IT STARTS HERE. ★

# Army Educational Outreach Program

## Research and Engineering Apprenticeship Program (REAP)

# 2017 Annual Program Evaluation Report

## PART 2: Evaluation Findings

February 2018

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

# 1 | AEOP Consortium Contacts


### U.S. Army Contacts

**Matthew Willis, Ph.D.**
Director, Laboratory Management
Office of the Assistant Secretary of the Army
Acquisition, Logistics, and Technology
matthew.p.willis.civ@mail.mil

**Andrea Simmons**
Army Educational Outreach Program (AEOP) Director
on behalf of the Office of the Deputy Secretary of the
Army for Research and Technology
andrea.e.simmons.ctr@mail.mil

### AEOP Cooperative Agreement Manager

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

### Battelle Memorial Institute – Lead Organization

**David Burns**
Project Director, AEOP CA
Director of STEM Innovation Networks
burnsd@battelle.org

### HSAP Program Administrators

**Pamela Hampton**
Apprenticeships Lead
Academy of Applied Science
phampton@aas-world.org

**Irene O'Mara**
REAP Program Administrator
Academy of Applied Science
renie@aas-world.org

### Evaluation Team Contacts – Purdue University

**Carla C. Johnson, Ed.D.**
Evaluation Director, AEOP CA
carlacjohnson@purdue.edu

**Toni A. Sondergeld, Ph.D.**
Assistant Director, AEOP CA
tonisondergeld@metriks.com

**Janet B. Walton, Ph.D.**
Assistant Director, AEOP CA
walton25@purdue.edu


Report REAP_02_02192018 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by Purdue University College of Education on behalf of Battelle Memorial Institute (Lead Organization) under award W911 SR-15-2-0001.

# 2 | Table of Contents

# 3 | Introduction

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

**AEOP Priorities**

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

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

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

This report documents the evaluation study of one of the AEOP elements, the Research and Engineering Apprenticeship Program (REAP). REAP is managed by the Academy of Applied Science (AAS). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium. Data analyses and reports were prepared using data collected by Purdue University.

## Program Overview

REAP is a paid summer internship program that focuses on developing STEM competencies among high school students from groups underserved in STEM[1]. For more than 30 years, REAP has placed talented high school students in research apprenticeships at colleges and universities throughout the nation. Each

[1] AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other Federal targeted outreach schools; females in certain STEM field.

REAP student (herein referred to as apprentice) works a minimum of 200 hours (over a 5 to 8-week period) 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, experience valuable mentorship, and learn about education and career opportunities in STEM through a challenging STEM experience that is not readily available in high schools.

REAP is guided by the following objectives:

1. Provide high school students from groups historically underrepresented 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.

A total of 709 students applied for the REAP program in 2017, an increase of 31% compared to the number of FY16 applications. REAP provided funding for 118 apprentices under the supervision of 118 mentors at 41 colleges and universities (shown in Table 1). This is a slight decrease from FY16 when 121 apprentices were enrolled. Of the 41 colleges and universities involved in REAP, 59% were historically black colleges and universities (HBCUs) or minority serving institutions (MSIs).

**Table 1. 2017 REAP Site Applicant and Enrollment Numbers**

| 2017 REAP Site | No. of Applicants | No. of Enrolled Participants |
|---|---|---|
| Alabama State University | 17 | 5 |
| Ball State University | 4 | 1 |
| California State University | 19 | 4 |
| College of Saint Benedict & Saint John's University | 7 | 2 |
| Colorado State University | 12 | 2 |
| Delaware State University | 7 | 2 |
| Fayetteville State University | 10 | 2 |
| Florida A&M University | 9 | 4 |
| Georgia State University | 33 | 0 |
| Harris-Stowe | 2 | 0 |
| Iowa State University | 8 | 3 |

| Table 1. 2017 REAP Site Applicant and Enrollment Numbers | | |
|---|---|---|
| **2017 REAP Site** | **No. of Applicants** | **No. of Enrolled Participants** |
| Jackson State University | 23 | 6 |
| Johns Hopkins University | 88 | 5 |
| Loyola University | 24 | 2 |
| Marshall University | 4 | 3 |
| Montana State University | 2 | 0 |
| Michigan Technological University | 1 | 1 |
| New Jersey Institute of Technology | 21 | 4 |
| New Mexico State University | 12 | 2 |
| Oakland University | 8 | 4 |
| Purdue School of Engineering & Technology | 2 | 2 |
| Savannah State University | 3 | 2 |
| South Dakota School of Mines & Technology | 14 | 3 |
| Texas Southern University | 26 | 4 |
| Texas Tech | 4 | 3 |
| University of Las Vegas, Nevada | 7 | 2 |
| University of Alabama at Huntsville | 34 | 6 |
| University of Arkansas at Pine Bluff | 1 | 1 |
| University of California – Berkeley | 34 | 2 |
| University of Central Florida | 14 | 1 |
| University of Colorado | 9 | 0 |
| University of Houston | 41 | 6 |
| University of Illinois at Urbana | 6 | 1 |
| University of Iowa | 1 | 0 |
| University of Maryland – Baltimore | 58 | 4 |
| University of Massachusetts – Lowell | 13 | 2 |
| University of Missouri | 4 | 2 |
| University of New Hampshire | 4 | 2 |
| University of New Mexico | 18 | 6 |
| University of North Carolina, Charlotte | 19 | 3 |
| University of Pennsylvania | 21 | 1 |
| University of Puerto Rico | 18 | 6 |
| University of South Florida | 16 | 0 |
| University of Texas – El Paso | 7 | 1 |
| University of Texas – Arlington | 11 | 2 |
| University of Utah | 4 | 2 |
| Xavier University | 9 | 2 |

| Table 1. 2017 REAP Site Applicant and Enrollment Numbers | | |
|---|---|---|
| **2017 REAP Site** | **No. of Applicants** | **No. of Enrolled Participants** |
| **TOTAL** | **709** | **118** |

Table 2 displays demographics for enrolled REAP apprentices. Over half (61%) of participants were female and the most frequently represented races/ethnicities were Black or African American (29%) and Hispanic or Latino (15%). Fewer students identified themselves as Asian (27%) or White (19%). Most students attended urban (46%) or suburban (40%) schools and nearly half (51%) indicated that they received free or reduced-price lunch, a commonly used indicator of low income status. These data indicate that REAP was successful in attracting students from groups that are historically underserved in STEM fields. English Language Learners (ELLs) comprised 33% of the participant group and 22% were potentially future first-generation college students.

| Table 2. 2017 REAP Participant Profile | | |
|---|---|---|
| **Demographic Category** | | |
| Participant Gender (n = 79) | | |
| Female | 48 | 61% |
| Male | 31 | 39% |
| Choose not to report | 0 | 0 |
| Respondent Race/Ethnicity (n = 79) | | |
| Asian | 21 | 27% |
| Black or African American | 23 | 29% |
| Hispanic or Latino | 12 | 15% |
| Native American or Alaska Native | 1 | 1% |
| Native Hawaiian or Other Pacific Islander | 0 | 0% |
| White | 15 | 19% |
| Other race or ethnicity | 6 | 8% |
| Choose not to report | 1 | 1% |
| School Setting (n = 67) | | |
| Urban | 31 | 46% |
| Suburban | 27 | 40% |
| Rural | 7 | 10% |
| Frontier or Tribal School | 0 | 0% |
| DoDDS/DoDEA School | 0 | 0% |
| Home school | 1 | 1% |
| Free/Reduced Lunch Status (n = 67) | | |
| Yes | 34 | 51% |
| No | 29 | 43% |
| Choose Not to Report | 4 | 6% |
| English as 1st Language (n = 67) | | |
| Yes | 45 | 67% |
| No | 22 | 33% |
| Parent Graduated College (n = 67) | | |
| Yes | 46 | 69% |
| No | 15 | 22% |
| Choose not to report | 6 | 9% |

The total cost of the 2017 REAP program was $390,924. The average cost per apprentice was $3,313. Aligned with the rates of similar AEOP initiatives, REAP provides participants with a stipend of $1500 for the 200 hours. REAP mentors receive a stipend of $1,000 for their participation regardless of the number of students they mentored. Table 3 summarizes these and other 2017 REAP program costs.

| Table 3. 2017 REAP Program Costs | |
|---|---|
| **2017 REAP - Cost Per Participant** | |
| Total Participants | 118 |
| Total Cost | $390,924 |
| Administrative Costs | $126,814 |
| Other Operational Costs | $13,110 |
| Participant Stipends | $251,000 |
| Cost Per Student Participant | $3,313 |

# 4 | Evidence - Based Program Change

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

***1. Expand apprenticeship opportunities for underserved populations in cooperation with HBCUs/MSIs and other affinity groups, and in cooperation with recruitment objectives of LPCs by disseminating program information to a broader and more diverse audience. (Supports Priority 1)***

