40% of REAP apprentice talent pool intended to pursue the applied STEM-field of medicine.

Mentor demographics. Demographic information collected from 2012 and 2013 REAP mentor questionnaire respondents are summarized in Table 9.

Table 9. 2012 and 2013 REAP Mentor Questionnaire Respondent Demographics

Demographic Category	2012 (n = 14)		2013 (n = 46)	
Gender				
Female	3	21%	11	24%
Male	11	79%	35	75%
Choose not to report	0	0%	1	2%
Race/Ethnicity				
American Indian or Alaskan Native	0	0%	0	0%
Asian or Other Pacific Islander[5]	2	14%	7	15%
Black or African American	2	14%	7	15%
Hispanic or Latino	1	7%	1	2%
White or Caucasian	8	57%	31	67%
Other	0	0%	0	0%
Choose not to report	1	7%	0	0%
Past REAP Participation				
Apprentices Mentored for REAP (Historically)	Avg. = 9, Range = 1-50		Avg. = 11, Range = 1-60	
Consecutive Years Mentoring for REAP	Avg. = 6, Range = 1-33		Avg. = 8, Range = 1-35	

REAP mentors were predominantly male (75%) and White/Caucasian (67%). Again, the poor statistical reliability associated in 2012 evaluation data, do not allow for conclusive determinations about REAP's progress in diversifying its

[5] 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.

mentors. However, a comparison of 2013 mentor and apprentice gender and race/ ethnicities suggests that a majority of apprentices of underserved or underrepresented populations were not likely to have access to mentors sharing the same gender or race/ethnicity characteristics—a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM. This is another area of potential growth for REAP.[6]

Once recruited, REAP mentors appear to have a long-term relationship with the program. Of 45 mentor questionnaire respondents, only 20% were first time REAP mentors. The average number of REAP apprentices mentored through the years was 11, ranging from 1 to 60 apprentices. Mentors reported an average of 8 years of participation ranging from 1-35 years. Two mentors reported being a REAP apprentice in the past. Mentors' long-term relationship with REAP provide a wealth of knowledge and experience mentoring for REAP, from which REAP apprentices benefit.

Just under half of the questionnaire respondents report mentoring for non-REAP programs. Five mentors (10% of the mentor respondents) mentor for the NSF Research Experience for Undergraduates program. In total, 35 other program were listed by these 22 mentors.

Mentors were asked to describe their area of research, with the same broad fields provided in the apprentice questionnaire. The majority of mentors identify with one of the three primary disciplines of science and engineering: Chemistry (26%), Life Science (24%), Physical Science (15%), and Engineering (15%). Fewer report environmental (7%), medicine/health (7%), or other STEM field (4%).

Mentor research foci are noticeably different apprentice interests, especially in terms of proportions reporting medicine/health fields. Future evaluations might explore whether REAP apprentices ultimately intend to be medical practitioners versus medical researchers, and also the extent to which those intentions are influenced by their REAP apprenticeships. For example, to what does the REAP apprenticeship attract any would-be medical practitioners into medical research or another field of science or engineering research with medical applications?

[6] Appendix G was added to this report in response to AAS' question: "Where is the evidence to support the claim that similar gender/race/ethnicity is a motivator for students to be interested in STEM?" A brief review of the literature and frequently cited references are provided.

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 6 and 7.

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

Marketing and Recruiting Underserved Populations

Online questionnaires, focus groups, and phone interviews all included items addressing how participants originally learned about REAP, 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 for both apprentice and mentor participants.

The apprentice questionnaire asked how apprentices heard about REAP, in order to understand how REAP ultimately attracts apprentice participants. Chart 3 summarizes apprentices' responses. Apprentices most frequently learned about REAP from high school staff, such as teachers and counselors (25%) or through family or family friends (22%). In total, 30% of apprentice questionnaire respondents reported having a family member or family friend at the university where the REAP apprenticeship took place. Apprentice interviewees also reported learning about REAP from friends, family members, or other influential acquaintances (e.g., teachers and civic group leaders) who connected them to REAP before they applied at the AEOP website. At one REAP site that evaluators visited, 7 of the apprentices had learned of REAP through their mothers, who were networked to one another and to the REAP mentor. Data suggest that most apprentices are recruited by REAP sites, rather than finding REAP on their own.

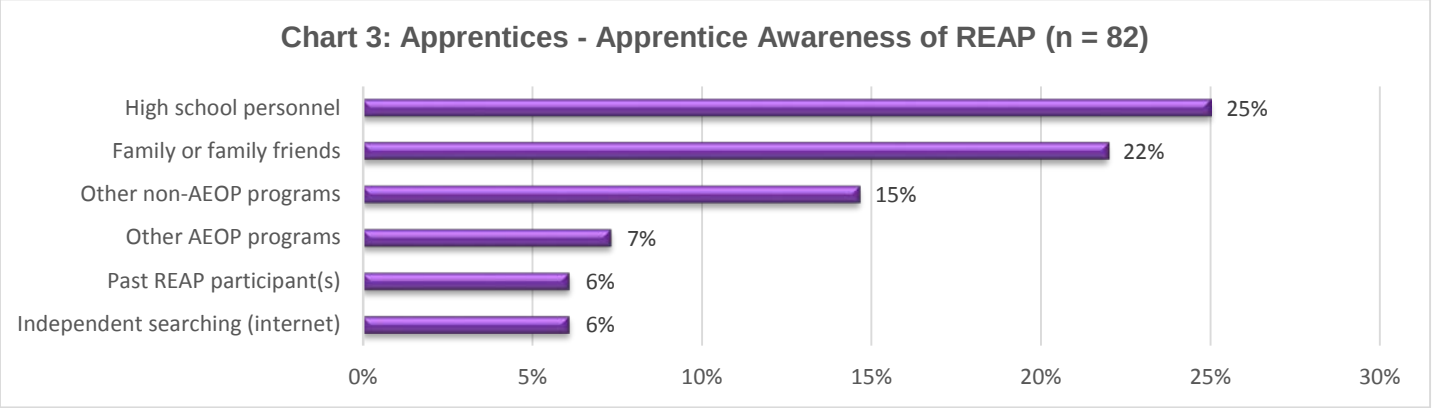
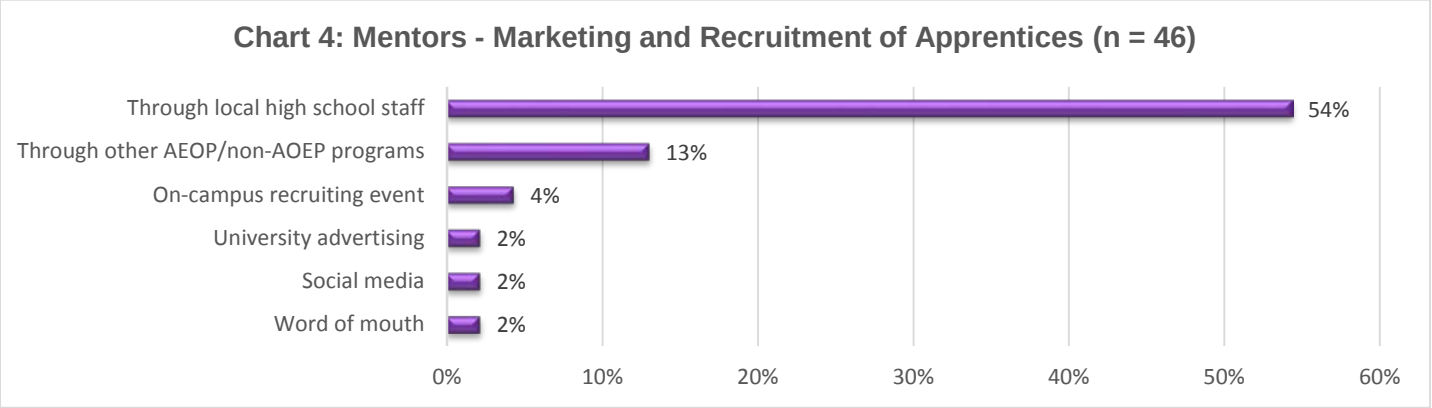


Chart 4 summarizes mentors' reports of REAP marketing and of apprentice recruitment and selection. Of 46 mentor questionnaire respondents, 54% report actively recruiting apprentices through connections with staff at local high schools, 13% through other programs for high school students, and 4% through on-campus recruiting events for high school students. This seems consistent with apprentice reports.



More than 48% of mentors report instructing their recruits to apply via the AEOP website and then selecting from their applications. Fewer mentors reported, in either questionnaires or interviews, selecting from an unknown (or unvetted) applicant pool or being assigned to an apprentice by the AEOP. Twenty one percent of mentors reported receiving an initial list from REAP and then using interviews and other performance records to select apprentices from the applicant pool. Less often, mentors report accessing another university program's applicant pool, inviting back past REAP apprentices, or lack of awareness about how the local REAP students were selected.

At UNITE-REAP pipeline universities, UNITE program alumni were identified by the UNITE site coordinator and recommended to a potential REAP mentor. Beyond the UNITE alumni, who are from historically underserved populations, only a small number of mentors specifically noted efforts to maximize diversity in their selection by targeting minority race/ethnicity or low-income apprentices. AAS reported that all sites were notified of the intent to transition back to serving underrepresented and underserved students and embraced the decision.

Most mentor interviewees reported learning about REAP from colleagues who had a personal connection to REAP or to another AEOP at the site (e.g., UNITE). Of the 46 mentor questionnaire respondents, 52% learned about REAP from a colleague, often a past or current REAP mentor or coordinator at the university. Additionally, 33% reported introduction and encouragement to pursue the REAP by a Department Chair, Center Director, or Dean. About 10% reported learning of the program from US Army Research Office, from the Junior Science & Humanities Symposium (also managed by AAS), or by AAS communications and websites. Two mentors learned of REAP after being approached by students who wished to apply to REAP and were searching for a mentor.

Motivating Factors for Participation

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

Motivating factors for apprentices. Most apprentice interviewees were primarily motivated to participate by the encouragement they received from others who have connections to the REAP program, including: parents, friends and relatives (past participants), teachers or other influential adults in their schools and community groups. Apprentice interviewees also chose to participate in REAP because it would help them progress in their intended STEM pathway, including: clarifying a future field of study, expanding understanding of a subject of interest, or providing research experience in a college research laboratory. A small number were motivated by their own positive experiences in REAP last year, or in other AEOP programs, such as West Point Bridge Design Competition, Junior Science & Humanities Symposium, and UNITE.

Motivating factors for mentors. Most REAP mentor interviewees were influenced to participate through personal or professional connections with current or past REAP staff who regarded their experiences highly, or because of their own positive experience as a REAP mentor. Several mentors describe the "passing down" of REAP from senior or retiring faculty to junior faculty. Mentors also expressed other motivating factors pertaining generally to university and STEM ambassadorship, including:

- promoting university values of community outreach;
- generating excitement and interest in high school students for STEM;
- enriching others' experiences in STEM beyond what is available in school;
- providing opportunities for high school students to learn STEM-specific, social, and job skills that would carry over into college and career; and
- developing a pipeline of STEM talent from high school through graduate school.

Mentor Capacity

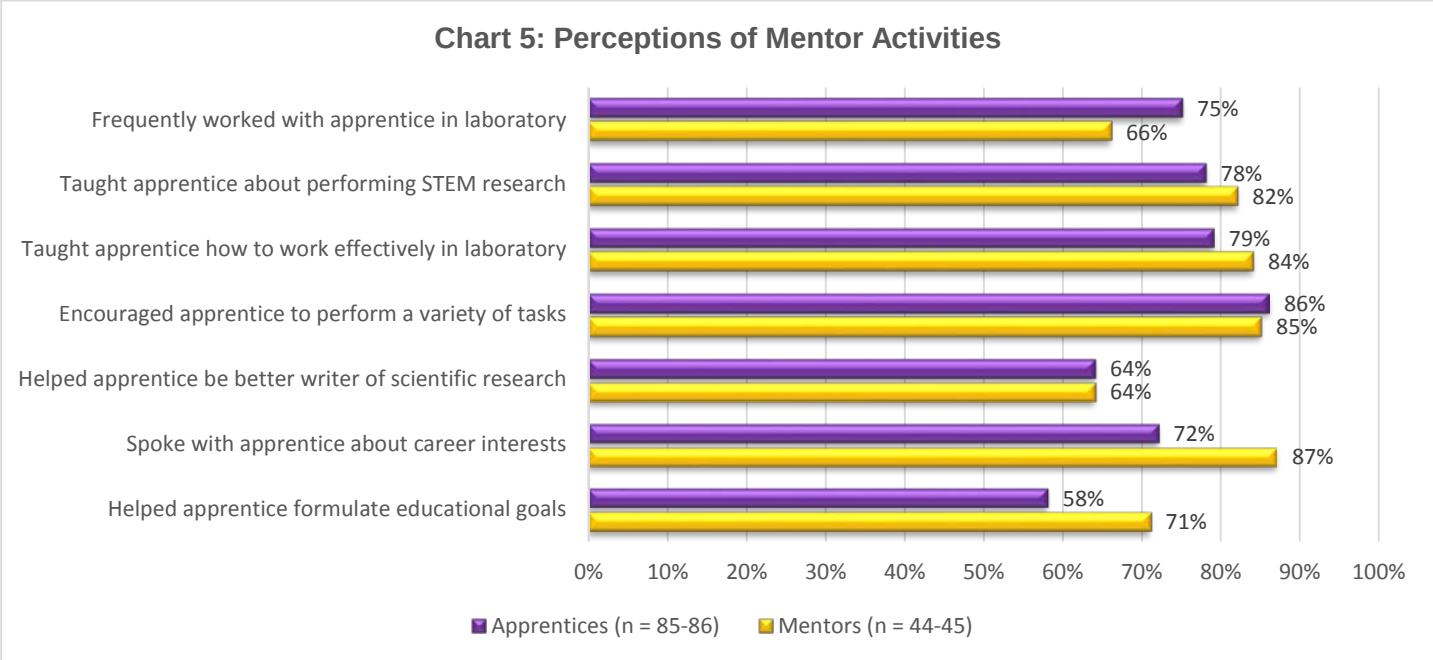
REAP's third objective is to provide participants with mentorship from a scientist or engineer for professional and academic development purposes. The nature and quality of mentoring provided is a critical factor to maximizing students' participation in STEM and sustaining or inspiring their interest in future STEM work. Understanding mentor activities from

the perspectives of mentors and apprentices can inform programmatic improvement for sustaining students' interest and participation in STEM.

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

General mentor activities. Mentor and apprentice questionnaires included seven items to elicit perceptions of general mentor activities. Mentors and apprentices responded on a 6-point scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree." Chart 5 summarizes the proportions of mentors and apprentices that selected "Agree" or "Strongly Agree" for each item. The full data are summarized in Appendices B and C. Interview and focus group assessments also included items asking apprentices and mentors to think about a typical day in REAP and describe mentoring received or provided, respectively.

Apprentice and mentor questionnaire respondents reported similar frequencies of mentor activities related to engaging apprentices in STEM research, as evident from questionnaire findings reported in Chart 5. Significance tests were performed on the item averages for each group. The only statistically significant difference found was between apprentices' and mentors' perceptions of speaking about apprentices' career interests.[7]



[7] p < 0.05 $p < 0.05$ with independent samples t-test (two tailed);Mean Diff. = .47, $p = .03$, $d = .36$, weak/small effect

Mentor and apprentice interviewees also described similar mentor activities occurring most frequently, including:

- academic research skills development;
- traditional teaching such as lectures or readings to build knowledge;
- a progression of modeling then coaching then fading their support for teaching apprentices how to use laboratory equipment and conduct laboratory procedures;
- a variety of feedback types and mechanisms; and,
- a team-based approach to supporting the REAP apprentice.

Chart 5 suggests that mentorship around academic/scientific writing was less prevalent than mentorship around laboratory-based work. This finding was also evident in interview and focus group findings, in which few apprentice and mentor interviewees reported efforts to involve apprentices in publications or any other formal or informal technical writing. A unique strategy involving scientific writing was reported from a team of three mentors at one site. The strategy involved apprentices authoring daily summaries of assigned literature reviews, of informal team discussions, and about their own laboratory work. These summaries were perceived as helping apprentices to review day-to-day progress (allowing apprentices and mentors to identify areas of need), to learn the language of science, and to cultivate interest in their work.

Chart 5 suggests that apprentices and mentors may perceive mentoring around educational and career pathways differently. Significance testing reveals real but small differences in perceptions of mentorship activities related to discussing careers, as described above. Subsequently, apprentice interviewees frequently described networking with other undergraduate and graduate students on campus or laboratory personnel to learn about educational and career pathways more frequently than engaging in such discussions with their mentors.

A trend noted in both apprentice and mentor focus groups and interviews was that other laboratory personnel contributed significantly to the day-to-day mentoring of REAP apprentices, sometimes more so than the faculty mentor. Apprentices and mentors both described the role that other undergraduate and graduate students, postdocs, and laboratory technicians play in mentoring apprentices. They described the benefits of team-based approaches to mentoring, most notably allowing work to continue in the absence of the faculty mentor during the period of the apprenticeship, or when competing demands of a large laboratory group prevented one-on-one mentorship from the faculty mentor. Mentor interviewees frequently reported benefits of a team-based mentoring approach to others in the laboratory, beyond just the apprentice being mentored.

***Mentoring underserved populations*.** The mentor assessments asked about strategies used, challenges faced, and ways in which REAP could support mentors in working with students from underserved or underrepresented groups. Mentors described a number of strategies for working with underserved students. The most frequently cited included treating all apprentices equally (30%) and providing encouragement and confidence in apprentice abilities (23%). At least 10% of mentors mentioned each of building personal relationships with apprentices, ensuring good role models are available (either themselves, former REAP apprentices, or others from underserved or underrepresented populations), and pairing apprentices with more senior students in the lab.

Mentors also expressed a number of challenges. Most frequently, mentors mentioned disparity in readiness of apprentices from underserved populations, including gaps in their conceptual understanding and skills (25%) that must be remediated. Second, mentors reported resource-related challenges (28%) with recruiting and hosting underserved students. For example, mentors perceived difficulty attracting underserved students because REAP apprenticeships must compete with higher paying summer jobs,[8] and underserved students are less likely to have access to transportation and other resources (e.g., laptops, software) to make participation feasible.

Mentor questionnaire respondents and interviewees suggested a number of ways REAP could support them in working with underserved populations, including efforts to expand site-based and REAP-wide community-building and support for post-REAP educational and career opportunities:

- Place more apprentices at a site or in a single lab to encourage collegiality, support, and community;
- Provide additional financial resources to support underserved apprentices, including funding for supplies and computers/software for apprentices, part-time academic year internships to continue their research, and funding for travel to a national meeting for presenting their research;
- Provide information and development opportunities for mentors, including guidance on recruitment efforts, establishing objectives for apprentice outcomes and products, and other best practices in mentoring;
- Provide more visibility of university REAP programs at the REAP and AEOP websites and in any AAS-led marketing conducted in high schools; and,
- Provide more networking opportunities for REAP apprentices such as a REAP conference, poster or oral competitions linked to scholarships, and an online REAP community with scholarship and job postings.

Mentoring about AEOP opportunities. The mentor assessments asked about strategies used, challenges faced, and ways in which REAP could support mentors in educating apprentices about AEOP opportunities. The majority of mentor questionnaire respondents (60% of 28) and interviewees (100% of 6 phone interviewees, 86% of 7 focus group interviewees) claimed they did not discuss any other AEOP initiatives with their apprentices much less encourage participation. The majority of mentor interviewees cited their own lack of awareness about AEOP initiatives as the primary challenge preventing them from educating apprentices about future AEOP opportunities. For example, nearly all REAP mentors reported they had not been provided any AEOP marketing materials at the time focus groups and interviews were conducted with them.

Mentors questionnaire respondents and interviewees suggested the following programmatic revisions for supporting them in educating their apprentices about AEOP initiatives, including:

[8] A few apprentices did mention the benefit of the paid REAP apprenticeship and/or the quality of the experience over a "typical" summer job; however, apprentices generally did not share sentiments that the payment was too low. Future application processes might gather data from all applicants about factors that motivate participation to assess the extent to which different groups are motivated by different factors. Marketing the program to underserved students may need to emphasize different aspects of the program that attend to their different motivations.