- Distributed program information to various organizations to increase diverse audience:
    - Published apprenticeship opportunities to high schools and universities located near Army labs and universities using direct mail and email campaigns.
    - Expanded outreach efforts to include superintendents of Title I high schools close to universities and DoD laboratories.
    - Received high school and community outreach assistance from The SEED School of Maryland, Center for Excellence in Education in McLean, Virginia, Iowa Education Services Officer (National Guard) and Educational Services Specialist (Army) in New Jersey.
- University directors provided outreach to local schools with materials supplied by AAS, such as, the AEOP brochure with rack cards, apprenticeship flyers, thumb drives, pencils and stickers.
- Improved program awareness and mentor participation by:
    - Working with university directors and mentors to develop a best practices document with roles and responsibilities. Will expand to include all university programs in FY18.
    - Sending mentors certificates of appreciation and letters of appreciation, as well as sending letters to the university deans, as appropriate.
    - Working with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights – 10 in FY17 with 7 more apprenticeship spotlights in development. It is anticipated that mentor blogs and spotlights will spark interest in future program participation.
    - Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
        - STEM Career links and FY17 STEM Career flyer
        - DoD STEM Webinar
        - Other AEOP programs
        - AEOP Travel Award
        - 21st Century Skill Assessment Pilot Program
        - Program Evaluation
        - Poster tips

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

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

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

- Worked with Army office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Students learned about Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.

- Worked with Widmeyer and Metriks to profile mentors in universities and DoD laboratories to showcase STEM careers in AEOP blogs and Alumni Spotlights.
- Since last year's ongoing summer communication was successful, continued this effort in FY17, sending student and mentor information on the following topics:
    - STEM Career links and FY17 STEM Career flyer
    - DoD STEM Webinar
    - Alumni Survey Link
    - Other AEOP programs
    - AEOP Travel Award
    - 21st Century Skill Assessment Pilot Program
    - Program Evaluation
    - Poster tips

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

- Worked with Metriks to secure Alumni information. Apprenticeship announcement flyers were sent to over 3,000 alumni from the GEMS, Unite, JSS, SEAP, HSAP, REAP, JSHS.
- Distributed alumni survey link to directors, mentors and students.
- Distributed Alumni Spotlight to current participants to showcase other programs.
- Worked with partners (e-Cybermission, Unite and JSHS) to distribute program information to cross promote.
- Reviewed and provided feedback to Widmeyer regarding the updates to the AEOP website.
- 26% of student participants in apprentice programs participated in GEMS or SEAP. However, it is important to note that 243 students (or 42%) participated in at least one other AEOP program. In addition, 23 REAP students are former Unite students, representing 19% of the REAP student participant population in FY17.

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

- Apprenticeship flyers were distributed to high schools, alumni and after school programs located near underserved/under-represented communities close to universities and DoD laboratories. Emails also included a link to the AEOP website outlining other AEOP opportunities.
- Welcome packets were distributed to participants comprised of: Lab coats, flash drives, notebooks, pens/pencils, AEOP brochures/rack cards and all AEOP program opportunities.
- Weekly communication to participants highlighted all AEOP programs and AEOP 2017 STEM Career Guide, AEOP blogs, AEOP social media info about other AEOP opportunities.

- Assisted university directors plan a Meet & Greet where students and mentors from other AEOP programs came together to talk about their experience. AAS provided additional AEOP material that talked about AEOP programs. Although the events were great for students, mentors could talk about their experiences, as well, and gained a better knowledge of AEOP. Each event was unique, however, some of the activities included:
  - Poster and/or power point presentations
  - Luncheon
  - Invited guest speakers
- Many universities provided an avenue where students presented their work to faculty, mentors, students and community members, and many attended (and presented at some) STEM venues, such as the Cancer Research Symposium in Opelika, Alabama, the Research Experience for Undergraduates (REU) and the Minority Science and Engineering Improvement Program (MSEIP) in Alabama, and the Summer Research Symposium in North Carolina.
- Visited WRAIR and spoke with mentors and apprentices about the student experience in a DoD laboratory, their research project, and their overall apprenticeship experience. Students indicated that this experience has increased their STEM knowledge and affirmed their choice to continue in a STEM related field in the future.
- Worked with Army office to develop and publicize DoD STEM Career webinars for all apprenticeships showcasing Army scientists and engineers.
- Worked with Widmeyer and Metriks to profile mentors (and students) in AEOP blogs and Alumni Spotlights.

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

- Worked with university directors/mentors to develop best practices.
- Developed and distributed poster guidelines to students and mentors.
- Distributed AEOP travel award information to participants. Twelve (12) apprenticeship participants were awarded in FY17.
- Assisted mentors with the 21st Century Pilot Program Evaluations.
- Developed student orientation & welcome document.
- Worked with the Army office to research, develop, and present the DoD STEM Career webinar series to showcase Army scientists and engineers.
- Instituted a new stipend policy to ensure prompt stipend processing.
- Regular communication with students and mentors regarding program outcomes and expectations.
- Applications opened earlier, and in some cases, closed earlier to allow for more time to complete security clearance and issuing of CAC cards at DoD laboratories. One of the primary goals of an earlier close date was to implement the notification process for selected and non-selected participants so that students would have time to apply to other summer STEM opportunities.

- The Mentor Toolkit provided valuable ideas for assisting mentors. The Toolkit suggested ideas to develop an ongoing conversation with mentors about how to assist students in research and life skills, develop best practices in mentoring, and security issues. The Toolkit is a resource for IPA's and LC's to use in helping mentors.

# 5 | Evaluation At-A-Glance

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

| Inputs | Activities | Outputs | Outcomes (Short term) | Impact (Long Term) |
|---|---|---|---|---|
| • Army sponsorship<br>• AAS providing oversight of site programming<br>• Operations conducted by 41 universities<br>• Students participating in 118 REAP apprenticeships<br>• STEM professionals and educators serving as REAP mentors<br>• Stipends for apprentices to support meals and travel<br>• Stipends for faculty<br>• Centralized branding and comprehensive marketing<br>• Centralized evaluation | • Apprentices engage in authentic science and engineering research experiences through hands-on summer apprenticeships at REAP-sponsored colleges and universities<br>• STEM professionals supervise and mentor apprentices' research<br>• Program activities that expose apprentice to AEOP programs and/or STEM careers in the Army or DoD | • Number and diversity of apprentice participants engaged in programs<br>• Number and diversity of STEM professionals serving as mentors for programs<br>• Number and diversity of Army/DoD scientists and engineers and other military personnel engaged in programs<br>• Number and Title 1 status of high schools served through participant engagement<br>• Apprentices, STEM professionals, site coordinators, and AAS contributing to evaluation | • Increased apprentice STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM)<br>• Increased apprentice interest in future STEM engagement<br>• Increased apprentice awareness of and interest in other AEOP opportunities<br>• Increased apprentice awareness of and interest in STEM research and careers<br>• Increased apprentice awareness of and interest in Army/DoD STEM research and careers<br>• Implementation of evidence-based recommendations to improve HSAP programs | • Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs<br>• Increased apprentice pursuit of STEM degrees<br>• Increased apprentice pursuit of STEM careers<br>• Increased apprentice pursuit of Army/DoD STEM careers<br>• 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.

The assessment strategy for REAP included apprentice and mentor questionnaires, 8 interviews with apprentices, 5 interviews with mentors, and the Annual Program Report (APR) prepared by AAS. Tables 4-8 outline the information collected in apprentice and mentor questionnaires, focus groups, apprentice interviews, and information from the APR that is relevant to this evaluation report.

**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' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

| Table 4. 2017 Apprentice Questionnaires | |
|---|---|
| **Category** | **Description** |
| Profile | **Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators |
| | **Education Intentions:** Degree level, confidence to achieve educational goals, field sought |
| AEOP Goal 1 | **Capturing the Student Experience:** In-school vs. In-program experience |
| | **STEM Competencies:** Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP |
| | **Transferrable Competencies:** Gains in 21st Century Skills |
| | **STEM Identity:** Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP |
| | **AEOP Opportunities:** Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources |
| | **Army/DoD STEM:** Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources |
| AEOP Goal 2 and 3 | **Mentor Capacity:** Perceptions of mentor/teaching strategies (students respond to a subset) |
| | **Comprehensive Marketing Strategy:** impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers |
| Satisfaction & Suggestions | Benefits to participants, suggestions for improving programs, overall satisfaction |

| Table 5. 2017 Mentor Questionnaires | |
|---|---|
| **Category** | **Description** |
| Profile | **Demographics:** Participant gender, race/ethnicity, occupation, past participation |
| Satisfaction & Suggestions | Awareness of HSAP, satisfaction with and suggestions for improving HSAP programs, benefits to participants |
| AEOP Goal 1 | **Capturing the Student Experience:** In-program experience |
| | **STEM Competencies:** Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP |
| | **Transferrable Competencies:** Gains in 21st Century Skills |
| | **AEOP Opportunities:** Past participation, awareness of other AEOP programs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing student AEOP metrics |
| | **Army/DoD STEM:** attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing student Army/DoD career metrics |
| AEOP Goal 2 and 3 | **Mentor Capacity:** Perceptions of mentor/teaching strategies |
| | **Comprehensive Marketing Strategy:** how mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers |
| Satisfaction & Suggestions | Benefits to participants, suggestions for improving programs, overall satisfaction |

| Table 6. 2017Apprentice Interviews | |
|---|---|
| **Category** | **Description** |
| Satisfaction & Suggestions | Awareness of HSAP, motivating factors for participation, awareness of implications of research topics, satisfaction with and suggestions for improving HSAP programs, benefits to participants |
| AEOP Goal 1 and 2 Program Efforts | **Army STEM: AEOP Opportunities –** Extent to which apprentices were exposed to other AEOP opportunities |
| | **Army STEM: Army/DoD STEM Careers –** Extent to which apprentices were exposed to STEM and Army/DoD STEM jobs |

| Table 7. 2017 Mentor Interviews | |
|---|---|
| **Category** | **Description** |
| Satisfaction & Suggestions | Perceived value of HSAP, benefits to participants suggestions for improving HSAP programs |
| AEOP Goal 1 and 2 Program Efforts | **Army STEM: AEOP Opportunities –** Efforts to expose apprentices to AEOP opportunities |
| | **Army STEM: Army/DoD STEM Careers –** Efforts to expose apprentices to STEM and Army/DoD STEM jobs |
| | **Mentor Capacity: Local Educators –** Strategies used to increase diversity/support diversity in HSAP |

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in the appendices, found in Part 3 of the REAP Evaluation Report. The reader is strongly encouraged to review Appendix A, the evaluation plan, to clarify how data are 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. Interview protocols are provided in Appendix B (apprentices) and Appendix C (mentors); the apprentice questionnaire

is provided in Appendix D and the mentor questionnaire is provided in Appendix E. The new assessment of apprentices' 21st Century Skills was piloted in 2017 and the tool is included in Appendix F. Major trends in data and analyses are reported herein.

## Study Sample

A total of 91 apprentices responded to the questionnaire (see Table 9). Seventy mentors completed the questionnaire as well. Table 9 provides an overview of apprentice respondents by site.

| Table 9. 2017 Apprentice Questionnaire Respondents by REAP Site | Apprentices | |
|---|---|---|
| | No. of Enrolled Participants | No. of Survey Respondents |
| Alabama State University | 5 | 3 |
| Ball State University | 1 | 1 |
| California State University | 4 | 3 |
| College of St. Benedict and St. John's University | 2 | 2 |
| Colorado State University | 2 | 2 |
| Delaware State University | 2 | 2 |
| Fayetteville State University | 2 | 1 |
| Florida A&M University | 4 | 2 |
| Iowa State University | 3 | 1 |
| Jackson State University | 6 | 7 |
| Johns Hopkins University | 5 | 4 |
| Loyola University | 2 | 2 |
| Marshall University | 3 | 5 |
| Michigan Tech | 1 | 1 |
| New Jersey Institute of Technology | 4 | 1 |
| New Mexico State University | 2 | 1 |
| Oakland University | 4 | 2 |
| Purdue University | 2 | 3 |
| Savannah State University | 2 | 1 |
| South Dakota School of Mines & Tech | 3 | 3 |
| Texas Southern University | 4 | 3 |
| Texas Tech University | 3 | 3 |
| University of Alabama - Huntsville | 6 | 5 |
| University of Arkansas - Pine Bluff | 1 | 1 |
| University of California, Berkeley | 2 | 0 |
| University of Central Florida | 1 | 1 |

| Table 9.<br>2017 Apprentice Questionnaire Respondents by REAP Site | Apprentices | |
|---|---|---|
| | No. of Enrolled Participants | No. of Survey Respondents |
| University of Houston | 6 | 5 |
| University of Illinois at Urbana | 1 | 1 |
| University of Maryland - Baltimore | 4 | 3 |
| University of Massachusetts - Lowell | 2 | 2 |
| University of Missouri | 2 | 1 |
| University of Nevada - Las Vegas | 2 | 2 |
| University of New Hampshire | 2 | 0 |
| University of New Mexico | 6 | 4 |
| University of North Carolina - Charlotte | 3 | 3 |
| University of Pennsylvania | 1 | 1 |
| University of Puerto Rico | 6 | 6 |
| University of Texas, El Paso | 1 | 0 |
| University of Texas, Arlington | 2 | 0 |
| University of Utah | 2 | 2 |
| Xavier University of Louisiana | 2 | 1 |
| **TOTAL** | **118** | **91** |

Table 10 provides an analysis of apprentice and mentor participation in the REAP questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). There was a slight decrease in apprentice participation in the questionnaire in FY17 as compared to FY16 (77% in FY17; 85% in FY16). There was, however, a substantial increase in mentor participation in the questionnaire with 59% of mentors responding in FY17 compared to 26% in FY16. In spite of this increase, the margin of error for the mentor questionnaire is larger than generally acceptable, indicating that the sample may not be representative of the overall mentor population. Mentor questionnaire findings should therefore be interpreted with caution.

| Table 10. 2017 REAP Questionnaire Participation | | | | |
|---|---|---|---|---|
| Participant Group | Respondents (Sample) | Total Participants (Population) | Participation Rate | Margin of Error @ 95% Confidence[2] |

[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 to the question had been asked of the entire population, there is a 95% likelihood that between 42% and 52% would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

| | | | | |
|---|---|---|---|---|
| Apprentices | 91 | 118 | 77% | ±4.94% |
| Mentors | 70 | 118 | 59% | ±7.50% |

Phone interviews were conducted with 8 apprentices and 5 mentors. The interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice and mentor questionnaire data. They 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

REAP apprentice respondents' demographic information is provided in Table 11. More females (61%) than males (39%) completed the questionnaire. More responding apprentices identified with the race/ethnicity of Black or African American (29%) than any other single race/ethnicity category, and over a quarter (27%) identified themselves as Asian while 15% indicated that they were Hispanic/Latino. The demographics of questionnaire respondents are similar to the population of participating apprentices, suggesting that the apprentice sample is representative of the overall population of REAP apprentices.

| Table 11. 2017 REAP Apprentice Respondent Profiles | | |
|---|---|---|
| **Demographic Category** | **Questionnaire Respondents** | |
| **Respondent Gender (n = 79)** | | |
| Female | 48 | 61% |
| Male | 31 | 39% |
| No Response | 0 | 0% |
| **Respondent Race/Ethnicity (n = 79)** | | |
| Asian | 21 | 27% |
| Black or African American | 23 | 29% |
| Hispanic or Latino | 12 | 15% |
| Native American or Alaska Native | 1 | 1% |
| Native Hawaiian or Other Pacific Islander | 0 | 0% |
| White | 15 | 19% |
| Other | 6 | 8% |
| No Response | 1 | 1% |
| **Respondent Grade Level (n = 91)** | | |
| High school freshman | 1 | 1% |
| High school sophomore | 10 | 11% |
| High school junior | 30 | 33% |
| High school senior | 36 | 40% |
| Choose not to report | 1 | 1% |
| Other | 13 | 14% |
| **Respondent Eligible for Free/Reduced-Price Lunch (n = 67)** | | |
| Yes | 33 | 49% |
| No | 30 | 45% |
| No Response | 4 | 6% |

Apprentices were asked how many times they had previously participated in each of the AEOP programs (Table 12). Many apprentices (41%) reported having never participated in any AEOP programs. Nearly a quarter (23%) of REAP apprentices had participated in Unite in the past while fewer had participated in REAP (16%) previously, and GEMS (5%). All other programs either had 1 or no past participants among the responding apprentices.

**Table 12. Apprentice Participation in AEOP Programs (n=79)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Camp Invention | 1.27% | 1 |
| eCYBERMISSION | 0.00% | 0 |
| Junior Solar Sprint (JSS) | 1.27% | 1 |
| Gains in the Education of Mathematics and Science (GEMS) | 5.06% | 4 |
| Unite | 22.78% | 18 |

| | | |
|---|---|---|
| Junior Science & Humanities Symposium (JSHS) | 1.27% | 1 |
| Science & Engineering Apprenticeship Program (SEAP) | 1.27% | 1 |
| Research & Engineering Apprenticeship Program (REAP) | 16.46% | 13 |
| High School Apprenticeship Program (HSAP) | 2.53% | 2 |
| College Qualified Leaders (CQL) | 0.00% | 0 |
| Undergraduate Research Apprenticeship Program (URAP) | 1.27% | 1 |
| Science Mathematics & Research for Transformation (SMART) College Scholarship | 0.00% | 0 |
| I've never participated in any AEOP programs | 40.51% | 32 |
| Other STEM Program | 37.97% | 30 |

## Mentor Demographics

Demographics for mentors who responded to the questionnaire are presented in Table 13. More females (69%) participated than males (31%). Most mentors reported being either White (37%) or Asian (30%).Mentors' primary areas of research interest were wide-spread with physical sciences (28%), engineering (27%), and biological sciences (22%) among the most frequently reported research areas.