- Provide comprehensive resources, such as brochures, executive summaries, online presentations and video that provide sufficient details about AEOPs. These could be disseminated through mentors or directly to apprentices through an improved AEOP website;
- Provide routine email communications and/or conference for informing mentors about AEOP programs; and,
- Establish a requirement that REAP apprentices serve as mentors or ambassadors to other AEOP programs, such as the UNITE program run on the same campus. (The suggestion emerged from a mentor team during an onsite focus group. This model of AEOP ambassadorship was already being enacted at another site which evaluators visited.)

A small number of mentors considered educating apprentices about other AEOP opportunities to be the responsibility of the AEOP and or the REAP administrator, AAS, and could be accomplished through an improved AEOP website.

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. The mentor assessments asked about strategies used, challenges faced, and ways in which REAP could support mentors in educating apprentices about STEM and specifically Army/DoD STEM careers. Mentors used different strategies in mentoring students about STEM careers: through direct discussions, storytelling about former students now employed in STEM professions, and even using online resources such as websites, webinars, and video (sources unspecified). A number of questionnaire respondents and interviewees reported that they limited their STEM pathway discussions with apprentices to college majors, programs, and funding (e.g., scholarships, ROTC) rather than STEM careers. A small portion of mentors who exposed their apprentices to Army/DoD careers did so through the research project, through website or video (sources unspecified), and through a doctoral student working at an Army lab. Most frequently, mentors cited their own limited awareness of Army/DoD research and career opportunities as the biggest challenge for exposing apprentices to Army/DoD STEM careers.

Mentors suggested the following programmatic revisions for supporting them in better educating their apprentices about Army/DoD STEM careers:

- Provide comprehensive resources, such as interactive website, video series, or booklet that detail various research foci and possible careers at Army/DoD laboratories. These could be disseminated through mentors or directly to apprentices;
- Provide information about Army/DoD funding for STEM pathways, including internship programs, scholarships, fellowships, and ROTC; and
- Provide opportunities for guest speakers from Army/DoD to visit REAP sites or opportunities for apprentices to visit Army/DoD sites.

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

Perceptions of REAP

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

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

Apprentices often compared their REAP experience to STEM learning in school settings. REAP provides

- Opportunities for deeper learning, and preferred mechanisms and support for this deeper learning (e.g., hands-on learning, application of concepts, one-on-one mentorship, balance of direction and autonomy, teamwork);
- Authentic research experiences that allow apprentices to engage with STEM practices, processes, and tools within an academic research setting;
- Experience and confidence in conducting, presenting, and writing about STEM research;
- Exposure to new STEM subject matter, majors, and careers;
- Opportunities to preview and clarify STEM interests and educational pathway; and
- Valuable mentorship and networking that will be advantageous through college and career.

Mentors most frequently described the ways in which REAP serves to advance apprentices in their STEM pathways. Mentors reported that REAP

- Provides apprentices with authentic research experiences in a college laboratory setting;
- Previews and better prepares apprentices for college and/or career;
- Exposes apprentices to and allows apprentices to explore STEM subject matter, majors, and careers;
- Motivates new interest or clarifies apprentices' existing interest in STEM; and,
- Develops apprentices' skills that are broadly applicable to future research endeavors.

Mentors also described REAP's value in terms of its benefit to them or their laboratories. Mentors reported that during REAP

- Apprentices made meaningful and significant contributions to the work of the lab;
- Mentors were able to promote university and personal values of community outreach;
- Mentors developed or expanded their teaching and mentoring skills; and,
- Mentors learned subject matter more intensely by teaching it to apprentices.

Successes and challenges in REAP. The questionnaire asked mentors to report successes and challenges they or their apprentices experienced. Of 34 respondents, 44% reported generally having positive experiences with the apprentice and/or REAP. Mentors perceived a number of apprentice successes, including that apprentices

- Developed as STEM researchers;
- Achieved their research goals;
- Engaged in research presentations and writing;
- Learned about and became interested in new STEM subjects, majors, and careers;
- Learned research skills that will be useful for future research;
- Built experimental apparatus that can be used by others in the lab;
- Became an integral part of the research team; and
- Taught other laboratory personnel about their research and equipment.

One mentor also found value in learning along with the apprentices.

Challenges described by mentors included the following:

- Conflicts with apprentice scheduling, and keeping apprentice on schedule to meet goals;
- Low stipends provided for apprentices and mentors;
- Dissatisfaction with under-performing and ill-behaved apprentices;
- Difficulties finding research projects and/or tasks that are appropriate for a high school apprentice; and
- Technical problems with REAP website.

Overall satisfaction and areas for improvement. Apprentices and mentors were asked several items to gauge their overall satisfaction with REAP. 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 REAP, what would you say?
Apprentice and Mentor Phone Interviews	Would you recommend participating in the program [as an apprentice/as a mentor] to others? If so, why? If not, why not?
Apprentice Questionnaire	Given the opportunity, would you participate in REAP again? Why or why not?

Most mentors wanted to share with Army decision makers that REAP provides access to STEM facilities and support to underserved students that wouldn't otherwise have opportunities. Mentors also would share their recommendations for improving REAP's impact, including that REAP should

- Organize an annual REAP conference, either nationally or regionally;

- Establish a REAP network, specifically for promoting scholarship and job opportunities for REAP alumni;
- Offer opportunities for REAP apprentices or alumni to compete for awards and/or scholarships, such as through a poster or oral research presentation competition; and,
- Require that each REAP apprentice "pay it forward" by mentoring other REAP apprentices, mentoring in another AEOP program, or serving as an ambassador for recruiting new participants to REAP.

Mentor interviewees were unanimous in stating they would recommend REAP to their colleagues. They gave reasons that included the following: REAP provides research opportunities to underserved students, mentors have opportunities to be good role models and motivate others to take more interest in STEM, and REAP fulfills the university's requirements that faculty participate in community outreach. Mentors cautioned that careful mentor selection is necessary for a good REAP program: mentors should be vetted mentors, good at working with kids, and have interest and ability to support students' research interests (not just the faculty members').

REAP apprentice interviewees were also unanimous in stating they would recommend REAP to their peers. Their reasons enumerated a number of opportunities REAP provides apprentices, all of which were described in the *Value of REAP* section above. These same sentiments were shared in focus groups, when asked what apprentices would share with an Army decision maker. Additionally, apprentices would suggest to Army decision makers increasing visibility of and access to the program through marketing (e.g., to the public), expanding the number of REAP apprenticeships at each university site, and lowering the age restriction for participation.

In post-REAP questionnaires, apprentices were asked if they would participate in the REAP program again if given the chance. Of 84 respondents, 88% said they would participate again if given the chance. About 30% of apprentices expressed general satisfaction with their REAP experience. Of the specific reasons given for participating again, apprentices most frequently described benefiting from learning or expanding their STEM knowledge and skills during REAP. REAP exposed apprentices to STEM in ways that clarified or advanced their STEM pathway, including preparation for college, experience working in a research laboratory, and exposure to a STEM field or career. A few apprentices reported satisfaction from networking with other students and working closely with a mentor. Of those claiming that they would not or are unsure if they would participate again, the reasons included that they were not interested in STEM, REAP does not provide enough of a stipend, the experience lacked direction and goals toward which the apprentice could work, or the apprentice is just too busy to repeat again.

Outcomes Evaluation

The evaluation of REAP 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 apprentices' and mentors' perceptions of apprentice engagement in STEM activities in REAP, post-REAP perceptions of apprentices' STEM competencies, and apprentices' awareness and interest in educational and career opportunities in Army STEM.

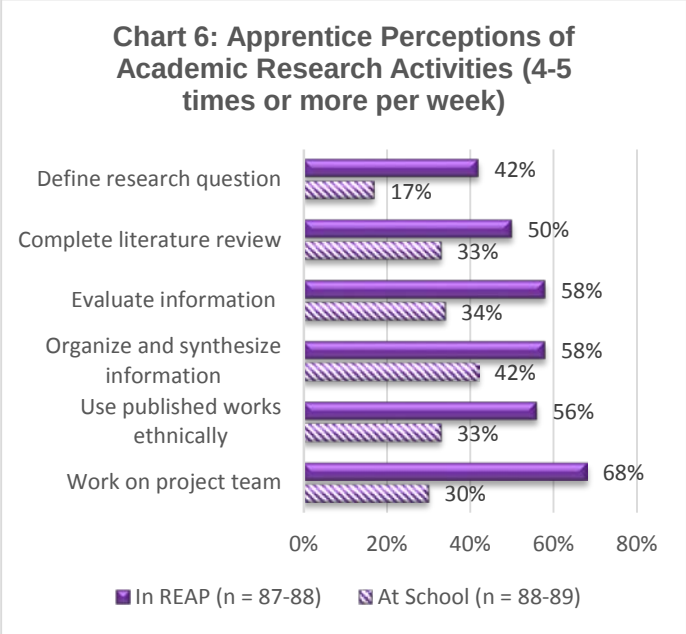
STEM Competencies

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 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 the following REAP Objectives:

- Objective 1—Provide high school students from groups historically under-represented and underserved in STEM, including alumni of AEOP's UNITE program, with an authentic science and engineering research experience; and,
- Objective 4—Develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.

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

Charts 6 and 7 on the next page summarize the proportions of apprentices reporting engaging in each activity 4-5 times per week or more in REAP and at school. Full items and data are summarized in Appendix B. The proportion of apprentices reporting engaging in these activities 4-5 times per week during REAP approaches or exceeds 50% for all activities (47%-75%). Smaller proportions of apprentices engaged in these kinds of activities at school with similar frequency (12%-44%).



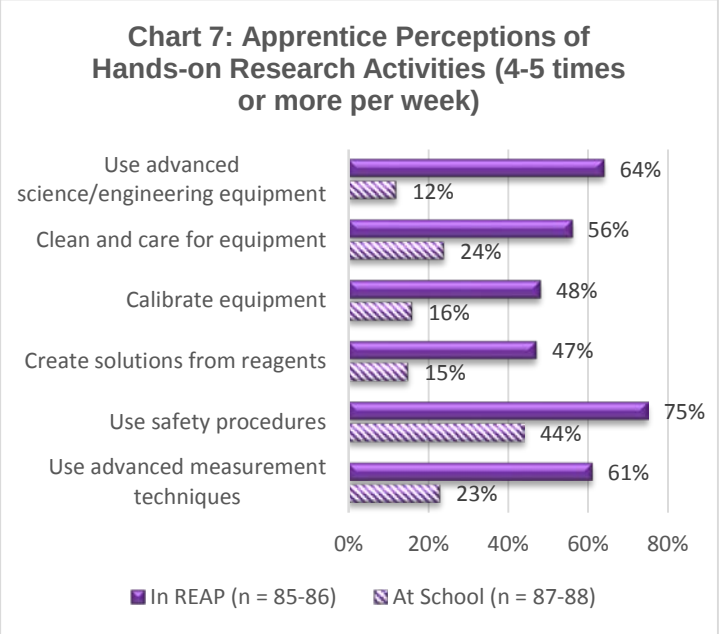


Table 11. Engagement in STEM activities, matched cases At school vs. In REAP

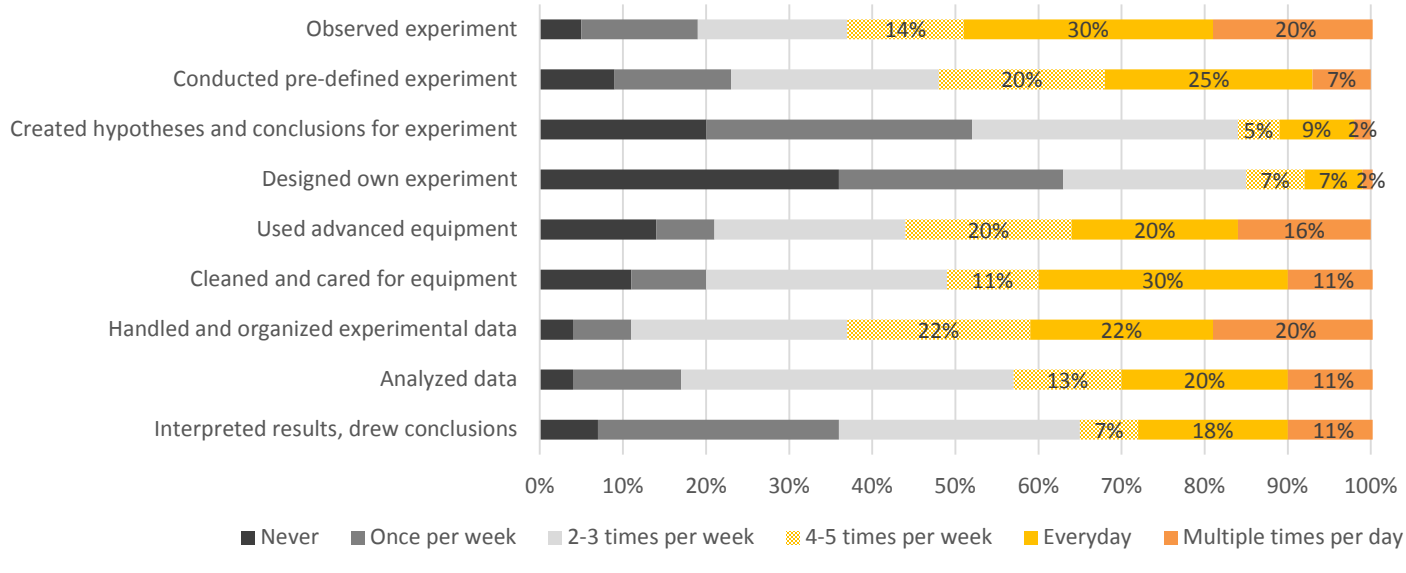
Item	At school Avg. (SD)	In REAP Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I had to define a research question or thesis and determine its critical concepts	2.41 (1.3)	3.46 (1.66)	87	**1.046***	5.68	.000	.609
I had to use academic search strategies (e.g., databases and journals) to complete a literature review	2.77 (1.53)	3.67 (1.76)	86	**.907***	4.34	.000	.468
I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	3.03 (1.57)	3.95 (1.55)	87	**.920***	4.25	.000	.456
I had to organize and synthesize information across academic sources	3.22 (1.58)	3.92 (1.65)	86	**.698***	3.31	.001	.357
I had to determine appropriate ethical and legal uses of published academic research for my own work	2.83 (1.59)	3.34 (1.91)	87	**.517***	2.2	.031	.236
I had to work as part of a team on research projects	3.03 (1.57)	4.25 (1.57)	88	**1.216***	5.3	.000	.565
I used advanced science or engineering equipment	2.28 (1.31)	4.09 (1.69)	86	**1.814***	8.68	.000	.936
I cleaned and cared for the equipment in a science or engineering laboratory	2.74 (1.47)	3.88 (1.73)	86	**1.140***	5.48	.000	.591
I calibrated laboratory equipment for experimentation	2.31 (1.3)	3.55 (1.74)	86	**1.233***	6.17	.000	.666
I created solutions from reagents in preparation for experimental procedures	2.15 (1.15)	3.24 (1.84)	85	**1.082***	5.28	.000	.572
I used proper safety procedures when handling equipment and material in the lab	3.52 (1.55)	4.47 (1.66)	86	**.942***	4.26	.000	.460
I employed advanced measurement techniques in science or engineering procedures	2.59 (1.44)	4.09 (1.65)	85	**1.506***	7.14	.000	.775

NOTE: ** = p < .05 with paired samples t-test (2-tailed)*

The statistical comparison of the frequency with which students report engaging in STEM activities in REAP and at school, is provided in Table 11 on the previous page. On average, students engaged in these activities approaching 4-5 times per week in REAP (Avg ~3.8/6.0) and approaching 2-3 times per week at school (Avg ~2.7/6.0). Table 11 reveals that these differences between REAP and school are statistically significant across all items ($p < .05$), with effects ranging from weak to strong. For example, the difference in engaging in ethical uses of published academic work in REAP and at school is real but considered a very weak effect ($d = .236$). The difference in using advanced science or engineering equipment in REAP and at school is a strong effect ($d = .936$). In general, significance testing reveals that REAP had a larger effect in providing apprentices with opportunities for hands-on research activities than it does the more academic research activities.

Mentor perceptions, summarized in Chart 8, corroborate the above finding. According to mentors, apprentices have more opportunities to observe experiments, conduct pre-defined experiments, use and care for equipment, and handle and organize data. In other words, apprentices had more opportunities for the hands-on aspects of STEM research. However, apprentices generally had fewer opportunities for the minds-on aspects of STEM research, including hypothesizing about experiments, designing their own experiments based on those hypotheses, analyzing and interpreting data, and drawing conclusions.[9] A small proportion of mentors reported that their apprentices never engaged in each of the activities. Substantial proportions of mentors reported that their apprentices had no opportunities to design their own experiment (35%) or create hypotheses and conclusions for experiments (20%).

Chart 8: Mentor - Assessment of Apprentice Engagement in STEM Activities (n =44-45)



[9] Appendix G was added to this report in response to AAS' assertions about the applicability of minds-on contributions in REAP. A brief review of the literature and frequently cited references are provided.

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 REAP program. In addition, six rubrics in the REAP mentor questionnaire leveraged mentors' expertise as researchers and observations of apprentices during the program to provide expert ratings of apprentices' academic and hands-on research skills and abilities. The STEM skills and abilities assessed by both apprentices and mentors have sufficient overlap to allow for some triangulation of findings. The apprentice items and mentor rubric items (defined at the expert level) are summarized in Table 12.

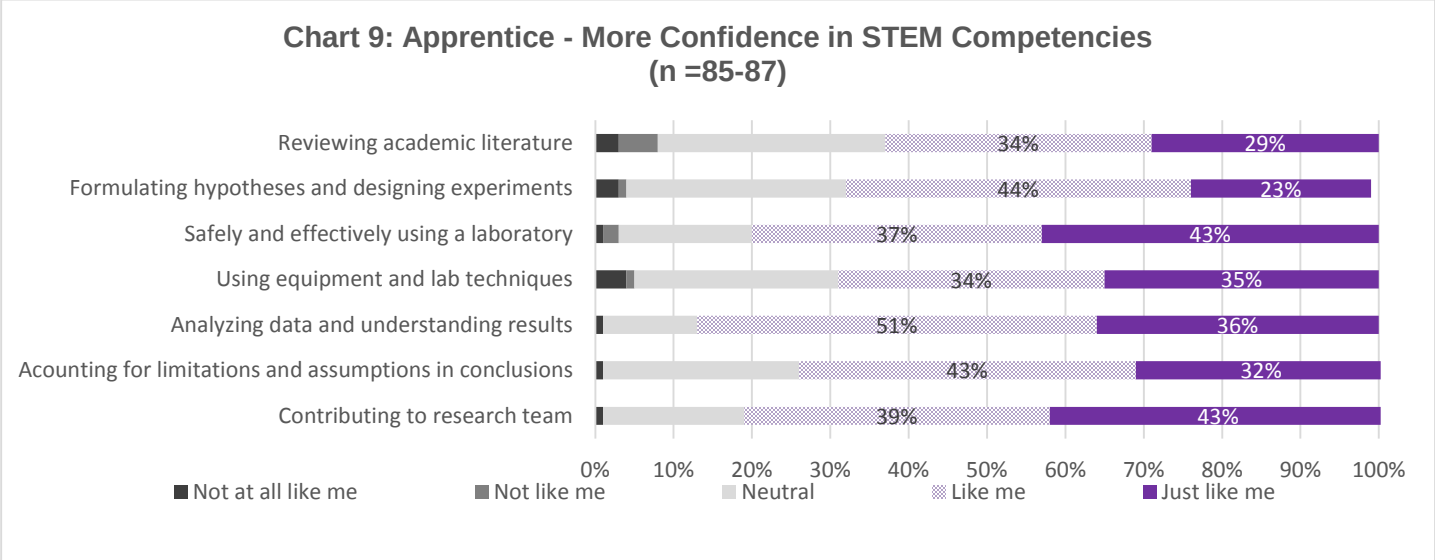
Table 12. Apprentice and Mentor Assessments of STEM Skills and Abilities

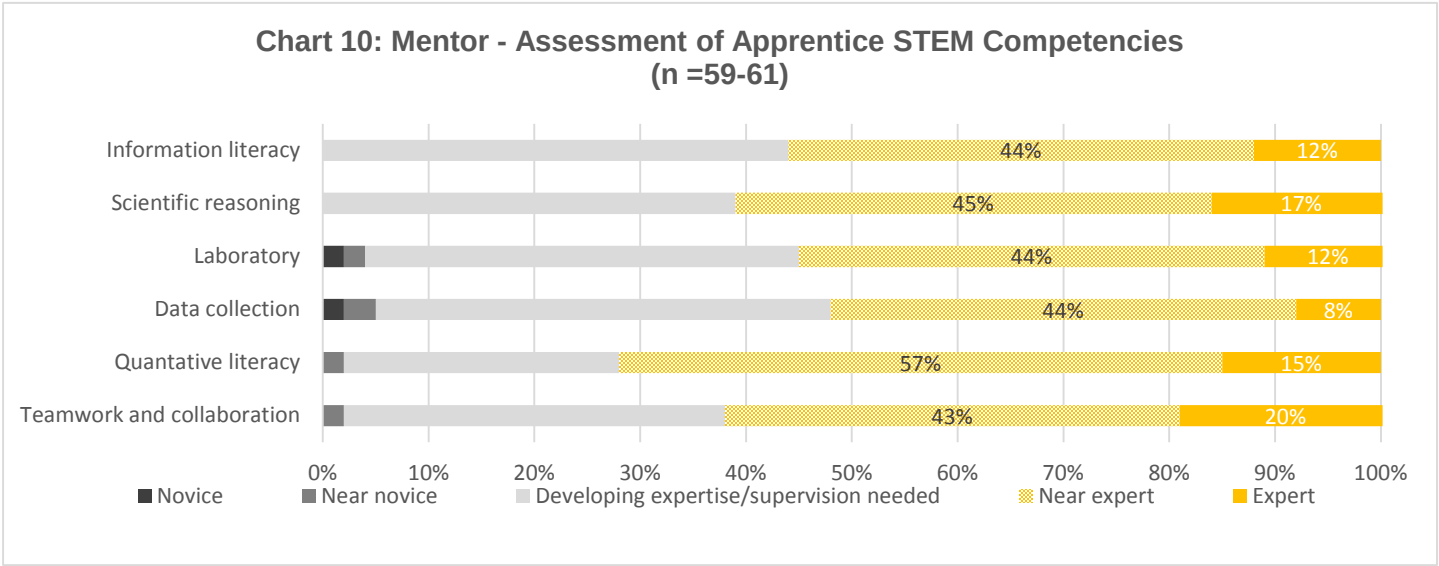
Apprentice Confidence Item	Mentor Rubric Item: Expert Level
I am more confident in my ability to complete academic literature reviews for my own research projects	**Information literacy skills/abilities:** Expertly determines, searches for, and accesses needed information. Synthesizes and uses information 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.
I am more confident that I can make significant research contributions as an effective part of a research team	**Teamwork and collaboration skills/abilities:** Frequently offers alternative ideas and synthesizes multiple points of view from team members. Completes work ahead of time and helps others complete their own tasks. Is always respectful and works to motivate the team as a whole.