**Table 13. 2017 REAP Participating Mentor Profiles**

| Demographic Category | Questionnaire Respondents | |
|---|---|---|
| **Gender (n = 70)** | | |
| Female | 48 | 69% |
| Male | 22 | 31% |
| **Race/Ethnicity (n = 70)** | | |
| Hispanic or Latino | 8 | 12% |
| Asian | 21 | 30% |
| Black or African American | 10 | 14% |
| Native American or Alaska Native | 1 | 1% |
| Native Hawaiian or Other Pacific Islander | 0 | 0% |
| White | 26 | 37% |
| Choose not to report | 4 | 6% |
| Other race or ethnicity | 0 | 0% |
| **Primary Area of Research (n = 67)** | | |
| Physical science (physics, chemistry, astronomy, materials science, etc.) | 19 | 28% |
| Biological science | 15 | 22% |
| Earth, atmospheric, or oceanic science | 1 | 1.5% |
| Environmental science | 5 | 8% |
| Computer science | 2 | 3% |

| | | |
|---|---|---|
| Technology | 0 | 0% |
| Engineering | 18 | 27% |
| Mathematics or statistics | 4 | 6% |
| Medical, health, or behavioral science | 1 | 1.5% |
| Social Science (psychology, sociology, anthropology) | 1 | 1.5% |
| Other | 1 | 1.5% |

# 6 | Actionable Program Evaluation

The intent of the Actionable Program Evaluation is 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 sections of Tables 4-8.

The Actionable Program Evaluation examines 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. REAP sites reach out to students from underserved populations. Thus, it is important to consider how REAP is marketed and ultimately recruits student participants, the factors that motivate students to participate in REAP, apprentices' perceptions of and satisfaction with activities, what value apprentices place on program activities, and what recommendations apprentices have for program improvement. The following sections report perceptions of apprentices and mentors that pertain to current programmatic efforts and AEOP programs and objectives.

## Marketing and Recruiting to Underserved Populations

A focus for REAP in 2017 was to expand apprenticeship opportunities for underserved populations in cooperation with HBCUs/MSIs and other affinity groups by disseminating program information to a broader and more diverse audience. Marketing activities for REAP and other apprenticeship programs included the following:

- Distributed program information to various organizations to increase diverse audience:
    - Published apprenticeship opportunities to high schools and universities located near Army labs and universities using direct mail and email campaigns.
    - Expanded outreach efforts to include superintendents of Title I high schools close to universities and DoD laboratories.
    - Received high school and community outreach assistance from The SEED School of Maryland, Center for Excellence in Education in McLean, Virginia, Iowa Education Services Officer (National Guard) and Educational Services Specialist (Army) in New Jersey.
- University directors provided outreach to local schools with materials supplied by AAS, such as, the AEOP brochure with rack cards, apprenticeship flyers, thumb drives, pencils and stickers.

Mentors were asked how students were recruited for apprenticeships (Table 14). Half (50%) of mentors indicated that their apprentices were recruited through applications from AAS or AEOP while 39% cited K-12 teachers at the local schools and 30% cited colleagues in their workplace as sources of apprentice recruitment. In addition, 24% reported that students were recruited through personal

acquaintances outside the workplace. Over a quarter of mentors (29%) reported not knowing how apprentices were recruited.

In order to investigate the effectiveness of various marketing strategies, apprentices were asked to report how they learned about AEOP (Table 15). They were most likely to indicate they learned about AEOP through someone who works at the school or university they attend (43%); a school or university newsletter, email, or website (35%); or someone who works with the program (28%). Another 22% learned about AEOP from a past participant. Few apprentices reported learning about REAP through AEOP on social media (4%) or the AEOP website (11%).

**Table 14. Mentor Reports of Recruitment Strategies (n=70)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Applications from the Academy of Applied Science (AAS) or the AEOP | 50.00 % | 35 |
| Personal acquaintance(s) (friend, family, neighbor, etc.) | 24.29 % | 17 |
| Colleague(s) in my workplace | 30.00 % | 21 |
| K-12 school teacher(s) outside of my workplace | 38.57 % | 27 |
| University faculty outside of my workplace | 8.57 % | 6 |
| Informational materials sent to K-12 schools or Universities outside of my workplace | 21.43 % | 15 |
| Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website) | 11.43 % | 8 |
| Communication(s) generated by a university or faculty (newsletter, email blast, website) | 18.57 % | 13 |
| STEM or STEM Education conference(s) or event(s) | 7.14 % | 5 |
| Organization(s) that serve underserved or underrepresented populations | 14.29 % | 10 |
| The student contacted me (the mentor) about the program | 14.29 % | 10 |
| I do not know how student(s) were recruited for REAP | 28.57 % | 20 |
| Other | 0.00 % | 0 |

**Table 15. How Apprentices Learned about AEOP (n=79)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Army Educational Outreach Program (AEOP) Website | 11.39% | 9 |
| AEOP on Facebook, Twitter, Instagram, or other social media | 3.80% | 3 |
| School or university newsletter, email, or website | 35.44% | 28 |
| Past participant of program | 21.52% | 17 |
| Friend | 17.72% | 14 |
| Family Member | 11.39% | 9 |
| Someone who works at the school or university I attend | 43.04% | 34 |
| Someone who works with the program | 27.85% | 22 |
| Someone who works with the Department of Defense | 0.00% | 0 |
| Community group or program | 3.80% | 3 |
| Choose Not to Report | 1.27% | 1 |

Mentors were also asked how they learned about AEOP (Table 16). The sources that the responding mentors most frequently identified were a supervisor or superior (39%), a colleague (26%), and the REAP site host or director (23%). Fewer reported learning about REAP through organizational websites such as AAS (10%) or AEOP (19%) and none had learned about AEOP through social media (0%). Collectively, apprentices and mentors reported learning about AEOP far more through personal interactions and communications rather than through the AAS or AEOP websites and/or social media outlets.

**Table 16. How Mentors Learned about AEOP (n=70)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Academy of Applied Science (AAS) | 10.00 % | 7 |
| Army Educational Outreach Program (AEOP) website | 18.57 % | 13 |
| AEOP on Facebook, Twitter, Pinterest, or other social media | 0.00 % | 0 |
| A STEM conference or STEM education conference | 0.00 % | 0 |
| An email or newsletter from school, university, or a professional organization | 4.29 % | 3 |
| Past REAP participant | 18.57 % | 13 |
| A student | 2.86 % | 2 |
| A colleague | 25.71 % | 18 |
| My supervisor or superior | 38.57 % | 27 |
| A REAP site host or director | 22.86 % | 16 |
| Workplace communications | 5.71 % | 4 |

| | | |
|---|---|---|
| Someone who works with the Department of Defense (Army, Navy, Air Force) | 1.43 % | 1 |
| Other | 4.29 % | 3 |

## Factors Motivating Apprentice Participation

Apprentice questionnaires and interviews included questions to explore what motivated apprentices to participate in REAP. Most apprentices responding to the questionnaire reported being motivated by internal factors to participate in REAP (Table 17). The most frequently reported motivators were apprentices' interest in STEM (94%), desire to learn something new or interesting (86%), desire to expand research or laboratory skills (81%), and learning in new ways that are not possible in school (78%).

**Table 17. Factors Motivating Apprentices to Participate in REAP (n=72)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Teacher or professor encouragement | 40.28% | 29 |
| An academic requirement or school grade | 5.56% | 4 |
| Desire to learn something new or interesting | 86.11% | 62 |
| The mentor(s) | 26.39% | 19 |
| Building college application or résumé | 63.89% | 46 |
| Networking opportunities | 52.78% | 38 |
| Interest in science, technology, engineering, or mathematics (STEM) | 94.44% | 68 |
| Interest in STEM careers with the Army | 31.94% | 23 |
| Having fun | 65.28% | 47 |
| Earning stipends or awards for doing STEM | 30.56% | 22 |
| Opportunity to do something with friends | 18.06% | 13 |
| Opportunity to use advanced laboratory technology | 69.44% | 50 |
| Desire to expand laboratory or research skills | 80.56% | 58 |
| Learning in ways that are not possible in school | 77.78% | 56 |
| Serving the community or country | 43.06% | 31 |
| Exploring a unique work environment | 72.22% | 52 |
| Figuring out education or career goals | 70.83% | 51 |
| Seeing how school learning applies to real life | 61.11% | 44 |
| Recommendations of past participants | 13.89% | 10 |

| | | |
|---|---|---|
| Choose Not to Report | 0.00% | 0 |

The apprentices participating in interviews cited similar motivations, focusing on learning opportunities, opportunities for hands-on research and laboratory experiences, and college preparation. For example,

> *I choose to participate in REAP this year is because I was interested in research and I like to move to the next step to learn more and wanted to experience how would it be in a research program.* (REAP Apprentice)

## The REAP Experience

In order to understand REAP participants' overall program experiences, several questions focused on the nature of apprentices' experiences. Table 18 shows that nearly half of apprentices were assigned a project for the experience by their mentor (44%), while 22% worked with their mentor and members of a research team to design a project, and 18% had a choice among various projects suggested by their mentor.

**Table 18. Apprentice Input on Design of Their Project (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|
| I did not have a project | 2.20 % | 2 |
| I was assigned a project by my mentor | 43.96 % | 40 |
| I worked with my mentor to design a project | 9.89 % | 9 |
| I had a choice among various projects suggested by my mentor | 17.58 % | 16 |
| I worked with my mentor and members of a research team to design a project | 21.98 % | 20 |
| I designed the entire project on my own | 4.40 % | 4 |

Apprentices were asked about how or whether they participated in research groups during their REAP experiences (Table 19). While 41% worked with a group on the same project during the REAP experience, over half of apprentices reported working independently in some capacity (59%).

**Table 19. Apprentice Participation in a Research Group (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|

| | | |
|---|---|---|
| I worked alone (or alone with my research mentor) | 12.09 % | 11 |
| I worked with others in a shared laboratory or other space, but we worked on different projects | 21.98 % | 20 |
| I worked alone on my project and I met with others regularly for general reporting or discussion | 4.40 % | 4 |
| I worked alone on a project that was closely connected with projects of others in my group | 20.88 % | 19 |
| I worked with a group who all worked on the same project | 40.66 % | 37 |

In alignment with the focus of REAP to increase the number and diversity of students who pursue STEM careers, apprentices were asked to report how many STEM jobs/careers they had learned about during REAP (Table 20). Nearly all apprentices reported learning about at least one STEM job/career (96%), and almost half of apprentices reported learning about four or more STEM jobs/careers (48%).

**Table 20. Number of STEM Jobs/Careers Apprentices Learned About During REAP (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|
| None | 4.40 % | 4 |
| 1 | 7.69 % | 7 |
| 2 | 20.88 % | 19 |
| 3 | 18.68 % | 17 |
| 4 | 10.99 % | 10 |
| 5 or more | 37.36 % | 34 |

Apprentices were also asked to report how many STEM jobs/careers in the Army or DoD they learned about during REAP (Table 21). Fewer apprentices had learned about these careers than about STEM careers more generally, with 69% reporting that they had learned about at least one STEM job/career in the Army or DoD. About 30% of students reported learning about 4 or more of these careers.

**Table 21. Number of Army or DoD STEM Jobs/Careers Apprentices Learned About During REAP (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|

| | | |
|---|---|---|
| None | 30.77 % | 28 |
| 1 | 8.79 % | 8 |
| 2 | 20.88 % | 19 |
| 3 | 9.89 % | 9 |
| 4 | 8.79 % | 8 |
| 5 or more | 20.88 % | 19 |

In order to understand what resources are most effective in providing career information to apprentices, REAP apprentices were asked to report on the impact of various resources on their awareness of DoD STEM careers (Table 22). More than half of apprentices reported that their awareness was somewhat or very much impacted by participating in REAP (61%), the AEOP website (58%), and their mentors (54%). However, many apprentices reported not experiencing resources such as AEOP on social media (55%) and the ARO website (47%).

**Table 22. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n =91)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 24.2% | 3.3% | 14.3% | 22.0% | 36.3% | |
| | 22 | 3 | 13 | 20 | 33 | **91** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 54.9% | 13.2% | 11.0% | 12.1% | 8.8% | |
| | 50 | 12 | 10 | 11 | 8 | **91** |
| **Army Research Office (ARO) website** | 47.3% | 3.3% | 15.4% | 9.9% | 24.2% | |
| | 43 | 3 | 14 | 9 | 22 | **91** |
| **AEOP brochure** | 25.3% | 5.5% | 22.0% | 19.8% | 27.5% | |
| | 23 | 5 | 20 | 18 | 25 | **91** |
| **My Apprenticeship Program mentor** | 23.1% | 8.8% | 14.3% | 18.7% | 35.2% | |
| | 21 | 8 | 13 | 17 | 32 | **91** |
| **Presentations or information shared in the Apprenticeship Program** | 31.9% | 4.4% | 16.5% | 12.1% | 35.2% | |
| | 29 | 4 | 15 | 11 | 32 | **91** |
| **Participation in the Apprenticeship Program** | 17.6% | 7.7% | 14.3% | 13.2% | 47.3% | |
| | 16 | 7 | 13 | 12 | 43 | **91** |

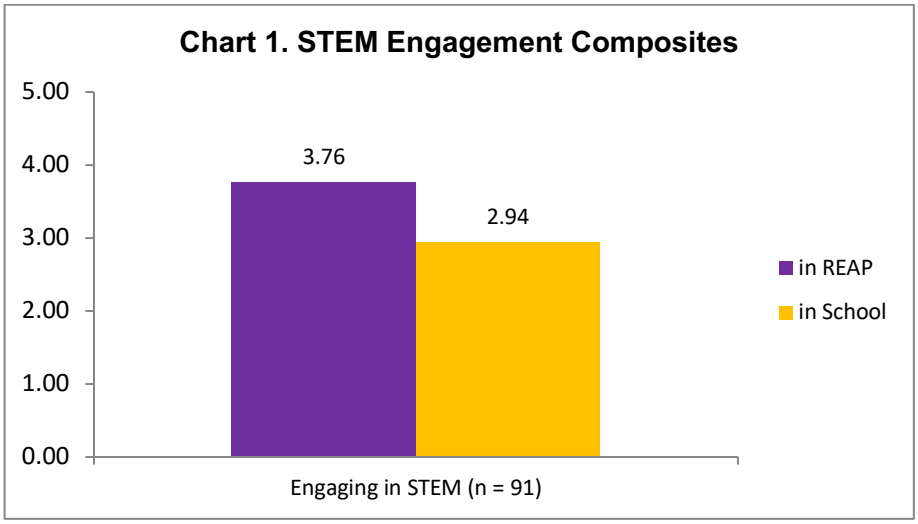
The evaluation of REAP included questions regarding apprentices' engagement in STEM practices during their apprenticeship experiences. Results indicate that apprentices were very actively engaged in STEM practices (Table 23). Apprentices reported greatest engagement (engaged in weekly or every day) in practices such as interacting with STEM researchers (95%), analyzing data or information and drawing conclusions (91%), working with a STEM researcher or company on a real-world STEM research project (89%), and working collaboratively as part of a team (89%). More than half of apprentices (54%) reported they did not build or create a computer model during REAP.

**Table 23. Apprentice Engagement in STEM Practices in REAP (n=91)**

| | Not at all | At least once | Monthly | Weekly | Every day | Response Total |
|---|---|---|---|---|---|---|
| **Work with a STEM researcher or company on a real-world STEM research project** | 3.3% | 7.7% | 0.0% | 20.9% | 68.1% | |
| | 3 | 7 | 0 | 19 | 62 | **91** |
| **Work with a STEM researcher on a research project of your own choosing** | 31.9% | 8.8% | 0.0% | 14.3% | 45.1% | |
| | 29 | 8 | 0 | 13 | 41 | **91** |
| **Design my own research or investigation based on my own question(s)** | 33.0% | 15.4% | 2.2% | 12.1% | 37.4% | |
| | 30 | 14 | 2 | 11 | 34 | **91** |
| **Present my STEM research to a panel of judges from industry or the military** | 42.9% | 34.1% | 6.6% | 4.4% | 12.1% | |
| | 39 | 31 | 6 | 4 | 11 | **91** |
| **Interact with STEM researchers** | 2.2% | 3.3% | 0.0% | 17.6% | 76.9% | |
| | 2 | 3 | 0 | 16 | 70 | **91** |
| **Use laboratory procedures and tools** | 4.4% | 6.6% | 2.2% | 20.9% | 65.9% | |
| | 4 | 6 | 2 | 19 | 60 | **91** |
| **Identify questions or problems to investigate** | 4.4% | 6.6% | 4.4% | 19.8% | 64.8% | |
| | 4 | 6 | 4 | 18 | 59 | **91** |
| **Design and carry out an investigation** | 9.9% | 14.3% | 2.2% | 17.6% | 56.0% | |
| | 9 | 13 | 2 | 16 | 51 | **91** |
| **Analyze data or information and draw conclusions** | 1.1% | 6.6% | 1.1% | 25.3% | 65.9% | |
| | 1 | 6 | 1 | 23 | 60 | **91** |
| **Work collaboratively as part of a team** | 4.4% | 5.5% | 1.1% | 19.8% | 69.2% | |
| | 4 | 5 | 1 | 18 | 63 | **91** |
| **Build or make a computer model** | 53.8% | 17.6% | 1.1% | 6.6% | 20.9% | |
| | 49 | 16 | 1 | 6 | 19 | **91** |
| **Solve real world problems** | 11.0% | 15.4% | 4.4% | 22.0% | 47.3% | |
| | 10 | 14 | 4 | 20 | 43 | **91** |

A composite score[3] was calculated for the Engaging in STEM in REAP items[4]. Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day," and the average across all items in the scale was calculated. The composite scores were used to test whether there were differences in apprentice experiences by gender and race/ethnic group (minority vs. non-minority). There were no significant differences between gender and race/ethnicity for this composite.