Apprentices responded on a 6-point scale of 1 = "Not at all like me" to 6 = "Just like me." Mentor rubrics defined a development continuum on a scale of 1, reflecting novice behaviors, to 6, reflecting expert behaviors, unique to each STEM skill or ability. Actual scales and data from each mentor rubric items are provided in Appendix C. For ease of visualizing mentor rubric responses here, we will assign a more generic scale across all of the rubrics of 1 = "Novice," 2 =

"Near novice," 3-4 = "Developing expertise/supervision needed", 5 = "Near expert," 6 = "Expert." Charts 9 and 10 summarize apprentices' and mentors' responses to the STEM Competency items.

Chart 9 indicates that the majority of apprentices (63%-87%) perceived growth in their confidence across the range of skills and abilities. Larger proportions of apprentices perceived gains in confidence analyzing data and understanding results (87%), contributing to the research team (82%), and safely and effectively using a laboratory (80%).





From Chart 10 the majority of mentors (52%-72%) rated their apprentice's skills and abilities in the near expert or expert levels of the development continuum across the range of skills or abilities, with apprentices performing more expertly in

quantitative literacy (72%), teamwork and collaboration (63%), and scientific reasoning (62%). The average apprentice receives a rating approaching 5.0/6.0 across all skills and abilities (4.54-4.80/6.0), except for data collection (Avg. 4.38/6.0).

From post-only assessments, the evaluation cannot conclusively report that REAP contributed to improvement in apprentices' skill and abilities. However, considerable agreement between perceptions of apprentice growth in confidence and mentor assessment of STEM skills and abilities, including in the two most highly rated items for each participant group, suggest REAP's contribution to their growth is likely. Taken together, and also considering "successes" reported in a previous section, we would conclude that students perceived growth in their STEM skills, and mentor assessment of their performance corroborates those perceptions.

Final project or presentation. Additionally, six rubrics were given to mentors to rate the quality of their apprentice's final research paper or presentation. Each rubric represents one of six dimensions of typical of STEM research papers or presentations. Much like the aforementioned mentor rubrics, each rubric defined a development continuum on a scale of 1, reflecting novice behaviors, to 6, reflecting expert behaviors, unique to each component of the research paper or presentation. Table 13 summarizes each dimension as it is defined at the expert level.

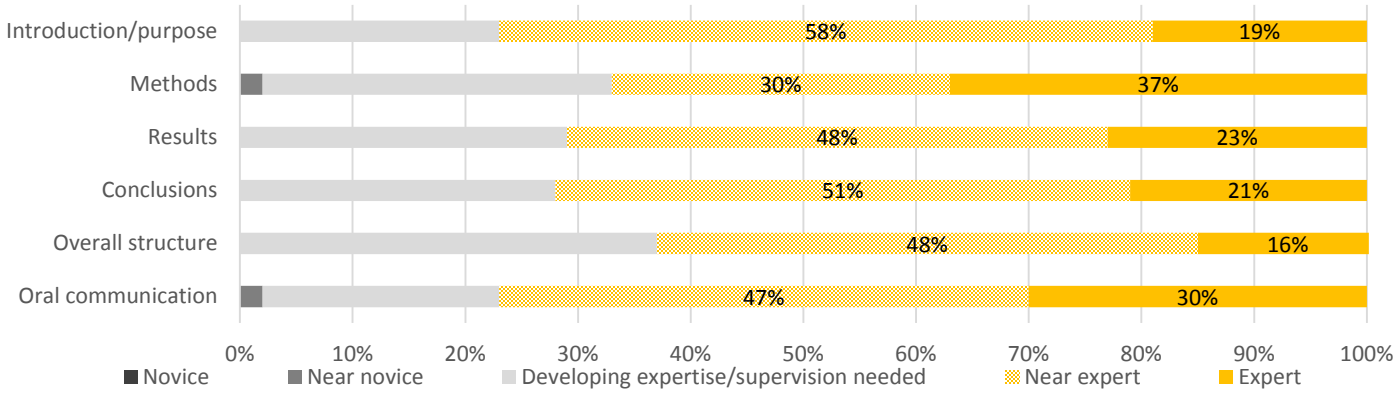
Table 13. Mentor Assessments of Final Paper or Presentation

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

Mentors rated all six components of their apprentices' final research project very highly. The average apprentice received a rating approaching 5.0/6.0 for all components of their research program (Avg. 4.75-5.00/6.0). These data suggest that apprentices produced high level research projects within the university laboratories where they worked.

Chart 11: Mentor - Assessment of Apprentice Final Paper or Presentation (n =36-47)



Army STEM

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[10] and University of Virginia[11] found that exposure to STEM as adolescents peaked immediate interest in near-term STEM-related pursuits and had a significant effect on future pursuit of STEM degrees and careers, respectively.

Subsequently, 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,

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)

[10] 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

[11] 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.

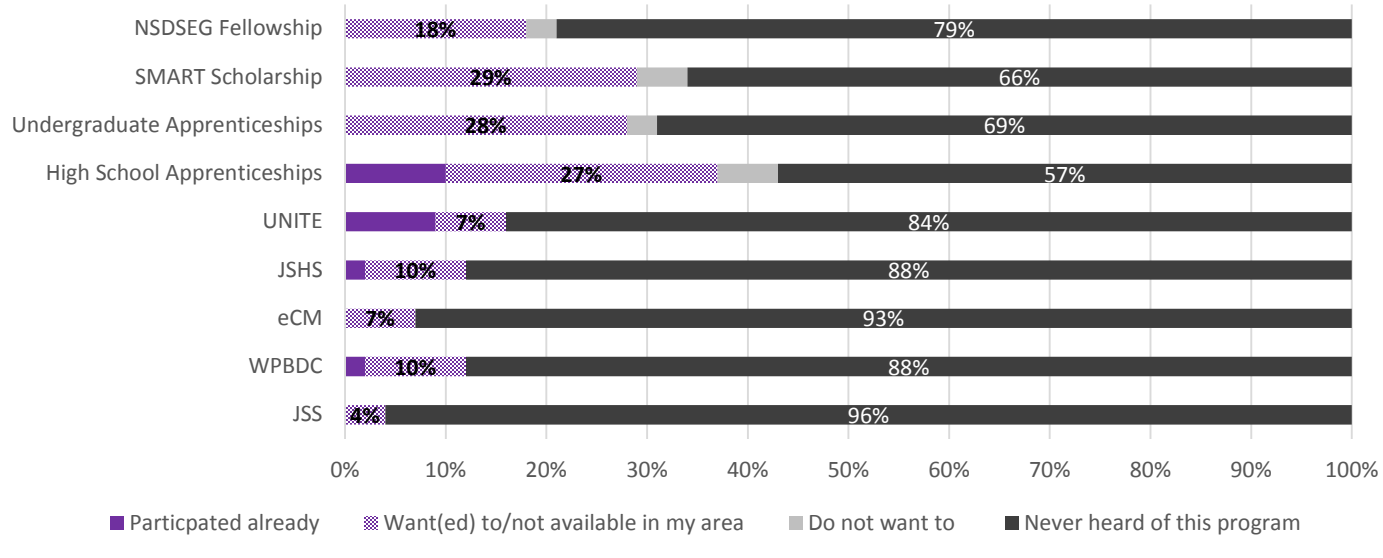
requires that each program promote its participants' awareness of both AEOP initiatives and Army/DoD STEM careers. Apprentices and mentors who are aware of the portfolio of AEOP programs can serve as stewards of AEOP in their personal and professional relationships, advancing the AEOP's mission of outreach. Mentors who are aware of and knowledgeable about the portfolio of AEOP programs can provide guidance and encouragement to apprentices regarding next steps in their AEOP pathway. Mentors who are knowledgeable about 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 DoD STEM careers are more likely to seek them out in the future.

The assessments measured apprentice awareness and interest in participating in AEOP opportunities and Army/DoD STEM careers. In addition, the apprentice assessment measured apprentice attitudes toward Army/DoD STEM research and careers. Mentor assessments included corresponding items to corroborate apprentice findings and are shown here for comparison. These measures correspond to REAP program Objective 2: To introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP.

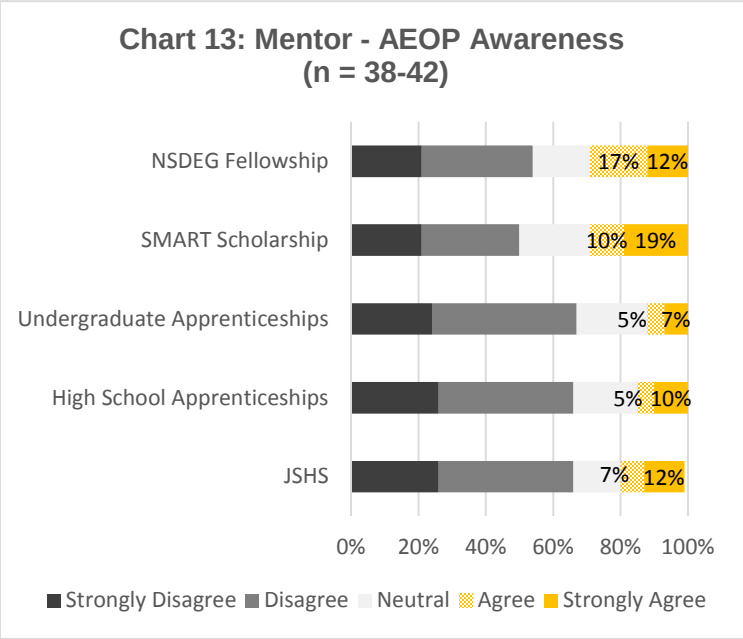
AEOP Opportunities. Apprentice questionnaires simultaneously elicited past participation in, awareness of, and interest in other AEOP opportunities. These data are reported together in Chart 12.

A very small number of students had participated in West Point Bridge Design Competition (2%), Junior Science & Humanities Symposium (2%), UNITE (9%), and High School Internships (10%). Of those 10% completing AEOP-sponsored high school internships, 8% participated in REAP once before, and 2% participated in REAP twice before.

Chart 12: Apprentice - AEOP past participation, awareness, and future interest (n =36-47)



The most striking finding is that at the time of this questionnaire (near or after the conclusion of most REAP apprenticeships), the majority of students (57%-96%) indicated that they have never heard about various AEOP opportunities. A substantial proportion reported that they want to participate in, or would participate but perceive the program is not available in their area. For example, nearly one third of apprentices were interested in other high school and undergraduate internships, college scholarships, or graduate school fellowships, and 10% expressed interest in JSHS, a research competition. A small proportion (3-6%) of apprentices expressed awareness of but lack of interest in each of the high school and undergraduate apprenticeship programs.



Mentors were asked to report their level of awareness of AEOP and DoD opportunities for which their high school apprentices may still qualify. The items asked mentors to respond on a scale of 1 = "Strongly Disagree" (reflecting lack of awareness) to 6 = "Strongly Agree" (reflecting awareness). As shown in Chart 13, most mentors (50-66%) were unaware of these AEOP and DoD opportunities. A small proportion of mentors (12%-29%) reported awareness of these programs. When asked whether they provided information to their apprentices about AEOP and DoD programs, 10% of mentors answered in the affirmative, whereas 70% disagreed or strongly disagreed.

The apprentice questionnaire introduced JSHS as regional research symposia and a national scholarship-awarding research competition. This program is a logical next step for participants of AEOP apprenticeship programs such as REAP. Of 87 respondents, 6% expressed interest in submitting their REAP project to the AEOP's JSHS this year. This is not surprising given that only 14% of 41 mentors report encouraging their apprentices to do so. Yet, 18% of apprentices expressed interest in submitting their presentation to other sponsored science fairs or competitions, such as Siemens Science & Engineering Fair, Intel International Science & Engineering Fair and the Google Science Fair.

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) in general, and specifically, STEM careers within the Army/DoD. Subsequently, apprentices were asked whether they became interested in those new STEM careers. Chart 14 summarizes apprentices' perceptions of exposure to STEM and Army/DoD STEM careers during REAP, and resulting interest. Chart 15 summarizes mentors' perceptions of efforts to educate their apprentices about careers and apprentice interest in STEM careers.

Chart 14: Apprentice - Awareness and Interest in STEM Careers (n = 86-87)

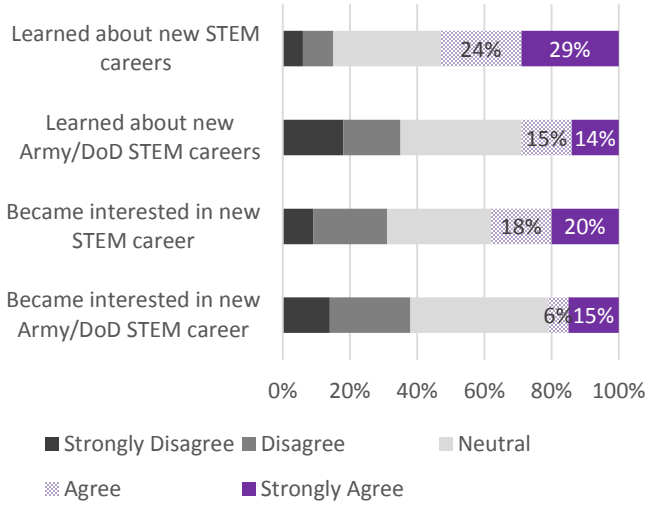
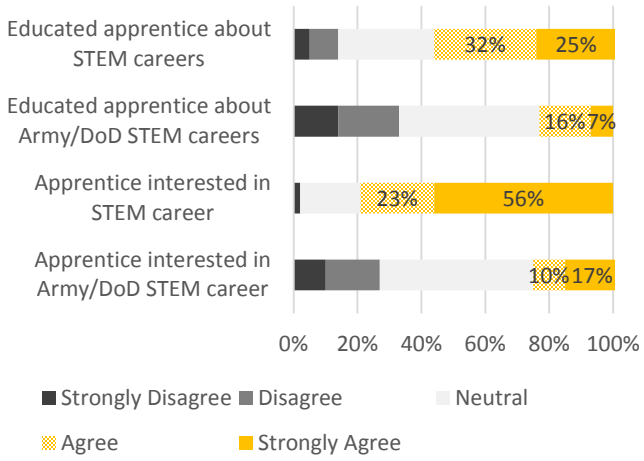


Chart 15: Mentor - Apprentice Awareness and Interest in STEM Careers (n = 41-42)



Charts 14 and 15 illustrate that a majority of apprentices had opportunities to and perceived learning about STEM careers during REAP. However, data from both apprentices and mentors revealed that apprentices were provided with significantly fewer opportunities to learn about Army/DoD STEM careers.[12] Mentors perceived significantly large differences in their efforts to educate apprentices about STEM careers in general as opposed to Army/DoD STEM careers. In addition, nearly 40% of REAP apprentices and mentors reported no opportunities for apprentices to learn about Army/DoD STEM jobs or careers. The majority of mentors interviewed by evaluators cite lack of awareness of Army/DoD STEM careers as the primary reason for not educating apprentices about them.

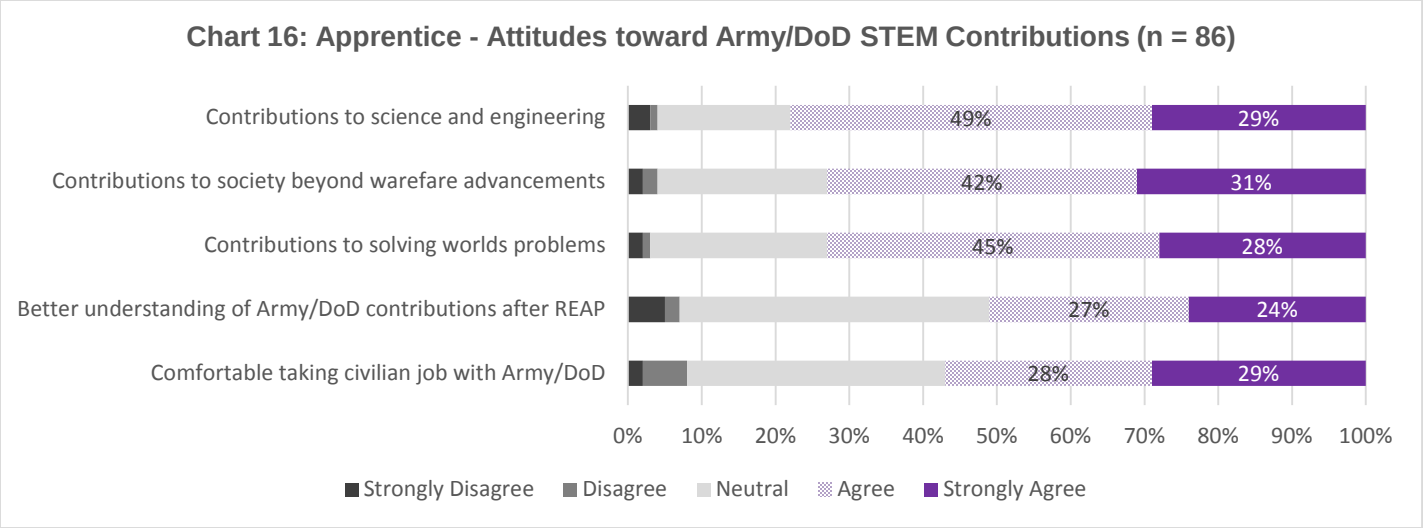
Nearly 40% of apprentices became interested in a new STEM career during REAP, and 79% of mentors suggest that their apprentices expressed genuine interest in future STEM careers. Significantly fewer apprentices became interested in Army/DoD STEM careers than STEM careers in general during REAP.[13] Apprentice data revealed significant though slightly lower interest in Army/DoD STEM careers versus STEM careers in general. Mentor data suggests significant larger differences in apprentices' expressed interest to pursue STEM versus Army/DoD STEM careers.