To examine how the REAP experience compares to their typical school experience, apprentices were asked how often they engaged in the same activities in school and these parallel items were combined into the composite variable Engaging in STEM Practices in School[5]. As can be seen in Chart 1, there is a statistically significant difference in student perceptions of STEM Engagement when comparing these activities in School and REAP. Apprentices report significantly higher STEM Engagement in REAP as compared to in school (effect size is large with d = 1.77)[6].




## The Role of Mentors

[3] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.
[4] The Cronbach's alpha reliability for these 12 Engagement in STEM in REAP items was 0.857.
[5] The Cronbach's alpha reliability for these 12 Engagement in STEM in School items was 0.916.
[6] Dependent Samples t-test results for Engagement in STEM; $t(90) = 8.39$, $p<.001$, two-tailed.

Mentors are a key component of REAP and other apprenticeship programs in the AEOP. The nature and quality of mentoring is an important factor in maximizing apprentice participation in these opportunities and sustaining or inspiring their interest in future STEM work. Mentors were therefore questioned regarding their use of strategies when working with apprentices (referred to as students in the mentor questionnaire items and in the descriptions of those items throughout this section of the report). These strategies comprised five main areas of effective mentoring:[7]

1. Establishing the relevance of learning activities;
2. Supporting the diverse needs of students as learners;
3. Supporting students' development of collaboration and interpersonal skills;
4. Supporting students' engagement in "authentic" STEM activities; and
5. Supporting students' STEM educational and career pathways.

Mentors were asked to respond to questionnaire items that aligned with each of these five areas of effective mentoring. Responses indicated that most mentors use at least some strategies from each of the five areas outlined above.

Mentors were asked to indicate what strategies they used to increase the relevance of learning activities for students (Table 24). More than two-thirds of mentors (70%-94%) reported using all strategies listed. The most frequently used strategies included finding out about students' backgrounds and interests at the beginning of REAP (94%) and giving students real-life problems to investigate or solve (91%).

[7] Mentoring strategies examined in the evaluation were best practices identified in various articles including:

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877-907.

Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation (2005-51-Ornstein). *Journal of Science Education and Technology*, *15*(3-4), 285-297.

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

**Table 24. Mentors Using Strategies to Establish Relevance of Learning Activities (n=70)**

| | Yes - I used this strategy | No - I did not use this strategy | Response Total |
|---|---|---|---|
| **Become familiar with my student(s) background and interests at the beginning of the REAP experience** | 94.3% | 5.7% | |
| | 66 | 4 | **70** |
| **Giving students real-life problems to investigate or solve** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |
| **Selecting readings or activities that relate to students' backgrounds** | 77.1% | 22.9% | |
| | 54 | 16 | **70** |
| **Encouraging students to suggest new readings, activities, or projects** | 70.0% | 30.0% | |
| | 49 | 21 | **70** |
| **Helping students become aware of the role(s) that STEM plays in their everyday lives** | 84.3% | 15.7% | |
| | 59 | 11 | **70** |
| **Helping students understand how STEM can help them improve their own community** | 72.9% | 27.1% | |
| | 51 | 19 | **70** |
| **Asking students to relate real-life events or activities to topics covered in REAP** | 75.7% | 24.3% | |
| | 53 | 17 | **70** |

Mentors also reported using a variety of strategies to support the diverse needs of students as learners (Table 25) with 60% -90% reporting having used each strategy listed. For example, mentors reported using a variety of teaching and/or mentoring activities to meet the needs of all students (97%), and providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (89%).

**Table 25. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=70)**

| | Yes - I used this strategy | No - I did not use this strategy | Response Total |
|---|---|---|---|
| **Identify the different learning styles that my student (s) may have at the beginning of the REAP experience** | 60.0% | 40.0% | |
| | 42 | 28 | **70** |
| **Interact with students and other personnel the same way regardless of their background** | 85.7% | 14.3% | |
| | 60 | 10 | **70** |
| **Use a variety of teaching and/or mentoring activities to meet the needs of all students** | 97.1% | 2.9% | |
| | 68 | 2 | **70** |
| **Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM** | 70.0% | 30.0% | |
| | 49 | 21 | **70** |
| **Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills** | 88.6% | 11.4% | |
| | 62 | 8 | **70** |
| **Directing students to other individuals or programs for additional support as needed** | 74.3% | 25.7% | |
| | 52 | 18 | **70** |
| **Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM** | 64.3% | 35.7% | |
| | 45 | 25 | **70** |

Mentors also reported using strategies to support students' development of collaboration and interpersonal skills (Table 26). More than three-quarters (79%-93%) of mentors reported using all strategies listed in this section. Strategies used by 90% or more of mentors included having students explain difficult ideas to others (93%), having students listen to the ideas of others with an open mind (92%), and having students work on collaborative activities or projects as a member of a team (91%).

**Table 26. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=70)**

| | Yes - I used this strategy | No - I did not use this strategy | Response Total |
|---|---|---|---|
| **Having my student(s) tell other people about their backgrounds and interests** | 84.3% | 15.7% | |
| | 59 | 11 | **70** |
| **Having my student(s) explain difficult ideas to others** | 92.9% | 7.1% | |
| | 65 | 5 | **70** |
| **Having my student(s) listen to the ideas of others with an open mind** | 92.9% | 7.1% | |
| | 65 | 5 | **70** |
| **Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own** | 87.1% | 12.9% | |
| | 61 | 9 | **70** |
| **Having my student(s) give and receive constructive feedback with others** | 85.7% | 14.3% | |
| | 60 | 10 | **70** |
| **Having students work on collaborative activities or projects as a member of a team** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |
| **Allowing my student(s) to resolve conflicts and reach agreement within their team** | 78.6% | 21.4% | |
| | 55 | 15 | **70** |

Large majorities of mentors reported using all strategies to support student engagement in authentic STEM activities (Table 27). Over 90% (91%-96%) of responding mentors reported implementing all of the practices listed including providing students with constructive feedback to improve their STEM competencies (96%), demonstrating laboratory/field techniques, procedures, and tools for students (94%), and allowing students to work independently to improve their self-management abilities (94%).

**Table 27. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=70)**

| | Yes - I used this strategy | No - I did not use this strategy | Response Total |
|---|---|---|---|
| **Teaching (or assigning readings) about specific STEM subject matter** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |
| **Having my student(s) search for and review technical research to support their work** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |
| **Demonstrating laboratory/field techniques, procedures, and tools for my student(s)** | 94.3% | 5.7% | |
| | 66 | 4 | **70** |
| **Supervising my student(s) while they practice STEM research skills** | 94.3% | 5.7% | |
| | 66 | 4 | **70** |
| **Providing my student(s) with constructive feedback to improve their STEM competencies** | 95.7% | 4.3% | |
| | 67 | 3 | **70** |
| **Allowing students to work independently to improve their self-management abilities** | 94.3% | 5.7% | |
| | 66 | 4 | **70** |
| **Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |
| **Encouraging students to seek support from other team members** | 91.4% | 8.6% | |
| | 64 | 6 | **70** |

Most mentors (53%-96%) also reported using all strategies focused on supporting students' STEM educational and career pathways, although there was variation in the use of specific strategies in this area (Table 28). Two of the most widely reported used strategies were asking students about their educational and/or career goals (96%), and providing guidance about educational pathways that will prepare students for a STEM career (89%). Fewer mentors reported helping students with their resume, application, personal statement, and/or interview preparations (53%).

**Table 28. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=70)**

| | Yes - I used this strategy | No - I did not use this strategy | Response Total |
|---|---|---|---|
| **Asking my student(s) about their educational and/or career goals** | 95.7% | 4.3% | |
| | 67 | 3 | **70** |
| **Recommending extracurricular programs that align with students' goals** | 72.9% | 27.1% | |
| | 51 | 19 | **70** |
| **Recommending Army Educational Outreach Programs that align with students' goals** | 62.9% | 37.1% | |
| | 44 | 26 | **70** |
| **Providing guidance about educational pathways that will prepare my student(s) for a STEM career** | 88.6% | 11.4% | |
| | 62 | 8 | **70** |
| **Discussing STEM career opportunities within the DoD or other government agencies** | 61.4% | 38.6% | |
| | 43 | 27 | **70** |
| **Discussing STEM career opportunities in private industry or academia** | 80.0% | 20.0% | |
| | 56 | 14 | **70** |
| **Discussing the economic, political, ethical, and/or social context of a STEM career** | 61.4% | 38.6% | |
| | 43 | 27 | **70** |
| **Recommending student and professional organizations in STEM to my student(s)** | 68.6% | 31.4% | |
| | 48 | 22 | **70** |
| **Helping students build a professional network in a STEM field** | 70.0% | 30.0% | |
| | 49 | 21 | **70** |
| **Helping my student(s) with their resume, application, personal statement, and/or interview preparations** | 52.9% | 47.1% | |
| | 37 | 33 | **70** |

Mentors were asked which of the AEOP programs they explicitly discussed with their students during REAP (Table 29). Not surprisingly, the most frequently discussed program was REAP (67%). Other programs discussed with students by roughly a quarter of responding mentors were Unite (27%) and URAP (23%). Many mentors reported discussing AEOP in general with students, but without reference to any specific programs (39%).

**Table 29. Mentors Explicitly Discussing AEOPs with Students (n=70)**

| | Yes - I discussed this program with my student(s) | No - I did not discuss this program with my student(s) | Response Total |
|---|---|---|---|
| **Unite** | 27.1% | 72.9% | |
| | 19 | 51 | **70** |
| **Junior Science & Humanities Symposium (JSHS)** | 14.3% | 85.7% | |
| | 10 | 60 | **70** |
| **Science & Engineering Apprenticeship Program (SEAP)** | 18.6% | 81.4% | |
| | 13 | 57 | **70** |
| **Research & Engineering Apprenticeship Program (REAP)** | 67.1% | 32.9% | |
| | 47 | 23 | **70** |
| **High School Apprenticeship Program (HSAP)** | 18.6% | 81.4% | |
| | 13 | 57 | **70** |
| **College Qualified Leaders (CQL)** | 8.6% | 91.4% | |
| | 6 | 64 | **70** |
| **GEMS Near Peer Mentor Program** | 12.9% | 87.1% | |
| | 9 | 61 | **70** |
| **Undergraduate Research Apprenticeship Program (URAP)** | 22.9% | 77.1% | |
| | 16 | 54 | **70** |
| **Science Mathematics, and Research for Transformation (SMART) College Scholarship** | 15.7% | 84.3% | |
| | 11 | 59 | **70** |
| **National Defense Science & Engineering Graduate (NDSEG) Fellowship** | 12.9% | 87.1% | |
| | 9 | 61 | **70** |
| **I discussed AEOP with my student(s) but did not discuss any specific program** | 38.6% | 61.4% | |
| | 27 | 43 | **70** |

Mentors were asked to report on their perception of the usefulness of various resources for exposing students to AEOPs (Table 30). Participation in REAP (80%), the REAP Program administrator or site coordinator (69%), and the AEOP website (54%) were most frequently rated somewhat or very much useful for this purpose. On the other hand, a majority of mentors reported not experiencing AEOP on social media (70%) and invited speakers or "career" events (63%).

**Table 30. Usefulness of Resources for Exposing Students to AEOPs (n=70)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 34.3% | 0.0% | 11.4% | 11.4% | 42.9% | |
| | 24 | 0 | 8 | 8 | 30 | **70** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 70.0% | 2.9% | 8.6% | 11.4% | 7.1% | |
| | 49 | 2 | 6 | 8 | 5 | **70** |
| **AEOP brochure** | 42.9% | 1.4% | 10.0% | 15.7% | 30.0% | |
| | 30 | 1 | 7 | 11 | 21 | **70** |
| **REAP Program administrator or site coordinator** | 22.9% | 2.9% | 5.7% | 17.1% | 51.4% | |
| | 16 | 2 | 4 | 12 | 36 | **70** |
| **Invited speakers or "career" events** | 62.9% | 1.4% | 7.1% | 11.4% | 17.1% | |
| | 44 | 1 | 5 | 8 | 12 | **70** |
| **Participation in REAP** | 12.9% | 1.4% | 5.7% | 11.4% | 68.6% | |
| | 9 | 1 | 4 | 8 | 48 | **70** |

Two of the mentors participating in phone interviews were not familiar with AEOPs other than REAP, two indicated that they were aware of AEOPs generally, and one was familiar with Unite but no other AEOP initiatives. These mentors' suggestions for strategies to expose students to AEOPs included visiting high schools, referring students to the AEOP website, and maintaining contact with AEOP alumnae to provide information about programs for which they may qualify.

Mentors were also asked to report on the usefulness of these resources were for exposing students to DoD STEM careers (Table 31). Participation in REAP (69%), REAP program administrators (59%) and the AEOP website (54%) were the resources most likely to be rated as somewhat or very much useful. Again, a majority of mentors had not experienced AEOP on social media (66%) or invited speakers or "career" events (63%).

**Table 31. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=70)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 35.7% | 4.3% | 5.7% | 14.3% | 40.0% | |
| | 25 | 3 | 4 | 10 | 28 | **70** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 65.7% | 4.3% | 5.7% | 15.7% | 8.6% | |
| | 46 | 3 | 4 | 11 | 6 | **70** |
| **AEOP brochure** | 35.7% | 1.4% | 11.4% | 24.3% | 27.1% | |
| | 25 | 1 | 8 | 17 | 19 | **70** |
| **REAP Program administrator or site coordinator** | 32.9% | 2.9% | 5.7% | 15.7% | 42.9% | |
| | 23 | 2 | 4 | 11 | 30 | **70** |
| **Invited speakers or "career" events** | 62.9% | 2.9% | 8.6% | 10.0% | 15.7% | |
| | 44 | 2 | 6 | 7 | 11 | **70** |
| **Participation in REAP** | 24.3% | 1.4% | 5.7% | 18.6% | 50.0% | |
| | 17 | 1 | 4 | 13 | 35 | **70** |

Mentors who were interviewed reported that personal contacts, including DoD speakers and mentors with military experiences, are most useful in efforts to inform apprentices about Army and DoD careers. Suggestions for exposing apprentices to these careers included providing more speakers and workshops and referring them to websites for information.

## Satisfaction with REAP

Understanding apprentice and mentor satisfaction with the program was also a focus of the evaluation. Apprentices reported being highly satisfied with REAP program features they had experienced (Table 32) with 75% or more indicating they were somewhat or very much satisfied with each feature listed. For example, large majorities of apprentices were at least somewhat satisfied with the physical location of activities (92%), the application process (91%), the teaching or mentoring they experienced (87%), and communication with host site organizers (85%).

**Table 32. Apprentice Satisfaction with REAP Program Features (n=91)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Applying or registering for the program** | 3.3% | 0.0% | 5.5% | 16.5% | 74.7% | |
| | 3 | 0 | 5 | 15 | 68 | **91** |
| **Other administrative tasks (in-processing, network access, etc.)** | 12.1% | 3.3% | 5.5% | 19.8% | 59.3% | |
| | 11 | 3 | 5 | 18 | 54 | **91** |
| **Communicating with your host site organizers** | 8.8% | 1.1% | 5.5% | 14.3% | 70.3% | |
| | 8 | 1 | 5 | 13 | 64 | **91** |
| **The physical location(s) of Apprenticeship Program activities** | 4.4% | 1.1% | 2.2% | 17.6% | 74.7% | |
| | 4 | 1 | 2 | 16 | 68 | **91** |
| **The variety of STEM topics available to you in the Apprenticeship Program** | 3.3% | 4.4% | 14.3% | 22.0% | 56.0% | |
| | 3 | 4 | 13 | 20 | 51 | **91** |
| **Teaching or mentoring provided during Apprenticeship Program activities** | 2.2% | 2.2% | 8.8% | 14.3% | 72.5% | |
| | 2 | 2 | 8 | 13 | 66 | **91** |
| **Amount of stipends (payment)** | 5.5% | 0.0% | 7.7% | 14.3% | 72.5% | |
| | 5 | 0 | 7 | 13 | 66 | **91** |
| **Timeliness of payment of stipends** | 9.9% | 6.6% | 8.8% | 22.0% | 52.7% | |
| | 9 | 6 | 8 | 20 | 48 | **91** |
| **Research abstract preparation requirements** | 6.6% | 1.1% | 12.1% | 28.6% | 51.6% | |
| | 6 | 1 | 11 | 26 | 47 | **91** |

In order to understand more about the apprentices' experiences, they were asked to report on the availability of their mentors (Table 33) and their satisfaction with the mentoring and research experience (Table 34). When asked about their mentors' availability (Table 33), more than three-quarters of apprentices indicating their mentor was available more than half of the time (81%) and nearly all apprentices reported that their mentors were available at least half of the time (92%).