[12] $p < .05$ with paired samples t-test (2- tailed); Apprentice learned about new STEM vs. Army/DoD STEM careers: Mean Diff = 1.011, t = 7.03, $p = .000$, $d = .753$ moderate effect; Mentors educated about STEM vs. Army/DoD STEM careers: Mean Diff = 1.047, t = 5.48, $p = .000$, $d = .835$ large effect.

[13] $p < .05$ with paired samples t-test (2- tailed); Apprentice STEM vs. Army/DoD STEM interest: Mean Diff = .453, t = 3.09, $p = .003$, $d = .333$ small effect; Mentors perceptions of interest in STEM vs. Army/DoD STEM: Mean Diff = 1.643, t = 7.37, $p = .000$, $d = 1.137$ very large effect

When asked which three new STEM jobs they found most interesting, apprentices listed 58 different jobs or careers. Of those listed, careers in engineering disciplines were most prevalent. Chemical engineering was most frequently cited (27%) by students, followed by environmental engineering (11%). Also, 10% of students listed each of biomedical engineering, computer software engineering, and mechanical engineering. Taken together, students cited engineering jobs with the most frequency. Three of 55 apprentices specifically referenced interest in a science or engineering career with the Army or military.

Attitudes toward Army/DoD STEM. Five items measured apprentices' attitudes toward Army STEM research and careers. Chart 16 summarizes apprentices' responses. Most apprentices (73-78%) expressed agreement that Army research and researchers have made valuable contributions to science and engineering fields and to society. A majority of REAP apprentices (51%) credited REAP with improving their understandings of Army/DoD STEM contributions. In contrast to the 21% who became interested in a job or career with the Army/DoD during REAP, 57% expressed they would be comfortable taking a civilian position in STEM with the Army/DoD. Subsequently, 35% of mentors agreed or strongly agreed that their apprentices expressed a positive attitude toward the Army/DoD and STEM careers it offers.



In summary, apprentice and mentor accounts conclude that a majority of apprentices had opportunities to learn about new STEM careers during REAP (54% apprentices, 57% mentors), but Army STEM careers get less attention (29% apprentices, 23% mentors). However, apprentice data suggests that REAP served to inspire interest in new STEM careers, including 21% expressing new interest in Army/DoD STEM careers. 51% credit REAP with improving their understanding Army/DoD STEM contributions, and 57% would consider a civilian position in STEM with the Army/DoD.

What Participants are Saying

An overwhelming majority of apprentices and mentors surveyed and interviewed spoke highly of their REAP experiences. Many apprentices and mentors encouraged expansion of REAP 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. The following quotations provide illustration of overall participant satisfaction:

REAP Apprentices would participant again, if given the chance:

- "Given the opportunity, I would definitely participate in REAP again. I don't get many chances to participate in a university lab, under the mentorship of a university professor. I think this opportunity is invaluable because working in a university under a professor can give you experience that a high school cannot. Additionally, I feel that I've gained so much knowledge from just seeing how a university research works; participating in it really pushed my intellectual limits."
- "If a genie granted me a wish to spend the summer anyway I will like, I would use that wish to participate in the REAP program again. I learned things from data software to fundamentals of research. It has given me a leg up on college and has inspired me to pursue my interest in independent experimentation and research. This has probably been one of the most valuable summers of my high school years. I am grateful for the opportunity and knowledge REAP has given me. Thank You."
- "Yes! REAP opened up my view of what STEM careers were all about. In school, I participate in many science classes but NEVER get the opportunity like this!"
- "Yes, it was eye opening and interesting to see the varying job opportunities available utilizing similar skills and for the general advancement of society through science and technology."
- "Yes; through REAP I gained immense knowledge of the career field I intend to pursue and hands-on experience in a lab setting."

REAP Apprentices value the mentorship provided:

- "She has taught me fundamentals of research by introducing me to databases that most scientist look upon for resources and how to properly display and present data to scientists. Most importantly, through her I have gained insight into the world of atmospheric sciences and she has widen my view of science and the opportunities it can give me."
- "[He] helped me to create detailed 3-D visual models for my research regarding nanotechnology and neuroscience. He was always very eager to help me and also explained the steps involved in making such models very thoroughly. I am very thankful I was able to work with him!"

REAP Apprentices value the experience REAP offers:

- "I am satisfied with my REAP experience because I feel as if I am walking away with stronger foundation of the sciences that will help me greatly later on in life. I'm grateful for this opportunity that encourages high school students to be ambitious and try to move beyond the traditional boundaries."
- "I worked with nanotechnology and it was eye opening. I have never even heard of nano-particles before this program, but throughout this program I was working with them every day. It gave me a better understanding of the STEM field that I am happy to take with me throughout my years. Working in labs also helps me in school because I have a better understanding of things at school."
- "Through my REAP project, I learned the impact of climate change on health. I was able to combine the two worlds of medicine and public health with environmental science…This journey of research has changed the way I view weather and I am more cautious of its effect on my asthma. I plan to spread this insight and bring awareness to my community."

REAP mentors value their apprentice's contributions:

- "We prepared a poster about our research. This was posted during the 18th International Conference on Cold Fusion at Univ. of Missouri, July 21 to 27, 2013. There were 39 posters. Ours received the Best Poster award."
- "[Her] initial experiment for her project failed to return any positive results, but she was able to use this challenge to learn how to diagnose problems with these experiments, and her most recent attempt at the experiment yielded a positive result, so I'm pleased that she was able to improve her lab skills and gain success in the lab after a challenge."
- "[She] was placed on a project in which she also worked with a visiting scientist from Mexico. She was great at communicating with him, helping him in the lab, and actually showing him how some of the equipment was used when I was not available."
- "It was really great to see how excited he was when he was able to design and build (by machining) a specialized holder for a detector that we use for optical measurements. It is always great when you see a student get excited about something that they accomplished, especially when it is something that they have never had the opportunity to try before."
- "For each new technique [she] learned, she prepared, without prompting, a short presentation on the theory and principles of the technique, its primary applications and what she used it for. This was very informative, not only for her but for other students in the research group. Several undergraduate and graduate students learned about aspects of techniques they commonly employed and had not realized."
- "It took some time to get her to understand that she was an integral part of the laboratory…The success was of course that she actually become one of the research team."

Summary of Findings

The 2013 evaluation of REAP collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 14.

Table 14. 2013 REAP Evaluation Findings	
Participant Profiles	
REAP apprentice and mentor participation in evaluation yielded sufficient confidence in the findings.	• The statistical reliability achieved for the REAP apprentice questionnaires allow us to sufficiently generalize findings of the evaluation sample to the population. Findings from mentor questionnaires can be cautiously generalized with consideration given to the margin of error and triangulation of findings with mentor focus group and interview data. Expanded participation in 2013 evaluation assessments is a success for REAP.
REAP had some success in serving historically underrepresented and underserved populations.	• REAP was successful in attracting participation of female students (60%)—a population that is historically underrepresented in engineering fields.
	• REAP had some success in providing outreach to students from historically underserved minority race/ethnicity and low-income groups. Questionnaire respondents included apprentices identifying as Black or African American (33%), American Indian or Alaskan Native (2%), and Hispanic or Latino (15%), as well as apprentices who qualify for free or reduced lunch (27%).
REAP's mentor diversity did not mirror the diversity of apprentices.	• Mentors identified as predominantly male (75%) and White or Caucasian (67%).
	• A comparison of apprentice and mentor demographics suggested that many apprentices of underserved or underrepresented populations are not likely to have mentors sharing the same gender or race/ethnicity characteristics—a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.
REAP provides outreach to the Nation's future STEM workforce.	• 91% of the 86 respondents indicated their intent to pursue a career in a STEM-related field. More respondents intended to pursue careers in Medicine/Health (36%) than any other field, with Engineering (26%), Chemistry (9%), and non-STEM fields (8%) being the next most frequently reported fields.
Actionable Program Evaluation	
REAP marketing and recruitment was largely a site-based endeavor.	• 54% of mentors reported actively recruiting apprentices through connections with local high schools, 13% through other programs for high school students, and 4% through on-campus recruiting events. University- and faculty-led advertising, social media, and word of mouth are also used to recruit apprentices.
	• Apprentices most frequently learned about REAP from high school personnel (25%) or through family or family friends (22%). 30% of apprentices reported having a family member or family friend at the university where the REAP apprenticeship took place.
	• 52% of mentors learned about REAP from a colleague and 33% from a superior, such as a Department Chair, Center Director, or Dean.
REAP apprentices participate to clarify and advance their STEM pathways.	• Apprentices received encouragement to participate from others, including friends, family members, and school staff, often who have current or past connections to the REAP program. Additionally, apprentices participated to clarify and advance their STEM pathways. A small number were motivated by their own positive experiences in REAP or other AEOPs.

REAP mentors participate to serve as university and STEM ambassadors.	• Mentors received encouragement to participate from other colleagues, including peers, more senior faculty, and superiors, often who have current or past connections to the REAP program. Additionally, mentors participated in REAP to serve as university and/or STEM ambassadors.
REAP mentors used a team-based approach to engaging their REAP apprentices in STEM research.	• Apprentices and mentors reported similar frequencies and types of mentor activities related to engaging apprentices in STEM research, with more focus on laboratory-based work than on academic or scientific writing.
	• Apprentices and mentors suggested that other students and laboratory personnel contributed significantly to the day-to-day mentoring and guidance about STEM educational and career pathways, sometimes more than the designated REAP faculty mentor.
	• Mentors suggested a number of ways that REAP can improve its impact on underserved students, including efforts to establish or expand site-based and REAP-wide community-building and support for post-REAP educational and career opportunities.
REAP mentors lacked awareness and resources for promoting AEOP opportunities and Army/STEM careers.	• Most mentors had limited awareness of or past participation in an AEOP initiative beyond REAP or the AEOP UNITE program on their campus. Most mentors suggested that more resources were necessary to educate apprentices about AEOP opportunities. A small number of mentors reported that educating apprentices about other AEOP opportunities is the responsibility of the AEOP and REAP administrator, AAS, and could be accomplished through an improved AEOP website.
	• Many mentors educated apprentices about STEM majors, programs, and funding sources for their educational pursuits. Some mentors educated apprentices about STEM careers, but few of those were Army/DoD STEM careers. Most mentors suggested that more resources are necessary to allow them to comfortably educate apprentices about Army/DoD STEM careers, in particular.
REAP benefited apprentices, mentors, and laboratories.	• Apprentices and mentors perceived that REAP benefits apprentices by providing authentic and deeper learning opportunities not available typical school settings. Mentors suggested establishing program features to engage apprentices in a larger community of REAP and AEOP alumni after during and after their apprenticeship.
	• Mentors also perceived benefit to their laboratories and to themselves, most notably that apprentices made meaningful contributions to the work of the lab.
Outcomes Evaluation	
REAP engaged apprentices in authentic STEM activities and improved their STEM competencies.	• Apprentices perceived that REAP provides significantly more opportunities to engage in authentic STEM activities as compared to their school setting, including academic (42%-68% in REAP, 17-42% in school) and hands-on (47%-75% in REAP, 12%-44% at school) research activities. Apprentice and mentor data suggested REAP has a larger effect with providing apprentices opportunities for hands-on research activities (using equipment safely, following procedures) than it does academic research activities (generating questions, designing experiments, analyzing and interpreting data, formulating conclusions).
	• Most apprentices (63%-87%) perceived growth in their confidence across 7 STEM skills and abilities. A majority of mentors (52%-72%) rated their apprentices at near expert or expert levels of the development continuum across 6 skills and abilities. The majority of mentors (64%-77%) also rated all 6 components of their apprentices' final research project or presentation in the near expert or expert levels.

REAP apprentices were largely unaware of AEOP initiatives, but showed substantial interest in future AEOP opportunities.	• Apprentices (57%-96%) and mentors (50-66%) were largely unaware of other AEOP initiatives. Yet, substantial apprentice interest exists in AEOP opportunities: 27-29% of apprentices expressed interest in high school, college apprenticeship programs, and college scholarship program and 10% expressed interest in JSHS, a research competition program.
REAP had some success in increasing apprentices' awareness of, interest in, and attitudes toward Army/DoD STEM careers.	• Apprentice and mentor data suggested that a majority of apprentices had opportunities to learn about new STEM careers during REAP (54% apprentices, 57% mentors), but Army STEM careers received less attention (29% apprentices, 23% mentors).
	• REAP served to inspire interest in new STEM careers, with 21% of apprentices expressing new interest in Army/DoD STEM careers in particular.
	• 51% of apprentices credited REAP with improving their understanding Army/DoD STEM contributions, and 57% of apprentices would consider a civilian position in STEM with the Army/DoD because of their valuable contributions to society. 35% of mentors perceived their apprentices expressed a positive attitude toward the Army/DoD.

Recommendations

1. Based on the demographic data collected in evaluation assessments, REAP had some success in providing outreach to students from historically underserved minority race/ethnicity and low-income groups. Future evaluation and annual program reporting may provide a clearer picture of REAP's success in this area. However, additional program-level efforts and stronger collaboration between AAS and university sites may be required to fully realize this objective. For example, program level efforts such as AAS' competitive 2-year selection process, continued marketing to HBCUs and MSIs, and strengthening and expanding of the UNITE-REAP pipeline provide some assurance that universities receiving REAP awards are poised to serve minority and low-income populations. Further collaboration between AAS and universities are needed during the recruiting and selection processes for both apprentices and mentors. AAS and universities should consider
    a. How to mitigate underserved students' resource and educational gaps (identified by mentors), to ensure their participation is both feasible and successful;
    b. How to recruit and select apprentices in ways that do not unwittingly privilege certain students over others (e.g., those with personal connections to the university site, coordinator, or mentor); and
    c. How to recruit a more diverse yet highly qualified pool mentors that reflect the gender and race/ethnicity characteristics of apprentices. Access to mentors of the same gender and/or race/ethnicity have been suggested as a potential factor for reducing stereotypes and increasing students' performance and persistence in STEM.

2. Data suggests that REAP apprentices have more opportunities to do the *hands-on* aspects of research and fewer opportunities to contribute to the *minds-on* aspects. AAS, in collaboration with university sites, should explore creative strategies for supporting all apprentices in having opportunities to contribute to generating questions, designing experiments, analyzing and interpreting data, and formulating conclusions for research in which they are engaged. For example, sites may reproduce the daily written summary described in one of the REAP focus groups, or promising practices occurring at other sites or in the research literature pertaining to apprenticeship. In light of challenges expressed by mentors, including gaps in underserved students' education (lack of conceptual understanding and writing skills) and finding age- or ability-level appropriate projects for them to do, program level scaffolds may be needed, including any of the following: REAP apprentices participate in other AEOP programs before REAP, REAP apprenticeships extend beyond 5-8 weeks and include an apprentice-directed research project (though not necessarily paid beyond summer months), and/or REAP apprenticeships are awarded with a commitment of two summers from each apprentice.

3. REAP appears to serve as largely an entry and exit point to participation in AEOP. Only a small percentage of apprentices reported past participation in other AEOP initiatives before REAP, and data from REAP and other AEOP evaluations suggest few REAP apprentices participate in other AEOP initiatives after REAP. Subsequently, REAP apprentices and mentors were largely unaware of other AEOP initiatives. In light of these findings, we first recommend that both training and resources be provided to mentors to educate them about AEOPs, with clear

expectations that they educate apprentices about and encourage participation in other AEOP initiatives. Every REAP apprentice should at least know possible next steps to take in AEOP at the conclusion of their REAP apprenticeship. Second, we recommend that AAS be strategic in its cross-marketing of other AEOP initiatives to mentors and apprentices to better position itself within a pipeline and to support successful participation of underserved populations. For example, REAP will benefit from strengthening and expanding the UNITE-REAP bridge, ensuring readiness of REAP apprentices by mitigating any educational gaps before they arrive in REAP. REAP will also benefit from establishing a REAP-JSHS bridge, ensuring that REAP apprentices have opportunities to network and build community with other REAP apprentices (and non-REAP students), to present their research in a STEM-supportive environment, and to compete for college scholarships through their research.

4. Most apprentices had opportunities to learn about STEM careers during REAP. Army/DoD STEM careers received less attention than STEM careers in general. Apprentices are interested in an array of career fields that are of potential interest to the Army/DoD, but perhaps they do not recognize them as such. The majority of mentors interviewed cited their lack of awareness of Army/DoD STEM careers as the primary reason for not educating apprentices about them. AAS might consider a requirement, similar to that of the UNITE program, that REAP sites connect (either virtually or in-person) with local Army scientists, engineer, and/or research facilities. In addition, REAP and/or AEOP should consider developing a resource that profiles the research, educational pathway, and on-the-job training of one or more Army/DoD STEM professionals (or Army/DoD-sponsored researchers in private industry and academia) engaged in the fields of interest listed by apprentices. This evolving resource can assist mentors and apprentices in learning about Army/DoD STEM interests more broadly without the need for firsthand experience or professional connections with Army/DoD scientists and engineers.

Appendices

Appendix A: 2013 REAP Evaluation Plan AP-1
Appendix B: 2013 REAP Apprentice Questionnaire and Data Summary AP-4
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Appendix A:
2013 REAP Evaluation Plan

Key Evaluation Questions

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

- What aspects of REAP motivate participation?
- What aspects of REAP structure and processes are working well?
- What aspects of REAP could be improved?
- Did participation in REAP:
  - 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 REAP included onsite focus groups with apprentices and mentors at 4 REAP 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.

Focus groups were conducted at four REAP sites four sites in the West, Southwest, and Northeast, U.S. Mentor focus groups included 9 mentors (5 females, 4 males). Apprentice focus groups included 22 apprentices (13 females, 9 males). Females, a targeted population of REAP, were incidentally overrepresented in focus groups at the sites selected. 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.

Phone interviews were conducted with apprentices or mentors at 10 additional sites in the Northwest, Southeast, Midwest, and Northeast, U.S. Purposive sampling was employed by evaluators to maximize

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

diversity in geographic locations, gender, race/ethnicity, and STEM interests. Mentor phone interviews included 6 mentors (3 females, 3 males). Apprentice phone interviews included 6 apprentices (4 females, 2 males). Female apprentices were more responsive to individualized interview requests than their male counterparts.

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 REAP 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 REAP and school experience, or to compare participant group perceptions, ultimately to identify statistically and practically significant differences in these data. Statistical significance indicates whether a result is different than chance alone. Statistical significance is determined with t-, McNemar, ANOVA, or Tukey's tests, with significance defined at $p < 0.05$. Practical significance, also known as effect size, indicates how weak or strong (also noted as small or large) an effect is and is usually studied in relation to statistical significance. Practical significance is determined with Cohen's *d* or Pearson's *r*, with *d* or *r* of .250, which is considered weak but "substantively important" at $p < 0.05$.[3] Statistically and/or practically significant findings are noted as "statistical" or "significant" in the report narrative with footnotes or tables providing details and results of statistical tests. These findings should be taken as potential indicators of effect and

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

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

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 REAP or AEOP objectives.

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

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

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 REAP valuable information for improvement.

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

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

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

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

Irene O'Mara, Academy of Applied Science
REAP Program Director
(603) 228-4530, renie@aas-world.org

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Provide your personal information below (optional):

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

What is your age (in years)?

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

What grade/class rank will you start this fall?

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

Who is your REAP mentor?

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

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

Have you ever participated in REAP before?

- ❍ No
- ❍ Yes: How many times? _____

Have you ever worked in a UNITE program?

- ❍ No
- ❍ Yes: How many times? Where did you attend UNITE? _____

Prior to becoming a REAP apprentice, did you already know someone who works at the university where you got your REAP 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

Briefly describe the process by which you were recruited and became a REAP apprentice:

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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

What kind of school do you attend?
- ❍ Public
- ❍ Private
- ❍ Home School
- ❍ Other (Please Specify) _____

Which of the following best describes your REGULAR SCHOOL?
- ❍ It is in a RURAL setting
- ❍ It is in a SUBURBAN setting
- ❍ It is in an URBAN setting
- ❍ Other (Please Specify) _____

Do you qualify for free / reduced lunch at school?
- ❍ Yes
- ❍ No
- ❍ I don't know / choose not to answer

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

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

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

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

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

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

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

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

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

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2013 REAP Apprentice Questionnaire and Data Summary

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

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

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

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

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

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

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

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

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

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

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

Appendix B:
2013 REAP 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 REAP, I learned about new STEM-related jobs/careers.	❍	❍	❍	❍	❍	❍
In REAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	❍	❍	❍	❍	❍	❍
In REAP, I became interested in a STEM job/career I did not know about before.	❍	❍	❍	❍	❍	❍
In REAP, I became interested in a new STEM-related job/career with the Army/DoD	❍	❍	❍	❍	❍	❍

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

Job #1:

Job #2:

Job #3:

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

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

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

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

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

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

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

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

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

❍ No
❍ Yes, which one(s)? _____

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

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

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

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

If you have any questions or concerns, please email:

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

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What is your age?		
	Freq.	**%**
14 years	3	3%
15 years	5	5%
16 years	31	34%
17 years	41	45%
18 years	9	10%
19 years	3	3%
Total	**92**	**100%**

Note. Average age = 16.7 years

What grade/class rank will you start this fall?		
	Freq.	**%**
9th grade	1	1%
10th grade	5	5%
11th grade	25	27%
12th grade	42	45%
College freshman	19	20%
College sophomore	1	1%
Total	**93**	**100%**

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At which University are you and your mentor working?						
REAP Site	**Freq.**	**%**		**REAP Site**	**Freq.**	**%**
University of Houston	12	13%		Delaware State University	1	1%
Texas Southern University	4	4%		East Central University	1	1%
University of South Florida	4	4%		Florida Atlantic University	1	1%
South Dakota School of Mines & Technology	3	3%		Iowa State University	1	1%
University of Maryland	3	3%		Lemoyne	1	1%
University of South Carolina Upstate	3	3%		Montana State University	1	1%
University of Texas at El Paso	3	3%		New Mexico State University	1	1%
Alabama State University	2	2%		Norfolk State University	1	1%
Ball State University	2	2%		Oakland university	1	1%
Christian Brothers University	2	2%		Tennessee State University	1	1%
Colorado State University	2	2%		The City College of New York	1	1%
Loyola	2	2%		University of Colorado-Colorado Springs	1	1%
Miami Dade College	2	2%		University of Houston	1	1%
Michigan Technological University	2	2%		University of Alabama - Huntsville	1	1%
New Jersey Institute of Technology	2	2%		University of Arkansas at Pine Bluff (UAPB)	1	1%
North Carolina Central University	2	2%		University of California Irvine	1	1%
Polytechnic Institute of NYU	2	2%		University of Cincinnati	1	1%
Portland State University	2	2%		University of Huntsville	1	1%
Stony Brook University	2	2%		University of Illinois Urbana Champaign	1	1%
Texas Tech University	2	2%		University of Iowa	1	1%
University of Central Florida	2	2%		University of Massachusetts at Lowell	1	1%
University of Colorado at Boulder	2	2%		University of MS Medical Center	1	1%
University of Maryland Baltimore	2	2%		University of Texas at Arlington	1	1%
University of New Hampshire	2	2%		University of Texas at Austin	1	1%
Clark Atlanta University	1	1%		Not a university, but the World Aquarium.	1	1%
				Total	**92**	**100%**

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Have you ever participated in REAP before?		
	Freq.	**%**
No	83	90%
Yes – once before	7	8%
Yes – twice before	2	2%
Total	**92**	**100%**

Have you ever worked in a UNITE program?		
	Freq.	**%**
No	85	91%
Yes – one time before	7	8%
Yes – three times before	1	1%
Total	**93**	**100%**

Prior to becoming an REAP apprentice, did you already know someone who works at the university where you got your REAP apprenticeship?		
	Freq.	**%**
Yes - a family member that works at this university	11	13%
Yes - a family friend that works at this university	15	17%
No - I did not know anyone that works at this university	62	71%
Total	**88**	**100%**

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Briefly describe the process by which you were recruited and became a REAP apprentice? (n = 82)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP Awareness – becoming aware of REAP		**68**	
	High school personnel (e.g. a teacher or counselor) advertised REAP	22	• "My chemistry teacher told me about the program…" • "My high school guidance office announced this opportunity to all Juniors…"
	Family or friends told the apprentice about REAP	18	• "A friend of my Dad knew about the program and suggested that I'd apply." • "My mom told me about the program and I joined."
	Found REAP by participating in a different extracurricular program	12	• "I participated in a Science Olympiad competition that took place at CBU and was recruited by Linda Miller. She said she tried to contact schools and science teachers but could never get them to relay the information to the students. I'm really happy she talked to me." • "I was recruited through a program called the Apprenticeship in Science and Engineering (ASE)."
	Found REAP through other AEOP programs	6	• "I was originally applying for the SEAP internship and they gave me information about other research and engineering opportunities available. This is how i found out about REAP." • "I was recruited by…my advisor for the UNITE program… and of course I was more than willing to participate since I had a terrific experience with UNITE."
	Found REAP through past participants	5	• "My sister participated in the REAP apprenticeship last summer. That's how I found out about the program."
	Student found REAP independently	5	• "I started looking for research/lab opportunities. I had never heard about REAP before, but when I came across it on the internet, I thought it looked like a really great experience."
AEOP Participation – getting involved in REAP		**61**	
	Apprentice used the AEOP application process	28	• "I had to fill out the online application which required essays describing your research interests, your career goals, and how this program can help you reach those career goals." • "I found the program online and applied. Ms. O'Mara contacted me and put me in touch with [a mentor] who thereafter interviewed and selected me."
	Apprentice applied and/or was interviewed by university personnel	14	• "He sent me a link to an application, I filled it out, and sent it to [a professor]. I then received a reply…requesting an interview with me. A few days after the interview I was notified that I was accepted into the REAP program

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			• "I found the application for REAP at [a university's] website: http://www.luc.edu/biology/jshs/REAP2012.pdf."
	REAP mentor recruited the apprentice	7	• "After I confirmed I would be working in [the university] lab this summer, the professor in the lab asked me if I wanted to apply to REAP…"
	Personal connections with the program site got the apprentice involved	6	• "My friend's mom got me in it." • "I am in the Ecotek Lab and my dad contact the head person for the program…I applied and became a REAP apprentice"
	REAP fulfills a school requirement	2	• "I am involved in the Honors level Independent Research program at my high school and decided to participate in hands on research in a lab."
	Apprentice contacted mentor directly	2	• "I was interested so I emailed Dr. Kuebler to ascertain more information. I completed the associated forms and became a REAP apprentice."
	Apprentice decided to return for a second year	2	• "[mentor] showed an interest in hiring me back for another summer, so when spring came I applied online again and I received another letter in the mail saying that I was accepted."
Other		**3**	
	REAP was suggested to cover expenses	1	• "My professor recommended this program to help pay for my transportation fee."
	Apprentice was encouraged to apply again after rejection	1	• "I applied last year but there wasn't availability. I was told to apply again this year, so I did and was selected."
	Note about mentorship	1	• "I also want to leave a note about my mentor. Although Dr. Chiarelli is my mentor, I worked with grad students and undergrads."

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Which of the following best describes you?		
	Freq.	**%**
Male	34	38%
Female	53	60%
Choose not to report	2	2%
Total	**89**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	2	2%
Asian or Pacific Islander	16	18%
Black or African American	29	33%
Hispanic or Latino	13	15%
White/Caucasian	19	22%
Other	3	3%
Choose not to report	6	7%
Total	**88**	**100%**

Note. "Other" includes three responses for "multiracial"

What kind of school do you attend?		
	Freq.	**%**
Public	81	92%
Private	6	7%
Home School	0	0%
Other (Please Specify) • "Charter"	1	1%
Total	**88**	**100%**

Which of the following best describes your REGULAR SCHOOL?		
	Freq.	**%**
It is in a RURAL setting	10	11%
It is in a SUBURBAN setting	58	65%
It is in an URBAN setting	21	24%
Other	0	0%
Total	**89**	**100%**

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Do you qualify for free / reduced lunch at school?		
	Freq.	**%**
Yes	24	27%
No	53	60%
I don't know / choose not to answer	11	13%
Total	**88**	**100%**

Please take a moment to think about your REAP mentor. Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
My REAP mentor frequently worked with me in the laboratory	2 (2%)	5 (6%)	4 (5%)	11 (13%)	26 (30%)	38 (44%)	86	**4.95**	1.29
I learned a lot from my REAP mentor about performing STEM research	1 (1%)	2 (2%)	3 (3%)	13 (15%)	23 (26%)	45 (52%)	87	**5.18**	1.08
My REAP mentor encouraged me to perform a variety of tasks in the laboratory	2 (2%)	0 (0%)	2 (2%)	8 (9%)	25 (29%)	49 (57%)	86	**5.34**	1.01
My REAP mentor helped me to formulate my educational goals	1 (1%)	7 (8%)	9 (11%)	18 (21%)	19 (22%)	31 (36%)	85	**4.65**	1.35
My REAP mentor taught me how to work more effectively in a laboratory	2 (2%)	2 (2%)	4 (5%)	10 (12%)	24 (28%)	44 (51%)	86	**5.14**	1.18
MY REAP mentor spoke with me about my career interests	2 (2%)	5 (6%)	4 (5%)	14 (16%)	25 (29%)	37 (43%)	87	**4.91**	1.29
My REAP mentor helped me become a better writer of scientific research	5 (6%)	5 (6%)	7 (8%)	14 (16%)	28 (32%)	28 (32%)	87	**4.60**	1.45
I would like to work with my REAP mentor again	1 (1%)	0 (0%)	2 (2%)	11 (13%)	24 (28%)	49 (56%)	87	**5.34**	0.93

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

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Please take a moment to consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In school, I had to define a research question or thesis and determine its critical concepts	25 (28%)	31 (35%)	18 (20%)	6 (7%)	7 (8%)	2 (2%)	89	**2.38**	1.30
In school, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	22 (25%)	25 (28%)	13 (15%)	11 (13%)	13 (15%)	4 (5%)	88	**2.77**	1.54
In school, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	19 (21%)	17 (19%)	23 (26%)	9 (10%)	15 (17%)	6 (7%)	89	**3.02**	1.57
In school, I had to organize and synthesize information across academic sources	16 (18%)	17 (19%)	18 (20%)	14 (16%)	16 (18%)	7 (8%)	88	**3.20**	1.58
In school, I had to determine appropriate ethical and legal uses of published academic research for my own work	20 (22%)	30 (34%)	10 (11%)	9 (10%)	15 (17%)	5 (6%)	89	**2.82**	1.59
In school, I had to work as part of a team on research projects	13 (15%)	29 (33%)	20 (22%)	6 (7%)	12 (13%)	9 (10%)	89	**3.02**	1.57

Please take a moment to consider your REAP research experiences. Use the scale provided to indicate how often you performed each of the following activities IN REAP:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
In REAP, I had to define a research question or thesis and determine its critical concepts	13 (15%)	16 (18%)	19 (22%)	6 (7%)	23 (26%)	10 (11%)	87	**3.46**	1.66
In REAP, I had to use academic search strategies (e.g., databases and journals) to complete a literature review	13 (15%)	13 (15%)	17 (20%)	5 (6%)	23 (26%)	16 (18%)	87	**3.69**	1.75
In REAP, I had to critically evaluate information from academic sources (i.e., analyze assumptions and determine credibility)	7 (8%)	10 (11%)	19 (22%)	9 (10%)	28 (32%)	14 (16%)	87	**3.95**	1.55
In REAP, I had to organize and synthesize information across academic sources	9 (10%)	11 (13%)	17 (20%)	9 (10%)	24 (28%)	17 (20%)	87	**3.91**	1.65
In REAP, I had to determine appropriate ethical and legal uses of published academic research for my own work	22 (25%)	16 (18%)	9 (10%)	5 (6%)	20 (23%)	15 (17%)	87	**3.34**	1.91

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 consider your HIGH SCHOOL Science, Technology, Engineering, and Math classes and laboratories. Use the scale provided to indicate how often you performed each of the following activities IN SCHOOL:	1	2	3	4	5	6	n	Avg	SD
In school, I used advanced science or engineering equipment	30 (34%)	27 (31%)	20 (23%)	2 (2%)	7 (8%)	2 (2%)	88	**2.26**	1.30
In school, I cleaned and cared for the equipment in a science or engineering laboratory	19 (22%)	28 (32%)	20 (23%)	6 (7%)	10 (11%)	5 (6%)	88	**2.72**	1.47
In school, I calibrated laboratory equipment for experimentation	29 (33%)	28 (32%)	17 (19%)	5 (6%)	8 (9%)	1 (1%)	88	**2.30**	1.30
In school, I created solutions from reagents in preparation for experimental procedures	30 (34%)	33 (38%)	12 (14%)	7 (8%)	5 (6%)	1 (1%)	88	**2.17**	1.22
In school, I used proper safety procedures when handling equipment and material in the lab	6 (7%)	25 (28%)	18 (20%)	6 (7%)	23 (26%)	10 (11%)	88	**3.51**	1.57
In school, I employed advanced measurement techniques in science or engineering procedures	23 (26%)	27 (31%)	16 (18%)	8 (9%)	10 (11%)	3 (3%)	87	**2.59**	1.44
In REAP, I had to work as part of a team on research projects	7 (8%)	8 (9%)	13 (15%)	8 (9%)	32 (36%)	20 (23%)	88	**4.25**	1.57

Please take a moment to consider your REAP research experiences. Use the scale provided to indicate how often you performed each of the following activities IN REAP:	1	2	3	4	5	6	n	Avg.	SD
In REAP, I used advanced science or engineering equipment	11 (13%)	6 (7%)	14 (16%)	8 (9%)	27 (31%)	20 (23%)	86	**4.09**	1.69
In REAP, I cleaned and cared for the equipment in a science or engineering laboratory	13 (15%)	8 (9%)	14 (16%)	9 (10%)	25 (29%)	17 (20%)	86	**3.88**	1.73
In REAP, I calibrated laboratory equipment for experimentation	18 (21%)	6 (7%)	19 (22%)	9 (10%)	22 (26%)	12 (14%)	86	**3.55**	1.74
In REAP, I created solutions from reagents in preparation for experimental procedures	24 (28%)	11 (13%)	12 (14%)	7 (8%)	21 (25%)	10 (12%)	85	**3.24**	1.84
In REAP, I used proper safety procedures when handling equipment and material in the lab	9 (10%)	4 (5%)	11 (13%)	6 (7%)	26 (30%)	30 (35%)	86	**4.47**	1.66
In REAP, I employed advanced measurement techniques in science or engineering procedures	9 (10%)	10 (12%)	13 (15%)	9 (10%)	25 (29%)	20 (23%)	86	**4.06**	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*".

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Use the scale provided to tell us how accurately each statement describes you AFTER REAP:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg**	**SD**
After REAP, I am more confident in my ability to formulate hypotheses and design experiments to test them	3 (3%)	1 (1%)	2 (2%)	23 (26%)	38 (44%)	20 (23%)	87	**4.75**	1.09
After REAP, I am more confident that I can analyze data and understand the results of an experiment	1 (1%)	0 (0%)	2 (2%)	9 (10%)	44 (51%)	31 (36%)	87	**5.16**	0.85
After REAP, I am more confident in my abilities to effectively and safely use a science or engineering laboratory	1 (1%)	2 (2%)	2 (2%)	13 (15%)	32 (37%)	37 (43%)	87	**5.11**	1.03
After REAP, I am more confident that I can identify and account for limitations and assumptions when formulating my conclusions	1 (1%)	0 (0%)	3 (3%)	18 (21%)	37 (43%)	28 (32%)	87	**5.00**	0.93
After REAP, I am more confident in my abilities to perform equipment calibration and perform complex laboratory techniques	3 (4%)	1 (1%)	4 (5%)	18 (21%)	29 (34%)	30 (35%)	85	**4.87**	1.19
After REAP, I am more confident in my ability to complete academic literature reviews for my own research projects	3 (3%)	4 (5%)	9 (10%)	16 (19%)	29 (34%)	25 (29%)	86	**4.62**	1.32
After REAP, I am more confident that I can make significant research contributions as an effective part of a research team	1 (1%)	0 (0%)	4 (5%)	11 (13%)	34 (39%)	37 (43%)	87	**5.16**	0.95

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*".

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Which of the following most accurately describes the HIGHEST LEVEL of education that you are going to pursue?		
	Freq.	**%**
I do not plan to attend college	0	0%
2-year/Associate's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	0	0%
2-year/Associate's degree in something other than a STEM-related field.	0	0%
Bachelor's degree in a science, technology, engineering, and/or mathematics (STEM) related field.	18	21%
Bachelor's degree in something other than a STEM-related field.	2	2%
Master's degree in a STEM-related field.	19	22%
Master's degree in something other than a STEM-related field.	7	8%
Doctoral degree in a STEM-related field.	38	44%
Doctoral degree in something other than a STEM-related field.	3	3%
Total	**87**	**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%)	0 (0%)	7 (8%)	18 (21%)	30 (34%)	32 (37%)	87	**5.00**	0.95
I will attend college to pursue this educational degree	0 (0%)	1 (1%)	1 (1%)	6 (7%)	26 (30%)	53 (61%)	87	**5.48**	0.78
I will get good grades in my classes	0 (0%)	0 (0%)	0 (0%)	10 (12%)	32 (37%)	44 (51%)	86	**5.40**	0.69
I will be able to overcome any obstacle between me and this educational degree	0 (0%)	0 (0%)	0 (0%)	9 (10%)	33 (38%)	45 (52%)	87	**5.41**	0.67
I will finish this degree	0 (0%)	0 (0%)	0 (0%)	6 (7%)	27 (31%)	54 (62%)	87	**5.55**	0.62

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

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Which of the following categories best describes the STEM field you want to pursue?		
	Freq.	**%**
Engineering	22	26%
Environmental Science	2	2%
Physical Science	3	3%
Chemistry	8	9%
Life Science	2	2%
Medicine / Health	31	36%
Mathematics / Computer Science	5	6%
Social Science	1	1%
Other STEM Field	5	6%
A field unrelated to STEM	7	8%
Total	**86**	**100%**

Use the scale provided to tell us how much you agree or disagree with the following statements:									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
In REAP, I learned about new STEM-related jobs/careers.	5 (6%)	8 (9%)	7 (8%)	21 (24%)	21 (24%)	25 (29%)	87	**4.38**	1.50
In REAP, I learned about STEM-related jobs/careers within the Army/Department of Defense (DoD)	16 (18%)	15 (17%)	14 (16%)	17 (20%)	13 (15%)	12 (14%)	87	**3.37**	1.69
In REAP, I became interested in a STEM job/career I did not know about before.	8 (9%)	19 (22%)	12 (14%)	15 (17%)	16 (18%)	17 (20%)	87	**3.72**	1.66
In REAP, I became interested in a new STEM-related job/career with the Army/DoD	12 (14%)	21 (24%)	17 (20%)	18 (21%)	5 (6%)	13 (15%)	86	**3.26**	1.60

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

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

Of the new STEM jobs/careers that you learned about, which three did you find most interesting? (n = 55 apprentices)

Job/Career	Freq.	%		Job/Career	Freq.	%
Chemical engineering	15	27%		Civil engineering	1	2%
Environmental engineering	6	11%		Computer Vision Expert	1	2%
Biomedical engineering	5	9%		Combustion Engineer	1	2%
Computer Software Engineer	5	9%		DARPA Scientist	1	2%
Mechanical engineer	5	9%		Dentistry	1	2%
Biologist	4	7%		Economics	1	2%
Electrical Engineering	4	7%		Ecotoxicologist	1	2%
Genetic Careers	4	7%		Engineering	1	2%
Researcher	4	7%		Engineering for the Army	1	2%
Aerospace Engineer	3	5%		Forensic Scientist	1	2%
Biochemist	3	5%		Game Development	1	2%
College professor	3	5%		Graphic design	1	2%
Materials Engineer	3	5%		Hard Drive Research	1	2%
Medicine	3	5%		Healthcare	1	2%
Neuroscience Careers	3	5%		Making ammunition	1	2%
Biostatistician	3	5%		Mentor	1	2%
Doctor	3	5%		Nano Tech	1	2%
food science	2	4%		Pathophysiology Careers	1	2%
Lab technician	2	4%		Physician	1	2%
Lichenologists	2	4%		Plasma engineering	1	2%
Molecular biologist	2	4%		Psychologist	1	2%
Scientist in the military	2	4%		Public Health	1	2%
Software engineering	2	4%		Pulse Power	1	2%
Statistician	2	4%		Recycle-bots and 3D printers	1	2%
Advertising	1	2%		Technical Specialist	1	2%
Alternative energy	1	2%		Transportation Engineer	1	2%
Astronomer	1	2%		Unmanned Air Vehicles (UAV)	1	2%
Biophysics	1	2%		Vehicle Development	1	2%
Botanist	1	2%		Veterinarian	1	2%
				Total # of jobs/careers listed	**124**	**100%**

Note. % = proportion of apprentices who listed the job/career.

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

Use the scale provided to tell us how much you agree or disagree with the following statements about the Department of Defense (DoD):									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
The Army/DoD has made many important contributions to science and engineering with applied research	3 (3%)	1 (1%)	0 (0%)	15 (17%)	42 (49%)	25 (29%)	86	**4.94**	1.07
Army/DoD researchers contribute much more to society than just "warfare" advancements	2 (2%)	2 (2%)	3 (3%)	16 (19%)	36 (42%)	27 (31%)	86	**4.90**	1.11
Army/DoD researchers use cutting-edge technology to solve the world's problems	2 (2%)	1 (1%)	4 (5%)	16 (19%)	39 (45%)	24 (28%)	86	**4.87**	1.06
I would feel very comfortable taking a civilian job with the Army/DoD because their work is valuable to society	2 (2%)	5 (6%)	4 (5%)	26 (30%)	24 (28%)	25 (29%)	86	**4.63**	1.25
After REAP, I have a better understanding of the important contributions that Army/DoD researchers have made everyday civilian life	4 (5%)	2 (2%)	10 (12%)	26 (30%)	23 (27%)	21 (24%)	86	**4.45**	1.30

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

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

Have you ever participated in or heard about any of the following programs?			
	Yes, I participated	I would have participated but it was not available in my area / I did not qualify for this program	I have never heard about this program
Junior Solar Sprint (JSS):	0 (0%)	3 (4%)	82 (96%)
Junior Science and Humanities Symposium (JSHS):	2 (2%)	8 (9%)	76 (88%)
UNITE:	8 (9%)	6 (7%)	72 (84%)
West Point Bridge Contest:	2 (2%)	8 (9%)	76 (88%)
eCYBERMISSION:	0 (0%)	6 (7%)	79 (93%)

Have you been provided with information about the following programs that are sponsored by the U.S. Army? Do you want to participate?					
	I already participated in this program	Yes - I want to participate	Yes - I would participate but it is not available in my area	Yes - but I do not want to participate	I have never heard about this program
High School Internships:	9 (10%)	18 (21%)	5 (6%)	5 (6%)	49 (57%)
College Internships: (URAP)	0 (0%)	20 (23%)	4 (5%)	3 (3%)	59 (69%)
The Science, Mathematics And Research for Transformation (SMART) scholarship offered by the Department of Defense (DoD) for students pursuing degrees in STEM	0 (0%)	20 (23%)	5 (6%)	4 (5%)	57 (66%)
The National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	0 (0%)	10 (12%)	5 (6%)	3 (3%)	68 (79%)

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

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

	1	2	3	4	5	6	n	Avg.	SD
I will submit my research project/final presentation to JSHS during the 2013-2014 school year	25 (29%)	22 (25%)	23 (26%)	11 (13%)	3 (3%)	3 (3%)	87	**2.47**	1.31

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

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

	Freq.	%
No	69	82%
Yes, which one(s)?	15	18%
Total	**84**	**100%**

Table X. Do you intend to submit your REAP research project/final presentation to any other science fairs or competition? Which one(s)? (n = 15)

Which one(s)?	Freq.	%		Which one(s)?	Freq.	%
Unspecified	3	20%		**Tennessee Academy of Science**	1	7%
Siemens: Science and Engineering Fair	3	20%		Hernando County Science Fair	1	7%
Intel International Science and Engineering Fair	2	13%		Jersey Shore Science Fair	1	7%
Florida State Science and Engineering Fair	2	13%		North East Christian Academy Science Fair	1	7%
Robert Sheffield East Panhandle Regional Science and Engineering Fair	1	7%		ASE Symposium	1	7%
Google Science Fair	1	7%		MS academy of Sciences	1	7%
Prince George County Science Fair	1	7%		Unsure of which one	1	7%

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

Given the opportunity, would you participate in REAP again? Why or Why not? (n = 84)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Yes – no explanation		**74**	
Academic Research Activities		**28**	
	Individuals advanced their knowledge of materials	24	• "…it furthered my knowledge into the STEM fields." • "I get to learn new things […] and gain experience with new technology."
	Allows for networking	4	• "I was able to meet other students who share a similar passion for math and science."
General Satisfaction		**25**	
	Interesting or fun experience	10	• "I would because it was inspirational and fun."
	Great experience	9	• "…it was an amazing experience for me."
	Found the program very valuable	3	• "This has probably one of the most valuable summers of my high school years. I am grateful of the opportunities and knowledge Reap has given me."
	Given an opportunity not normally given	3	• "I got hands on work and experience I would have never gained anywhere else."
Hands-On Research Activities		**18**	
	Hands-on / lab-based experiences, skills, and abilities	18	• "It gave me valuable experience in working with data analysis and statistical applications. I learned a lot about using various methods of data collection and various software programs."
STEM Pathway		**13**	
	Prepares individuals for college	5	• "…it's excellent practice for what I will be doing in college being that my major is biology."
	Opportunity to benefit from the program	4	• "This summer program has given me a multitude of opportunities to perform high-level research that I know will help me grow as an aspiring scientist."
	Provides information/experience with a career	4	• "[This program] has given me a view of what I will be doing if I want to pursue a career in the science field." • "I learned about a lot of careers I may be interested in."
No		**7**	
	Not interested in the materials presented	5	• "The REAP program was a great opportunity but it did not cater towards my main interests which is History and English."
	Not enough money to justify again	1	• "I like the program but I need to make more money."
	Too busy to repeat	1	• "No, I'm too busy after this summer."
Effective Mentorship		**4**	

	Enjoyed working with the mentor	4	• "Getting the opportunity to work one-on-one with a mentor was amazing."
	Not enough time to repeat	2	• "Possibly if I had the time in the summer before my freshman year of college because it really helped me learn how to do various formulas in science and math classes."
Conditional Yes		**1**	
	REAP experience lacked direction	1	• "There was no straightforward direction to go in. I would participate again if I were given a goal."

Do you have any other comments or input to provide us regarding your REAP mentor? (n = 43)

Broad Theme	Narrow Theme	Freq.	Example Response(s)
Effective Mentorship		**47**	
	Mentor was great	18	• "My mentor is great and I would love to work with him again."
	Mentor was helpful	12	• "[My mentor] seems very involved and helpful with all of the research projects in his lab."
	Mentor effectively shares knowledge	5	• "He was very willing and able to answer any of my questions."
	Mentor was smart	5	• "He is a very knowledgeable man and has good devotion in what he researches."
	Mentor inspired personal growth	4	• "She has taught me fundamentals of research by introducing me to databases that most scientists look upon for resources and how properly display and present data to scientist. Most importantly, through her I have gained insight into the world of atmospheric sciences and she has widened my view of science and it opportunities it can give me."
	Mentor was kind	3	• "[My mentor] was really easy to get along with."
Program mechanics		**5**	
	REAP Program was enjoyable	5	• "Awesome program."
Lack of Mentorship		**3**	
	Did not work with mentor directly	2	• "My mentor did not work with me personally. I worked with grad students and undergrads." • "Instead of working directly with [my mentor], I worked with a grad student in his lab."
	Mentor could have been more involved	1	• "He could have been more involved."

Appendix B:
2013 REAP Apprentice Questionnaire and Data Summary

In a couple of sentences, tell us about your overall satisfaction with the REAP research project/final presentation: What was the most valuable part of that experience? (n = 73)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Academic Research Activities		**46**	
	Enhanced gains in STEM knowledge	20	• "I learned so much that I would have never learned in school." • "The most valuable part of the experience was learning new things about miRNA." • "I learned the impact of climate change on health."
	Gains in scientific reasoning	17	• "…so much of [REAP] was valuable…learning how to conduct research." • "It taught me that things don't always go how you expect them…when they don't you have to think your way around the problem."
	Gains in presentation skills	5	• "Well, I am a very shy person when it comes to talking in front of new people, so I do not like the idea of presenting my research in front of others. However, by doing this, I am gaining great experience talking in front of a crowd."
	Academic writing skills	4	• "I think it will really help me with writing research papers in high school and college."
Satisfaction with program		**36**	
	General satisfaction with the REAP program	18	• "I do believe that I learned a great deal more than I have at other science camps or institutions." • "I am satisfied with my REAP experience because I feel as if I am walking away with stronger foundation of the sciences that will help me greatly later on in life."
	General satisfaction with REAP final project	10	• "I am very satisfied with the REAP project, and it was worth every moment."
	Enjoyed meeting new peers	4	• "I made friends and got to do exciting things such as collecting lichens in the field." • "My most valuable part of this experience was making new friends…"
	Dissatisfaction with the REAP program	4	• "I don't feel as though I am doing valuable work. I don't see conclusions being made." • "I got on the organic farm and learned about what organic farming is and how it helps the community. I was very impressed but, I didn't get any lab time."
Hands-on / Laboratory research activities		**26**	

	Hands-on / lab-based experiences, skills, and abilities	22	• "The REAP program was a great opportunity for me to get involved with experiments that a lot of high school and undergrad students aren't able to do. The hands on experiments that I participated in were definitely the most valuable part of my experience" • "Not only was the research content very interesting, it was great to be able to get used to working in a lab with different instruments."
	Applying concepts learned in school	3	• "Working in labs also helps me in school because I have a better understanding of things at school." • "The most valuable part for me was that I realized all the practice and scenarios I experienced in high school actually happen in the real world."
	Teamwork / Collaboration	1	• "The most valuable part of the experience was learning how to collaborate with another student in order to write a meaningful research paper. I learned more about teamwork."
STEM Pathway		**17**	
	Clarifying education or career goals	6	• "The most valuable part is that I know more about the area I studied and whether I want to go into that area for future research." • "I have also learned that I do not wish to pursue a STEM career and that I have no interest to pursue research opportunities in the future."
	Insight into new fields	3	• **"**The most valuable part of the program was gaining insight into a field I had never explored."
	Offered a valuable college preview	3	• **"**For me, the most valuable part was being able to see what kinds of research and techniques I might be doing and using when I am in graduate school."
	Will help apprentices achieve their goals	2	• **"**The REAP program has definitely been beneficial to the career path I am currently pursuing."
	Networking	2	• **"**I think the most valuable part of my experience was the people and connections I made in the time I was at the lab."
	Work ethic	1	• **"**I have become a better student with a stronger work ethic."
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Effective Mentorship		**9**	
	Valued mentorship on research issues	7	• "My mentors were there to help me whenever I had questions and also were there to deeply discuss topics that were pertaining to my interests." • "I was offered a plethora of resources and help from established professors to help me form and tweak my research project."
	Education and career advice	2	• "[my mentor and I] had a lot of conversations about college and future plans."

Appendix B:
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Confidence		**10**	
	More confidence with STEM research	6	• "I believe the process of learning how to research was the most valuable part because it gave me confidence in myself that I am ready for college-level work."
	Confidence presenting research	2	• "The final presentation helped me determine how I could compress a wide range of information into a concise presentation…it gave me confidence in my work and taught me to have a more organized thought process."
	Encouraged ambition	2	• "I'm grateful for this opportunity that encourages high school students to be ambitious and try to move beyond the traditional boundaries."
STEM Ambassadorship		**2**	
	Want to spread knowledge to the larger community	2	• "This journey of research has changed the way I view weather and I am more cautious of its effect on my asthma. I plan to spread this insight and bring awareness to my community" • "The most valuable part of my time in this program is knowing that the data that I have analyzed can help other researchers develop cures"

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

Thank you for your participation in this study about the 2013 Research and Engineering Apprenticeship Program (REAP). The following assessment will collect information about you and your REAP 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 REAP.

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 REAP apprentice(s).
- We do hope that you will finish the survey because your responses will give REAP 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 REAP research/evaluation study

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

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

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

Irene O'Mara, Academy of Applied Science Inc.
REAP Program Director
(603) 228-4530, renie@aas-world.org

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

Provide your personal information below (optional):

First Name: _____

Last Name: _____

Email Address: _____

At which university are you and your apprentice(s) working? _____.

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

Total # of apprentices mentored: _____, apprentices.

Including 2013, for how many consecutive years have you mentored REAP apprentice(s)?

# of consecutive years: _____, years.

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

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

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

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

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

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2013 REAP Mentor Questionnaire, Rubrics, and Data Summary

Which of the following categories best describes your research field?

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

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

Please take a moment to briefly describe how you learned about the REAP program:

Briefly describe how your REAP apprentice(s) were recruited and selected for your apprenticeship positions:

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

Use the scale provided to estimate how often your apprentice(s) conducted or were exposed to each of the following experiences during their REAP 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 REAP mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

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

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

Please describe any practices or strategies you used/have used when mentoring students from underserved/underrepresented groups in STEM research. The following populations are considered historically underrepresented and underserved in STEM: African American/ Black, Hispanic, or Native American/Alaskan Native students; students who qualify for free or reduced lunch, attend a Title I school, or be low-income according to Federal TRIO criteria; and women and girls in physical science, computer science, mathematics or engineering**.**

Please describe any challenges you faced/have faced when mentoring students from underserved/underrepresented groups.

Please describe how REAP could better support you in your efforts to mentor students from underserved/ underrepresented groups.

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

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

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

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

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

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

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

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

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

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

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

Please describe how REAP could better support you in your efforts to educate your REAP 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: _____

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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]'s level of skill with the Data Collection Techniques (e.g., Lab, Research, and/or Measurement Techniques) that are used in your laboratory.

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

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

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

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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]'s scientific reasoning skills/abilities?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Do you have any other comments or input to provide us regarding your REAP 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 REAP this year:

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

If you have any questions or concerns, please email:

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

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At which University are you and your apprentice(s) working?						
REAP Site	**Freq.**	**%**		**REAP Site**	**Freq.**	**%**
Loyola University-Chicago	2	5%		Michigan technological university	1	2%
Portland State University	2	5%		New Mexico State University	1	2%
University of Central Florida	2	5%		Norfolk State University	1	2%
University of Maryland, College Park	2	5%		Oakland University	1	2%
University of New Hampshire	2	5%		Polytechnic Institute of New York University	1	2%
University of South Carolina-Upstate	2	5%		Stony Brook Uinversity	1	2%
University of South Florida	2	5%		Tennessee State University	1	2%
University of Texas at El Paso	2	5%		Texas Southern University	1	2%
Ball State University	1	2%		Texas Tech University	1	2%
	1	2%		University of Arkansas at Pine Bluff	1	2%
Christian Brothers University	1	2%		University of Colorado at Colorado Springs	1	2%
Colorado State University	1	2%		University of Illinois	1	2%
Delaware	1	2%		University of Iowa	1	2%
East Central University	1	2%		University of Maryland Baltimore	1	2%
Florida Atlantic University (FAU)	1	2%		University of Maryland School of Medicine	1	2%
Georgia State University/Clark Atlanta University	1	2%		University of Massachusetts Lowell	1	2%
Iowa State University	1	2%		University Of Missouri-St. Louis	1	2%
Le Moyne College	1	2%		Washington State University	1	2%
				Total	**43**	**100%**

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In total, how many REAP apprentices have you mentored through the years? (Avg. = 11.07 apprentices, SD = 14.34)

# of apprentices	Freq.	%		# of apprentices	Freq.	%
60	1	2%		11	2	4%
53	1	2%		10	1	2%
50	1	2%		9	2	4%
40	1	2%		8	1	2%
30	1	2%		6	1	2%
21	1	2%		5	4	9%
20	2	4%		4	2	4%
16	1	2%		3	5	11%
15	1	2%		2	4	9%
14	1	2%		1	8	18%
12	3	7%		0	1	2%
				Total	**45**	**100%**

Including 2013, for how many consecutive years have you mentored REAP apprentice(s)? (Avg. = 8.02 years, SD = 9.42)

# of years	Freq.	%		# years	Freq.	%
35	1	2%		11	1	2%
34	1	2%		10	2	4%
31	1	2%		8	3	7%
30	1	2%		7	1	2%
23	1	2%		6	1	2%
20	1	2%		5	3	7%
17	1	2%		3	9	20%
16	1	2%		2	4	9%
13	1	2%		1	8	17%
12	2	4%		0	3	7%
				Total	**46**	**100%**

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Do you serve as a mentor for apprentices or students in programs other than REAP? (n = 22 responding mentors)						
Program	**Freq.**	**%**		**Program**	**Freq.**	**%**
NSF-Research Experience for Undergraduates	5	23%		MD/PhD	1	5%
McNair Scholars program	2	9%		Mulcahy Scholars	1	5%
NSF-STARS	2	9%		NIH-Bridges to the Baccalaureate	1	5%
ACS	1	5%		NSF-CREST	1	5%
Apprentices in Science and Engineering	1	5%		OKAMP	1	5%
Beckman Scholars	1	5%		SMART MINDS	1	5%
CBU research students	1	5%		SSTP	1	5%
CIBER/EPSCOR High School Summer Research	1	5%		Summer Program for gifted high school students	1	5%
Engineering Scholar Program	1	5%		SURE-STEP	1	5%
GPILS PhD	1	5%		TSAMP	1	5%
Graduate programs	1	5%		UCF RAMP	1	5%
Honors College at USF	1	5%		Undergraduate Research (USC Upstate)	1	5%
INBRE	1	5%		Univ. Iowa	1	5%
Loyola programs for undergraduates	1	5%		University of Texas at El Paso	1	5%
LSAMP	1	5%				
				Total # of programs listed	**35**	

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

In the past, have you ever worked as a REAP apprentice?		
	Freq.	**%**
No	44	96%
Yes	2	4%
Total	**46**	**100%**

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Which of the following best describes you?		
	Freq.	**%**
Male	35	76%
Female	11	24%
Choose not to report	0	0%
Total	**46**	**100%**

Which of the following best describes your ethnicity/race?		
	Freq.	**%**
American Indian or Alaskan Native	0	0%
Asian or Pacific Islander	7	15%
Black or African American	7	15%
Hispanic or Latino	1	2%
White/Caucasian	31	67%
Other	0	0%
Choose not to report	0	0%
Total	**46**	**100%**

Which of the following categories best describes your research field?		
	Freq.	**%**
Engineering	7	15%
Environmental Science	3	7%
Physical Science	7	15%
Chemistry	12	26%
Life Science	11	24%
Medicine / Health	3	7%
Mathematics / Computer Science	1	2%
Social Science	0	0%
Other STEM Field	2	4%
A field unrelated to STEM	0	0%
Total	**46**	**100%**

Note. Other = "*materials science and engineering*" & "*Biochemistry*"

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Please take a moment to briefly describe how you learned about the REAP program. (n = 46)		
List	**Freq.**	**Example Response(s)**
Adviser/Department chair	10	• "Information about the program was forwarded to the faculty by our Department Chair and Dean. "
Peer/Colleague	9	• "I learned about REAP from a colleague at a conference." • "I learned about the REAP program from one of my colleagues."
Another REAP mentor	8	• "I work for Professor John Dash who has mentored REAP students for several decades."
REAP Coordinator	4	• "I was contacted related to REAP through Division of Research. The coordinator of the program contacted FAU for mentoring for the students at South Florida."
Given/passed down	3	• "From Dr. Donald Mikkola I worked with him for many years and took over after he retired." • "My department chair had 'inherited' it from a retired colleague and passed it on to me."
Director of the Center	3	• "I learned about this program from my Center Director and PI on the grant Dr. Dudley Strickland."
Encouraged by others	2	• "I got an e-mail from the Dean of my college encouraging interested faculty members to participate in the program."
US Army Research Office	2	• "From my US Army Research Office contract monitor."
Junior Science and Humanities Symposium/ other AEOP	2	• "We learned about REAP through the Junior Science and Humanities Symposium via the Academy of Applied Science."
Students directly approached	2	• "I was approached by a student two years back who was interested in working with my group, funded under REAP."
Apprenticeship program	1	• "Program Office of Minority high school Apprenticeship Program"
AAS website	1	• "I saw a description on the AAS website."
Newspaper	1	• It was advertised in the Skanner, a minority newspaper in Portland, OR.

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Briefly describe how your REAP apprentices were recruited and selected for your apprenticeship positions. (n = 46)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
AEOP Awareness: Recruiting & Marketing		**35**	
	Recruit students through local high school staff	23	• "Several chemistry teachers at local high schools were contacted to recommend students." • "Through contacts with science teachers and guidance counselors at the local high schools."
	Recruit using other events / programs / organizations	6	• "Our University hosts the Science Olympiad…I talk to parents, teachers and students to try to get the word out." • "Telephone calls were made to several teachers [who are] active in JSHS." • "Through church advisement…"
	Program preview as recruitment	2	• "We invite the students to visit us at CSU, show them around the laboratory, tell them about the program, and introduce them to some of our graduate students to give them a feel for the program."
	University advertisement	1	• "I have advertisement about REAP at the [university] website."
	Guest lecturer at a high school	1	• "I just finished teaching a Genetics lecture/lab course for High School students in the Gifted Program. Some of these students where interested in doing research about the field of genetics."
	Social media	1	• "…advertising through Internet , and Facebook."
	Word – of – Mouth Advertising	1	• "Much of the recruiting has been by word-of-mouth as well. The students tell other students about the opportunities in REAP."
AEOP participation: Application & Selection		**36**	
	Recruit broadly then elected from applicant pool	22	• "Students are instructed to apply via the AEOP website and their applications are forwarded to me for selection."
	Faculty interview after application	12	• "They give us an initial list and we interview them and choose them on the basis of their records and the interview."
	Selected from alternate applicant pool	1	• "…picked from the applications of several high school students who applied for NSF-CREST program."
	Continuation of a mentor – student project	1	• "My student worked together with me last summer. All lab members were impressed by her talent and

			diligence. We are glad to recruit her and continue the research work in this summer."
Other		**8**	
	Diversity efforts	3	• *"Selection was based on under-represented groups based on their high school GPAs."* • *"We have set up a program with Philips Exeter Academy to select underrepresented and low income students to participate."*
	Local REAP coordinator provides applicants	2	• "Our local REAP coordinator then placed this apprentice in my laboratory."
	Unsure	1	• "Not sure about how they were picked, just got a list of people who were going to be in this summer 2013."
	Local questionnaire	1	• "Our lab has developed a questionnaire to standardize the process."
	Email rejected students	1	• "Now the hard part (at least for me because we sometimes receive many applications). Once the student accepts, then, I send out a letter to the deselected candidates."

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

	1	2	3	4	5	6	n	Avg.	SD
Observed an experiment and took notes	2 (5%)	6 (14%)	8 (18%)	6 (14%)	13 (30%)	9 (20%)	44	**4.11**	1.51
Used a workbook or a pre-defined set of procedures to conduct an experiment	4 (9%)	6 (14%)	11 (25%)	9 (20%)	11 (25%)	3 (7%)	44	**3.59**	1.42
Created their own hypotheses and conclusions after witnessing an experiment	9 (20%)	14 (32%)	14 (32%)	2 (5%)	4 (9%)	1 (2%)	44	**2.57**	1.26
Designed their own experiment to answer a set of their own hypotheses	16 (36%)	12 (27%)	9 (20%)	3 (7%)	3 (7%)	1 (2%)	44	**2.27**	1.34
Used advanced laboratory equipment including necessary adjustments	6 (14%)	3 (7%)	10 (23%)	9 (20%)	9 (20%)	7 (16%)	44	**3.75**	1.60
Cleaned, handled, and cared for laboratory equipment	5 (11%)	4 (9%)	12 (27%)	5 (11%)	13 (30%)	5 (11%)	44	**3.73**	1.55
Organized and handled experimental data	2 (4%)	3 (7%)	11 (24%)	10 (22%)	10 (22%)	9 (20%)	45	**4.11**	1.40
Analyzed experimental data	2 (4%)	6 (13%)	17 (38%)	6 (13%)	9 (20%)	5 (11%)	45	**3.64**	1.37
Interpreted the results of an experiment and drew their own conclusions	3 (7%)	13 (29%)	13 (29%)	3 (7%)	8 (18%)	5 (11%)	45	**3.33**	1.51

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 REAP mentor activities. Then, use the scale provided to tell us how much you agree or disagree with each of the following statements:

	1	2	3	4	5	6	n	Avg.	SD
I frequently worked with my REAP apprentice(s) in the laboratory	1 (2%)	5 (11%)	2 (5%)	7 (16%)	11 (25%)	18 (41%)	44	**4.73**	1.45
I taught my REAP apprentice(s) about performing STEM research	1 (2%)	1 (2%)	0 (0%)	6 (14%)	14 (32%)	22 (50%)	44	**5.20**	1.09
I encouraged my REAP apprentice(s) to perform a variety of tasks in the laboratory	1 (2%)	1 (2%)	0 (0%)	5 (11%)	13 (30%)	24 (55%)	44	**5.27**	1.09
I helped my REAP apprentice(s) formulate their educational goals	1 (2%)	1 (2%)	3 (7%)	8 (18%)	18 (40%)	14 (31%)	45	**4.84**	1.15
I taught my REAP apprentice(s) how to work more effectively in a laboratory	1 (2%)	2 (5%)	1 (2%)	3 (7%)	19 (43%)	18 (41%)	44	**5.07**	1.17
I spoke with my REAP apprentice(s) about their career interests	1 (2%)	0 (0%)	0 (0%)	5 (11%)	13 (29%)	26 (58%)	45	**5.38**	0.96
I helped my REAP apprentice(s) be better writers of scientific research	1 (2%)	0 (0%)	3 (7%)	12 (27%)	15 (33%)	14 (31%)	45	**4.82**	1.09
I would like to work with my REAP apprentice(s) again	0 (0%)	0 (0%)	0 (0%)	3 (7%)	14 (32%)	27 (61%)	44	**5.55**	0.63

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 any practices or strategies you used/have used when mentoring students from underserved/ underrepresented groups in STEM research The following populations are considered historically underrepresented and underserved in STEM: African American/ Black, Hispanic, or Native American/Alaskan Native students; students who qualify for free or reduced lunch, attend a Title I school, or be low-income according to Federal TRIO criteria; and women and girls in physical science, computer science, mathematics or engineering **. (n = 36)**

Broad Theme	Narrow Theme(s)	Freq.	Example Response(s)
Effective Mentorship		**32**	
	Treated all students equally	11	• "I treat all students the same. I encouraged all students to continue their education in college."
	Encouraged personal development	7	• "Letting the student know that you think that they can do the required work goes a long way to helping with this problem."
	Created a personal relationship with apprentice	4	• "I am a "hands-on" person and work with students in my laboratory and also foster interactions between undergraduate students working in my laboratory and my apprentices." • "Always tried to maintain a personal relationship with them as well."
	Role modeled/examples	3	• "I am a good role model and most of my former REAP students have continued in STEM fields in several Universities." • "I also try to make sure that they have the opportunity to see examples of other members of underrepresented groups contributing to science."
	Paired apprentices with grad/undergrad student	3	• "I pair the student with a senior level undergraduate or graduate student, depending on the research interest and demographics of the student and have them work closely with their senior mentor."
	Provided helpful reading material	2	• "[I] give them fun and relevant reading material/novels to read in their off hours."
	Provides one goal at a time	1	• "The strategy is to introduce one goal at a time that can be achieved and when it's done is when a more high goal is set till completion of all the goals of the program."
	Provides choices for projects	1	• "Always asked them what their interests were, and instead of forcing them into a particular project, gave them choices."
STEM Pathway		**6**	
	Encouraged STEM education programs	2	• "Encourage them to participate in various STEM outreach programs"
	Detailed career options	2	• "I talk to them about career options in the sciences. "
	Benefits of STEM	1	• "Provided them with concrete examples of the benefits and challenges of STEM research by explaining my own career path."

	Provide scholarships	1	• "We provide scholarship for students from low-income families."

Please describe any challenges you have faced when mentoring students from underserved/underrepresented groups in STEM research. (n = 25)

List	Freq.	Example Response(s)
Educational gaps	4	• "Filling in educational gaps is among the greatest challenges when working with underrepresented students[;] it is very important to work with them until they have grasped these fundamental concepts."
Students unable to join or devote enough time to participate	3	• "It is difficult to recruit students who are low-income because many of them feel that they need to find higher paying jobs for the summer and cannot devote the time needed to benefit from the program."
Lack of trust in themselves	2	• "…these students may be lacking in some basic science knowledge and have not considered that they could become scientists themselves."
Transportation issues	2	• "Transportation and other conventional resources were always a challenge."
Difficulty communicating with student(s)	1	• "The REAP student this year was very difficult to communicate with."
Too few underrepresented students	1	• "…there are so few students that it is hard to create a good cohort. In the case of the REAP, there will be one or two students in my lab but not a larger group of students that the interns can plug into."
High achievers are likely to travel often but may be unable to afford it	1	• "…when [underserved/underrepresented group students] comes in with excellent grades, they tend to be high achievers and pursue many activities. This results in surprisingly frequent vacations to school/educational related events in other parts of the country."
Writing skills are of poor quality	1	• "Writing skills are below average and lots of help must be given to get to an acceptable product."

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Please describe how REAP could better support you in your efforts to mentor students from underserved / underrepresented groups. (n = 33)		
List of Suggestions	**Freq.**	**Example Response(s)**
Expand the program; accept more apprentices & allow groups of apprentices at one site.	8	• "It would be helpful to have two or three students together as a cadre in the laboratory setting so that they could support and encourage one another." • "The main thing would be to be able to support more students."
Increase funding	6	• "REAP could help mentor these students by providing additional financial resources."
Provide more information and training for mentors	5	• "REAP can have a workshop and help with recruitment." • "Publish a set of guidelines/guideposts on what students should get from the program."
Increase REAP's visibility / marketing efforts	4	• "Be more visible in local high schools…a more concerted promotional outreach effort to local schools…would be helpful." • "It might be helpful if our program is advertised on their web site and underserved/underrepresented groups are encouraged to apply"
Satisfied with current support	4	• "I believe the program provides marvelous support already."
Funding for supplies and computers	3	• "If underrepresented students had access to laptops (with admin rights), it would be easier for me to teach them how to use free/open source (science and math) software which would benefit them for the rest of their academic careers and could potentially help them get a job using such software."
Expand the REAP program timeline	2	• "An increase in stipend would be useful--particularly to continue the relationship on a part-time basis during the ensuing school year."
Provide money for mentors	2	• "After taxes this year, I will take home about $660 for my REAP work… I have probably spent in excess of 500 hours working on this program."
Adjust the applicant vetting process	2	• "It would be nice to have access AOEP online to determine who has applied for the REAP program." • "Adaquate time to conduct interviews and a formal selection process."
Fund a national event	1	• "I think a national meeting would be great where they could present their REAP research."

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

	1	2	3	4	5	6	n	Avg.	SD
I educated my REAP apprentice(s) about a wide variety of STEM jobs/careers.	2 (5%)	4 (9%)	0 (0%)	13 (30%)	14 (32%)	11 (25%)	44	**4.50**	1.37
I educated my REAP apprentice(s) about many different STEM jobs/careers within the Army/Department of Defense (DoD)	6 (14%)	8 (19%)	4 (9%)	15 (35%)	7 (16%)	3 (7%)	43	**3.42**	1.50
During REAP, I provided information to my apprentice(s) about civilian research programs within the Army/DoD	6 (14%)	8 (19%)	7 (17%)	11 (26%)	5 (12%)	5 (12%)	42	**3.38**	1.58
My REAP apprentice(s) expressed a lot of interest about pursuing a STEM career	1 (2%)	0 (0%)	2 (5%)	6 (14%)	10 (23%)	24 (56%)	43	**5.23**	1.11
My REAP apprentice(s) expressed genuine interest in pursuing an Army/DoD STEM career	4 (10%)	7 (17%)	10 (24%)	10 (24%)	4 (10%)	7 (17%)	42	**3.57**	1.55
My REAP apprentice(s) expressed a positive attitude toward the Army/DoD and the STEM careers that it offers	4 (9%)	3 (7%)	6 (14%)	15 (35%)	7 (16%)	8 (19%)	43	**3.98**	1.49

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

Please describe the ways in which you educated your REAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=37)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Awareness of STEM Careers		**24**	
	Discussed various STEM careers	20	• "My apprentice and I have discussed some STEM career opportunities and the challenges that are present in each of these careers, especially the difficulties of acquiring funding in the academic field and the alternatives including NIH and industrial careers." • "I discuss the various careers in science or the different professions one can pursue."
	Career discussion has not been a focus	3	• "This actually has not been a focus of mine with my apprentices."
	Provided examples of previous students	1	• "[I gave] examples of where some of our former students have ended up."
Awareness of Army/DoD careers		**19**	
	Did not discuss Army/DoD careers	5	• "I did not discuss anything specific to the Army/DoD." • "We generally have not specifically educated our interns about programs in the army/DoD."
	Discussed various Army/DoD careers	4	• "Informed the students about the career path in the STEM area in the Army and how recruitment is done. Most of my student were surprised that indeed there are many options in the armed force."
	Need more information on Army/DoD careers	3	• "I am not familiar with the STEM careers in the Army so I couldn't provide my mentees with information and they didn't express an attitude about it"
	Situational exposure led to knowledge of Army/DoD careers	3	• "Some of our projects, particularly the blood substitute one, have direct application to the Army. Even if they are not directly working on that project they are exposed to it and its importance to the DoD."
	Utilized ACS webinars	1	• "We watched several ACS webinars throughout the summer which exposed the students to alternate careers."
	US Army graduate students discussed with apprentices	1	• "Several of my former PhD students work for the US Army and they are sometimes in the meeting via Skye and talk about their fields."
	Utilized website	1	• "I directed them to the website."
	Utilized videos	1	• "We watched some videos that related to research sponsored by DoD and discussed the opportunities."
STEM Pathway		**10**	
	Discussed future STEM studies	5	• "We focus primarily on maintaining interest in STEM programs as the students proceed toward the

			selection of their undergraduate institutions and academic majors."
	AEOP awareness	2	• "I discussed with my apprentice about the URAP, HSAP, and SEAP programs and she should consider applying for the URAP program when she begins college."
	Discussed ROTC options	1	• "We usually discuss ROTC programs."
	Discussed scholarship opportunities	1	• "I discussed undergraduate scholarship programs."
	AEOP ambassadorship	1	• "I gave her an extra banner to give it to her chemistry teacher at high school, who had selected my apprentice. This teacher had informed my apprentice that it was a summer job, but is not aware of the REAP program."
Other		**5**	
	General Discussions	4	• "Spoke at our weekly meetings." • "By talking to the candidate and informal discussion."
	Support from REAP coordinators	1	• "It would be nice if REAP could package a series of opportunities available like those presented at the National JSHS symposium that could be used as examples and points of discussion in the lab setting."
Effective Mentorship		**1**	
	Willing to provide mentorship throughout college	1	• "If they decide to stay at UCCS for the undergraduate degree I frequently help them choose classes that they would need to have good careers."

Please describe any challenges you faced when educating your REAP apprentice(s) about STEM-related careers, especially those within the Army/DoD? (n=23)		
List of Suggestions	**Freq.**	**Example Response(s)**
Unfamiliar with Army/DoD careers	7	• "I am limited in what I know about the career opportunities in the Army/DoD." • "Lack of information about specific Army/DoD programs related tot he students interests."
Could not fully express career options due to classified material	1	• "Several of my former PhD students worked for the Army and sometimes they cannot describe what they do due to classified information"
Could not relate to students	1	• "They had no experience or parental guidance as to what opportunities might exist and to relate them in a meaningful way in their own environmental context was a challenge."
Did not educate apprentice on STEM-related careers	1	• "I have not been focused on this."
National STEM call	1	• "…there is a large need for those [seeking STEM-related careers] and the mathematics, physics, and/or other sciences needed to pursue such a career."
REAP should provide presentations	1	• "It would be great if I had a presentation about the research at Army/DoD that I can present to my students."
Difficult to find scholarships	1	• "Readily finding all available scholarship opportunities."
Students were too young to think about careers	1	• "Most students at this age have not really thought about the eventual employment opportunities that they might have in the DoD departments."
Unaware of obligations	1	• "Not knowing that I was supposed to educate the apprentices about careers with the Army/DoD until seeing this survey."

Please describe how REAP could better support you in your efforts to educate your apprentice(s) about STEM careers, especially those within the Army/DoD. (n = 34)		
List of Suggestions	**Freq.**	**Example Response(s)**
Provide mentors with more information so they can relay it to their apprentices	23	• "Give mentors some information if the goal is to recruit students into Army/DoD STEM careers." • "I believe the mentors should be provided with information on various STEM-related careers within the Army. We can relay that information to our mentees during our routine mentoring sessions with our mentees."
Provide a presentation to be delivered to apprentices	5	• "…audiovisual modules that we could show the students would be helpful. But these materials would need to be designed with the students in mind." • "A series of videos that provided interesting examples and what career opportunities might be available would be helpful as per above."
Satisfied with REAP's efforts	3	• "Simply keep this program going. It is very well positioned and designed to create long-term advantage for our nation's workforce development in STEM-educated scientists/engineers who meet DoD needs."
Distribute information upon apprentices' application	2	• "I would only suggest that when a student applies for the REAP program that they respond with informational material to make interested students aware of possible STEM opportunities/careers within the Army/DoD."
Facilitate Army / DoD site-visits	1	• "Opportunities to schedule a visit at a Navy test site would be beneficial to both of us."
Longer apprenticeship duration	1	• "Better to support students for a longer time period. In this condition, students may have more time to explore a new field and will gain more."
Provide scholarships	1	• "Provide…scholarships so some of the best REAP students can continue in College."

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

	1	2	3	4	5	6	n	Avg.	SD
I know about the Junior Science & Humanities Symposium (JSHS): the national science competition offered by the AEOP	11 (26%)	17 (40%)	1 (2%)	5 (12%)	3 (7%)	5 (12%)	42	**2.69**	1.70
I encouraged my apprentice(s) to submit his/her research project/final report to JSHS	11 (26%)	16 (38%)	4 (10%)	5 (12%)	1 (2%)	5 (12%)	42	**2.62**	1.62
My apprentice(s) expressed interest in submitting his/her research project/final report to JSHS	12 (29%)	16 (39%)	4 (10%)	6 (15%)	0 (0%)	3 (7%)	41	**2.39**	1.43
I know about the other High School Internship programs offered by the AEOP: The Science and Engineering Apprenticeship Program (SEAP) & the High School Apprenticeship Program (HSAP)	11 (26%)	17 (40%)	5 (12%)	3 (7%)	2 (5%)	4 (10%)	42	**2.52**	1.55
I know about the College Internship programs offered by the AEOP: College Qualified Leaders (CQL) & the Undergraduate Research Apprenticeship Program (URAP)	10 (24%)	18 (43%)	6 (14%)	3 (7%)	2 (5%)	3 (7%)	42	**2.48**	1.44
I provided information to my apprentice(s) about one or more AEOP program(s)	12 (29%)	17 (41%)	3 (7%)	5 (12%)	0 (0%)	4 (10%)	41	**2.41**	1.52
My apprentice(s) expressed interest in pursuing AEOP programs in the future	9 (24%)	11 (29%)	3 (8%)	7 (18%)	4 (11%)	4 (11%)	38	**2.95**	1.69
I know about the National Defense Science and Engineering Graduate (NDSEG) fellowship offered by the Department of Defense	9 (21%)	14 (33%)	3 (7%)	4 (10%)	7 (17%)	5 (12%)	42	**3.02**	1.76
I know about the Science, Math, and Research for Transformation (SMART) scholarship program offered by the Department of Defense	9 (21%)	12 (29%)	3 (7%)	6 (14%)	4 (10%)	8 (19%)	42	**3.19**	1.85
I am interested in mentoring more REAP apprentices in the future	2 (5%)	2 (5%)	0 (0%)	3 (7%)	4 (10%)	31 (74%)	42	**5.33**	1.39
I would recommend my apprentice(s) for future Army internships	3 (7%)	2 (5%)	2 (5%)	5 (12%)	7 (17%)	23 (55%)	42	**4.90**	1.57

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 REAP apprentice(s) about AEOP programs. (n = 28)		
List of Suggestions	**Freq.**	**Example Response(s)**
Could not discuss because programs were unknown/not familiar	11	• "I was unable to due to lack of information/familiarity of the programs offered. "
Did not discuss	6	• "I have provided broad-based career information. I have not tried to promote AEOP opportunities specifically"
Sent students towards the website	4	• "I encouraged them to look at the website and told them it would be good for them if they were interested in a career in science."
Discussed with apprentices during the program	3	• "This issue should be addressed when students apply online with AEOP."
Gave apprentices fliers or brochures	2	• "I did distribute the fliers and brochures that I received at the JSHS national symposium."
Discussed possible internships	1	• "I informed them about different intern positions."
Spoke about multiple programs	1	• "I also discussed with my apprentice about the URAP, HSAP, and SEAP programs and that she should consider applying for the URAP program when she begins college."
Discussed the SMART program	1	• "I discussed the SMART program."

Please describe any challenges you faced when educating your REAP apprentice(s) about AEOP programs. (n = 12)		
List of Challenges	**Freq.**	**Example Response(s)**
Need more information about other AEOP Programs	7	• "I need more information about all the wide range of possibilities." • "My limited background and available information was a barrier to stimulate interest in the apprentice."
REAP apprenticeship required too much time to discuss other material	2	• "I feel responsible for running an efficient REAP program. For that reason, other AEOP programs are not given the attention they deserve."
Education should be addressed by AEOP website	1	• "This issue should be addressed when students apply online with AEOP."

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Please describe how REAP could better support you in your efforts to educate your apprentice(s) about AEOP programs. (n = 27)		
List of Suggestions	**Freq.**	**Example Response(s)**
Mentors would like more information to distribute to apprentices	19	• "A standard pamphlet would greatly help this process as I have only been informally educating the students about AEOP programs." • "Provide an exec-summary of AEOP programs beyond REAP."
An informational video to show apprentices	3	• "An online presentation video of possible programs would be helpful."
Distribute a regular informative email	2	• "By sending monthly-bi-weekly E-mails to mentors pertaining to available opportunities to students…"
Give information directly to apprentices	2	• "Provide more information to the mentor and students."
Mentors are satisfied	2	• "I think that the web site does quite a good job (www.usaeop.com)."
Should be addressed during apprentices' application process	1	• "This issue should be addressed when students apply online with AEOP."
Improve AEOP advertising	1	• "Improve advertising of the AEOP programs."
Information about other REAP sites	1	• "REAP could provide information about other REAP programs."
Invite mentors to an AEOP conference	1	• "Invite mentors to a conference on AEOP programs. The mentors could learn about the AEOP programs as well as best practices."

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Please rate your apprentice's laboratory skill level. (Avg. = 4.54, SD = .95)		
	Freq.	**%**
(1): Student is confused about the lab equipment and cannot use it effectively or safely.	1	2%
(2): Can identify the equipment and components. Knows about equipment care and safety but cannot consistently perform operations	1	2%
(3): Can perform rudimentary operations with equipment under supervision. Periodically violates proper safety and equipment care protocols	3	5%
(4): Can execute basic operations independently. Still needs periodic supervision for safety and equipment care	21	36%
(5): Skillfully executes equipment operations and adjustments. Safety and equipment care is almost always done without reminder or supervision	26	44%
(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	12%
Total	**59**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **33 (56%)**; 1&2 = **2 (4%).**

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. = 4.38, SD = 1.02)		
	Freq.	**%**
(1): Student is confused about techniques, how to perform them, and their importance. Training from a supervisor is needed regularly	1	2%
(2): Is beginning to understand techniques and their importance with supervision. Results are not useful at this point	2	3%
(3): Understands techniques and their importance but supervision is needed to perform them. Results are only useful when operations have been supervised heavily	7	11%
(4): Needs only occasional supervision to perform and understand techniques competently. Results are useful after being checked by supervisor	19	31%
(5): Understands and uses techniques competently without supervision. Yielded results are useful	27	44%
(6): Performs techniques with expert-skill. Yielded results are impeccable. Could teach other students to perform these techniques	5	8%
Total	**61**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **32 (52%)**; 1&2 = **3 (5%).**

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Which of the following categories most accurately describes your apprentice's scientific teamwork/collaboration abilities in your laboratory? (Avg. = 4.66, SD = 1.00)		
	Freq.	**%**
(1): Does not add or use ideas from teammates. Fails to complete tasks and team picks up their slack. Does not engage or actively avoids teammate interactions	0	0%
(2): Struggles to add ideas or use ideas from teammates. Is regularly late with task completion. Sometimes fails to be polite with teammates	1	2%
(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	8	13%
(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	14	23%
(5): Articulates alternative ideas and synthesizes information from teammates. Completes work on time. Is respectful and demonstrates positive motivation with teammates	26	43%
(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	12	20%
Total	**61**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **38 (63%)**; 1&2 = **1 (2%).**

Which of the following categories most accurately describes your apprentice's scientific reasoning skills/abilities? (Avg. = 4.67, SD = .90)		
	Freq.	**%**
(1): Does not grasp the purpose of a hypothesis, theory, or any tenants of scientific reasoning. Has not been exposed to ethical research principles	0	0%
(2): Hypotheses often lack scientific reasoning and are not derived from theory or research. Usually misunderstands ethical research principles	0	0%
(3): Hypotheses are reasonable but devoid of theory. Sometimes misunderstands ethical research principles	7	12%
(4): Creates reasonable hypotheses but they are not always derived from in-depth understanding of theory or main issues. Usually understands ethical research principles	16	27%
(5): Uses good reasoning and basic theory to identify an issue and create hypotheses. Has a good understanding of the principles of ethical research	27	45%
(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	10	17%
Total	**60**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **37 (62%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's information literacy skills/abilities? (Avg. = 4.63, SD = .76)		
	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	3	5%
(4): Has a rudimentary understanding of needed information and how or where to search for it. Finds mostly credible sources and understands that plagiarism is unacceptable	23	39%
(5): Accesses needed information using some refined search strategies. Usually organizes information from credible sources and has a basic understanding of ethical information uses	26	44%
(6): Expertly determines, searches for, and accesses needed information. Synthesizes, and uses information from credible sources in a highly ethical manner	7	12%
Total	**59**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **33 (56%)**; 1&2 = **0 (0%).**

Which of the following categories most accurately describes your apprentice's quantitative literacy skills/abilities? (Avg. = 4.80, SD = .80)		
	Freq.	**%**
(1): Incapable of understanding quantitative information or how to derive findings from them. Judgments and conclusions are purely conjecture and do not consider any limitations in their derivation	0	0%
(2): Frequently misunderstands quantitative information and generally has trouble discerning accurate results. Judgments and conclusions are often not based on results and do not consider any limitations in their derivation	1	2%
(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	2	3%
(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	14	23%
(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	34	57%
(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	9	15%
Total	**60**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **43 (72%)**; 1&2 = **1 (2%).**

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Which of the following categories best describes your apprentice's Introduction/Purpose? (Avg. = 4.92, SD = 0.77)		
	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	2	6%
(4): The purpose of the research is accurate but sometimes unclear. Connections with existing research are incomplete	6	17%
(5): Clearly identifies the purpose of the research. Understanding of and connections with existing research are sometimes vague	21	58%
(6): Completely identifies and articulates the purpose of the research. Fully understands and connects with existing research	7	19%
Total	**36**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **28 (77%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Methods (e.g., description of equipment & procedures)? (Avg. = 4.98, SD = 0.99)		
	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	1	2%
(3): Equipment and procedures are only listed; description and purposes for each are incomplete or inadequate. Replication would be difficult	1	2%
(4): Lists the equipment and procedures used in the study. Description and purpose of each is unclear. Replication would require more information	12	28%
(5): Describes the equipment and procedures used in the study. The purpose of each is sometimes vague. Replication would require clarification	13	30%
(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	16	37%
Total	**43**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **29 (67%)**; 1&2 = **1 (2%).**

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Which of the following categories best describes your apprentice's Results (e.g., data analysis, interpretation & findings)? (Avg. = 4.91, SD = 0.77)		
	Freq.	**%**
(1): Does not report or analyze data. Interpretation of findings is non-existent or not based on the provided evidence	0	0%
(2): Analyzes data incorrectly. Interpretation of results is inaccurate.	0	0%
(3): Misunderstands some data analyses and makes several mistakes. Makes some errors interpreting results. No synthesis of findings	1	2%
(4): Understands data analysis but makes one or two mistakes. Only rudimentary interpretation of results. Synthesis of findings is incomplete	12	27%
(5): Understands and analyzes data correctly. Interprets results adequately. Synthesis of findings is sometimes unclear	21	48%
(6): Performs and understands advanced data analysis. Accurately interprets results. Synthesizes results into findings that are more than the sum of their parts	10	23%
Total	**44**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **31 (71%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Conclusions? (Avg. = 4.81, SD = 0.91)		
	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	5	12%
(4): Answers the research questions fairly well. Limitations and future directions are not clearly discussed	7	16%
(5): Answers the research questions from the introduction. Limitations and future directions are discussed but narrow in focus	22	51%
(6): Uses findings to answer research questions from the introduction very well. Discusses limitations very clearly. Reaches beyond findings to guide future research	9	21%
Total	**43**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **31 (72%)**; 1&2 = **0 (0%).**

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

Which of the following categories best describes your apprentice's Structure? (Avg. = 4.75, SD = 0.78)		
	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	2	5%
(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	14	32%
(5): Abstract, body, appendices, citations, and bibliography are included with limited mistakes. Order of sections is appropriate and labeled. Grammar is of high quality	21	48%
(6): Abstract, body, appendices, citations, and bibliography are all included and properly formatted. Order of sections is well labeled and clear. Grammar is impeccable	7	16%
Total	**44**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **28 (64%)**; 1&2 = **0 (0%).**

Which of the following categories best describes your apprentice's Oral Communication? (Avg. = 5.00, SD = 0.88)		
	Freq.	**%**
(1): Does not present separate introduction, purpose, or conclusion sections. Does not use any supporting materials (e.g., statistics, images, examples, quotations, etc.)	0	0%
(2): Fails to present one intro, purpose, and/or conclusion. Very few and non-credible supporting materials are used	1	2%
(3): Presents intro, purpose, and conclusion information but distinction between them is unclear. Minimal use of supporting material and credibility is questionable at best	1	2%
(4): Presents intro, purpose, and conclusion but is hard to follow. Uses some supporting material but credibility is sometimes in question	9	19%
(5): Presentation of intro, purpose, and conclusions were adequate. Uses some supporting materials to establish credibility	22	47%
(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	14	30%
Total	**47**	**100%**

Note. Frequency and percentage of apprentices receiving ratings of: 5&6 = **36 (77%)**; 1&2 = **1 (2%).**

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

Do you have any other comments or input to provide us regarding your REAP apprentice's final project? (n = 22)		
List of Comments	**Freq.**	**Example Response(s)**
Student is talented and worked well	9	• "[My apprentice] will make an excellent science student and hopefully get into a research lab at her chosen college early on.
Final project is a work in progress	8	• "[My apprentice] has not yet completed her project. We have approximately 2 more weeks of work." • "Project has not yet been completed."
Results were successful	4	• "The results he obtained are well within the limits of the accepted distance for the open cluster NGC 6705."
Student did not use lab equipment	3	• "[My apprentice] doesn't use equipment for her research because that is not what my research is about." • "…he has not done any laboratory research with me."
Hope for publication after completion	1	• "[My apprentice] will be continuing to work on this project during the school year so she can finish it in a form suitable for publication."

Do you have any other comments or input to provide us regarding your REAP apprentice? (n = 23)		
List of Comments	**Freq.**	**Example Response(s)**
Positive experience with apprentice	11	• "She's very bright, has intellectual curiosity, and seems to be going forward with an education in a STEM field."
Has exhibited personal development	4	• "She had no computer skills when she came and learned a lot how to process information."
Apprentice will be successful in the future	4	• "She will make an excellent scientist/engineer should she ultimately choose to pursue this career path."
Apprentice is serious about work	3	• "He is a top student and took the research very serious. He also took work home at night."
Apprentice contributed greatly	2	• "[She] adds much to the group and will be highly successful in the future."
Disappointed in the apprentice	2	• "This student was a year younger than previous apprentices have been, and so his maturity level was rather less than I expected."
Apprentice has potential	2	• "[My apprentice] has a lot of potential."
Apprentice worked independently	2	• "She is an independent worker and thinker."
Apprentice inquired well.	1	• "[My apprentice] asks good questions as she encounters new information and concepts.
Apprentice was difficult to work with	1	• "[My apprentice] is difficult to work with and at times is unwilling to listen or follow instruction. He constantly disregards instructions and techniques that he has been taught and shown multiple times."
Apprentice is self-driven	1	• "For each new technique [the apprentice] learned, she prepared, without prompting, a short presentation on the theory and principles of the technique, its primary applications and what she used it for."
Apprentice's shyness interfered with her experience	1	• "She is a little shy and slow to ask questions; however, and I think her overall understanding of the project and lab work could be improved by more questioning on her part."

Appendix C:
2013 REAP 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 REAP this year. (n = 34)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
Satisfaction with program		**25**	
	Mentor has a positive experience with apprentice(s)	11	• "[Apprentice] has been great - she has learned and progressed throughout the year the 4 weeks we have worked together. I think she has a strong future ahead of her."
	Scheduling presented a challenge	5	• "The biggest challenge has been working around Cindy's summer schedule but we did it." • "It was difficult at first keeping them on schedule."
	Satisfaction with the program	4	• "Excellent program." • "This is a very good program for both REAP apprentice and Mentors."
	Suggest more stipend money	2	• "I feel the stipend should be at least $1500.00."
	Dissatisfied with apprentice(s)	2	• "[Apprentice] has been a complete disaster after the first week in the lab. He has not progressed in his abilities one bit and seems to refuse to listen or follow instructions on even the simplest and most basic of tasks. His attitude and indifference is becoming a safety liability and is wasting time and resources better used on other students."
	Technical problems with program	1	• "My apprentice could not login to the REAP website and I am having trouble logging into the REAP page."
Academic research activities		**13**	
	Apprentices have grown as scientists	4	• "[Apprentice's] initial experiment for her project failed to return any positive results, but she was able to use this challenge to learn how to diagnose problems with these experiments, and her most recent attempt at the experiment yielded a positive result • "It is common for REAP and other beginning students to under-estimate the amount of time it takes to do research. That being said she has adapted to this very well."
	Apprentices successfully achieved research goals	4	• "We were able to largely accomplished his research goals."
	Apprentices engaged in or presented academic writing	3	• "We prepared a poster about our research. This was posted during the 18th International Conference on Cold Fusion at Univ. of Missouri, July 21 to 27, 2013. There were 39 posters. Ours received the Best Poster award."

	Apprentices learned about new topics	2	• "He began the project with a minimal interest in insects but has gained a genuine interest in insects, even posting pictures of some insects on Facebook. "
Hands-On / Laboratory research skills		**6**	
	Apprentices learned applied research skills	3	• "Despite having very little hands-on laboratory experience, [apprentice] adeptly learned techniques." • "Both of our apprentices learned how to use Python programming language."
	Apprentices set up or built new experimental apparatus	2	• "It was really great to see how excited he was when he was able to design and build (by machining) a specialized holder for a detector that we use for optical measurements."
	Apprentice became part of a research team	1	• "It took some time to get her to understand that she was an integral part of the laboratory…The success was of course that she actually became one of the research team."
STEM pathway		**4**	
	Encouraged students to pursue STEM in the future	2	• "It encourages students to join STEM education." • "…she left with a very positive attitude toward a STEM major and career."
	Preparation for future projects	1	• "I believe that this experience will give them a good basis for preparing their school science project."
	Strong STEM potential	1	• "I think she has a strong future ahead of her (especially if she stays in the STEM fields)."
Effective Mentorship		**3**	
	Challenge to find projects for REAP apprentices	2	• "Our challenge is to find experimental methods that lead straightforwardly to the execution of the project."
	Mentor learned with apprentices	1	• "The topics that the apprentices selected to work on are related to weather and health. It was a new topic for them and myself. It was quite interesting to find out how much research is ongoing in this field."
STEM ambassadorship		**1**	
	Apprentice teaching others	**1**	• "…which she also worked with a visiting scientist from Mexico. She was great at communicating with him, helping him in the lab, and actually showing him how some of the equipment was used when I was not available."

Appendix D:
2013 REAP 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 REAP 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 REAP 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 REAP?
    - What specific ways has it benefited you?
    - What does REAP offer that you don't get at school/college?

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

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

Ending questions:

7. If you had one minute to talk to an Army decision maker about REAP, 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 REAP 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 REAP.

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

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

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 REAP 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 REAP?
   - 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.

Appendix F:
Academy of Applied Science Response

Here are my observations regarding the 2013 REAP Evaluation Report:

1. Having read this report in detail, I can say that Rebecca Kruse did a very professional job in her analysis and reporting. Consequently, I have only a few minor disagreements.

2. The Evaluator claims that "a majority of apprentices of underserved or underrepresented populations were not likely to have mentors sharing the same gender or race/ethnicity characteristics - a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM."

   Where is the evidence to support the claim that similar gender/race/ethnicity is a motivator for students to be interested in STEM? Also, students need to learn to work with people of other genders, race, and ethnicity because this is the real world.

3. AEOP awareness and marketing - This clearly needs improvement, but is it provided for in the REAP budget? Also, from my observations at JSHS, AEOP has been sending the wrong message to the wrong audience. The AEOP awareness strategy (in my opinion) needs to be reviewed and more carefully analyzed.

4. The statement that "This program (JSHS) is a logical next step for participants of AEOP programs such as REAP" is clearly wrong. Most REAP students are not up to JSHS academic standards (in fact, most high school and even college students would have a hard time competing with JSHS students). The worst thing that we can do is to set REAP students up for failure. The two programs (REAP and JSHS) are very different and serve very different audiences.

5. "Data suggests that REAP apprentices have more opportunities to do the hands-on aspects of research and fewer opportunities to contribute to the minds-on aspects".

   This is as it should be. We want the REAP students to enjoy the experience and to feel that they are a valued participant in whatever project they are working on. Minds-on contributions

require a deeper knowledge of STEM than most high school students are likely to possess. My experience is that meaningful minds-on contributions come earliest at the graduate school level.

6. I note that we had 1500 applications for 101 positions, so I don't see why it makes sense to increase awareness of the REAP program. This would only lead to more frustration on the parts of the students, teachers, and mentors. The problem is not awareness of the opportunity, but rather our inability to meet the existing demand.

Appendix G:
Evaluation Resources

Same- and Cross-demographic Role Models and Mentors

Research to date offers strong evidence for the impact of STEM role models and mentors in the recruitment, retention, and achievement of females and minorities in STEM education and career pathways (NRC, 2011). Providing more access to STEM role models and mentors is among the federal priorities for expanding the nation's STEM talent across formal learning, informal learning and outreach, and workforce development sectors (CoSTEM, 2013). Limited access to and/or matching with role models and mentors of same gender or race/ethnicity have been suggested as possible factors (among many cited) contributing to the attrition of women and racial/ethnic minorities from STEM; however, research is less definitive regarding mentees' access to or matching with role models and mentors of same gender or race/ethnicity. For example, recent studies suggest that female and minority mentees may prefer same-demographic role models and mentor matches (Syed, et al., 2012), that same-demographic matching can provide greater satisfaction with the mentee-mentor experience and fewer match failures (Spencer, 2007), as well as 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 no significant difference in mentee outcomes with same-demographic matches as compared to cross-demographic matches (Cheryan, et al., 2011; Drury et al., 2011). Research both within and outside of STEM fields suggests that due to mentor availability, cross-demographic matches (e.g., typically white mentor, minority mentee) are more prevalent in formal mentoring programs. And indeed, studies have demonstrated that cross-demographic matches can enjoy similar benefits as same-demographic matches under a variety of conditions, including: when mentee has access to non-stereotypical role models or strong perceptions of similarity with a role model or mentor (Cheryan, et al., 2011); when mentee (or mentee parents) prefers cross-demographic matching (Jucovy, 2002); when mentee-mentor partners can effectively navigate cultural issues (e.g., mentor's cultural sensitivity, mentee's cultural mistrust, and shared cultural empathy) (Sanchez & Colon, 2005); when mentees have access to multiple mentors or are embedded in 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.

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Appendix G:
Evaluation Resources

Hands-on and Minds-on Activities for STEM Learning and Engagement Investments

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 and workforce development to students and teachers. U.S. DoE (2007) and more recently CoSTEM (2013) call for measurement of both learning and affective outcomes in STEM learning and engagement investments. U.S. DoE (2007) and NRC (2009) have suggested similar frameworks defining those learning and affective outcomes across STEM learning and engagement investments, and they recommend widespread adoption of such frameworks to support the ongoing assessment of the nation's progress toward achieving its goal of a STEM-literate citizenry. Although the evaluation frameworks preceded the NGSS, they generally reflect NGSS' vision (and supporting evidence base) for engaging learners in authentic and inspiring STEM experiences through the symbiotic development and application of core disciplinary ideas, cross-discipline concepts, and science and engineering practices. Engagement in science and engineering practices includes: 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 now advocated at the K-12 NGSS Lead States, 2013) and college level (AAAS 2009; NRC, 2003) and in informal settings (NRC, 2009). 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).

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