Apprentices also reported on their overall research experience (Table 34). More than 80% of apprentices reported being somewhat or very much satisfied with all aspects of their experience including the overall

research experience (95%), the mentor relationship (92%), and the group/team relationship (93%). One apprentice commented on her experience with her mentor during a phone interview, saying

> *[My mentor] is a great mentor. He's always there. He always made sure that we knew what we were doing.* (REAP Apprentice)

**Table 33. Apprentice Reports of Availability of Mentors (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|
| I did not have a mentor | 1.10 % | 1 |
| The mentor was never available | 1.10 % | 1 |
| The mentor was available less than half of the time | 5.49 % | 5 |
| The mentor was available about half of the time of my project | 10.99 % | 10 |
| The mentor was available more than half of the time | 23.08 % | 21 |
| The mentor was always available | 58.24 % | 53 |

**Table 34. Apprentice Satisfaction with Their Experience (n=91)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **My working relationship with my mentor** | 2.2% | 2.2% | 3.3% | 20.9% | 71.4% | |
| | 2 | 2 | 3 | 19 | 65 | **91** |
| **My working relationship with the group or team** | 3.3% | 1.1% | 2.2% | 12.1% | 81.3% | |
| | 3 | 1 | 2 | 11 | 74 | **91** |
| **The amount of time I spent doing meaningful research** | 1.1% | 4.4% | 5.5% | 29.7% | 59.3% | |
| | 1 | 4 | 5 | 27 | 54 | **91** |
| **The amount of time I spent with my research mentor** | 1.1% | 5.5% | 7.7% | 14.3% | 71.4% | |
| | 1 | 5 | 7 | 13 | 65 | **91** |
| **The research experience overall** | 1.1% | 1.1% | 3.3% | 17.6% | 76.9% | |
| | 1 | 1 | 3 | 16 | 70 | **91** |

Apprentices were provided an opportunity to provide additional feedback on their overall satisfaction with their REAP experience in an open-ended item on the questionnaire. Of the 71 apprentices who responded to this question, 62 (87%) commented on only positive aspects of the program. These responses were often simple affirmations such as, "I enjoyed the program and am honored to

be a part of it!" and "It was a very fun experience and I would recommend it to everybody." The apprentices who elaborated upon their experiences most often cited the learning opportunities, hands-on experiences, opportunity to conduct independent research, opportunities to network, and career information and exposure. Others cited their satisfaction with the program's focus on diversity and the workplace skills they gained. For example,

> *Overall, I consider the experience extremely valuable. I got to work in a real-life lab with real-life scientists, I learned about many careers in STEM, I learned a whole lot about nanoparticles and quantum dots, I learned how to do self-sufficient research and develop procedures for experiments, I established networks with professionals in STEM in my area, I learned how to work with peers and superiors toward common goals, and I developed great friendships with my fellow apprentices.* (REAP Apprentice)

> *I am extremely satisfied with this program. I have learned a lot in very little time, and the program has definitely increased my interest in STEM! I also appreciate and respect the inclusion of minority groups in STEM. As a Hispanic woman, I know my demographic is vastly underrepresented in STEM careers, and it is very important that we change that. I very much enjoy being a part of this program and definitely will apply again next year. Thank you so much for allowing me to participate; REAP has definitely changed my life for the better!* (REAP Apprentice)

> *Thanks to REAP, I have gained an incredible amount of knowledge and skills, much of which will aid me as I pursue a future in STEM. However, the most important lessons I have taken away from REAP are learning to be independent and possessing confidence in my abilities, both skills that will help me greatly outside of the STEM field.* (REAP Apprentice)

Another 8 (11%) apprentices responded with positive comments, but included some caveats. These caveats included suggestions for more hands-on content, more independence, more information for apprentices, and not having enough work to do. For example,

> *It was an enlightening experience. However, it would have been better to have had more hands-on lab work. My mentors were fantastic.* (REAP Apprentice)

> *Though I learned a lot during the program, my REAP experience was not what I expected. I thought I would be assigned a project to work on while my mentor helped me, however that is not what happened. I did not get my own project to work on. I mostly helped my mentor with his project. Most of the time, I found myself reading papers and confused about what I was supposed to be doing. Though I learned a lot during the program, I did not get as much hands-on experience as I would have liked.* (REAP Apprentice)

In addition to the opportunity to weigh in on their overall satisfaction, apprentices were asked to list three benefits of participating in REAP. The 89 apprentices who responded provided comments that echoed the themes identified in their responses about their overall satisfaction. The most frequently mentioned benefits were the lab experience and hands-on opportunities in REAP (mentioned in 44 comments), the career information and exposure they gained (mentioned in 40 comments), and their gains in STEM knowledge (mentioned in 32 comments). Other, less frequently mentioned, benefits included gaining specific STEM skills (for example, working with data charts, working with nanomaterials, learning new software) (mentioned in 24 comments); teamwork (mentioned in 18 comments); understanding how research is conducted (mentioned in 17 comments); networking (mentioned in 15 comments); gaining college information and experience (mentioned in 12 comments); problem solving (mentioned in 10 comments); and gaining confidence and communication skills (each mentioned in 8 comments).

Apprentices were also asked to list three ways that the REAP program could be improved. The 79 apprentices who responded provided a wide range of suggested improvements. The most frequently mentioned improvements were suggestions that apprentices have a choice of project (mentioned in 21 comments) and suggestions for mentor improvements (mentioned in 20 comments), focusing on improved communication between mentors and apprentices and improving the guidance apprentices receive from mentors. Another 15 comments focused on improving time management and scheduling of apprentices' time, while 14 comments suggested that REAP be expanded to more sites and include larger numbers of students. Other, less frequently mentioned, improvements included providing more interaction with DoD researchers, graduate students, and other adults (12 comments); more hands-on experiences (11 comments); more career information (10 comments); publishing and presenting opportunities and travel grants to support apprentices in presenting (10 comments); more resources such as webinars, seminars, and workshops (10 comments); more speakers, field trips, and lab visits (9 comments); better communication about the program and more streamlined paperwork and/or application processes (8 comments); time to interact with other apprentices (6 comments); more opportunities for independent work (6 comments); and more opportunities to work in groups.

Mentors were also asked about their overall satisfaction with REAP. Over half of mentors reported being somewhat or very much satisfied with all REAP program features about which they were asked (Table 35). For example, large majorities of mentors were at least somewhat satisfied with features such as support for instruction or mentorship during program activities (80%), communication with REAP organizers (78%), and research abstract preparation requirements (77%).

**Table 35. Mentor Satisfaction with REAP Program Features (n=70)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Application or registration process** | 28.6% | 0.0% | 1.4% | 18.6% | 51.4% | |
| | 20 | 0 | 1 | 13 | 36 | **70** |
| **Other administrative tasks (in-processing, network access, etc.)** | 30.0% | 0.0% | 1.4% | 20.0% | 48.6% | |
| | 21 | 0 | 1 | 14 | 34 | **70** |
| **Communicating with Army Research Office (ARO)** | 41.4% | 0.0% | 1.4% | 12.9% | 44.3% | |
| | 29 | 0 | 1 | 9 | 31 | **70** |
| **Communicating with REAP organizers** | 20.0% | 0.0% | 1.4% | 11.4% | 67.1% | |
| | 14 | 0 | 1 | 8 | 47 | **70** |
| **Support for instruction or mentorship during program activities** | 14.3% | 0.0% | 5.7% | 25.7% | 54.3% | |
| | 10 | 0 | 4 | 18 | 38 | **70** |
| **Stipends (payment)** | 24.3% | 1.4% | 8.6% | 21.4% | 44.3% | |
| | 17 | 1 | 6 | 15 | 31 | **70** |
| **Research abstract preparation requirements** | 11.4% | 2.9% | 8.6% | 21.4% | 55.7% | |
| | 8 | 2 | 6 | 15 | 39 | **70** |
| **Communicating with Academy of Applied Science (AAS)** | 38.6% | 1.4% | 1.4% | 8.6% | 50.0% | |
| | 27 | 1 | 1 | 6 | 35 | **70** |

Mentors were also asked to respond to open-ended items asking for their opinions about the program. Of the 46 mentors who responded to an item asking them about their overall satisfaction with REAP, 34 (85%) responded with only positive comments, focusing on the learning opportunities REAP provides for apprentices, the lab and research experience, the career exposure and information apprentices receive, gaining new perspectives on their own research, and positive comments about AEOP support and REAP program administration. For example,

> *This was an excellent program that gave my student an inside look into how to conduct research at the university level. The experience undoubtedly enhanced my student's desire to pursue a STEM degree and a STEM career.* (REAP Mentor)

*We are extremely pleased with this program and the support that AAS (Pamela and Renie) have provided. REAP is life changing experience for high school students and opens their eyes to careers in the STEM fields. Keep up the good work!* (REAP Mentor)

*The students were all brilliant, and we grew as a group over the summer. The students furthered my interest in research by helping me understand problems from different points of view.* (REAP Mentor)

Another 8 mentors also responded positively, but offered caveats. These caveats included a variety of suggestions for program improvement including assigning two students to each mentor to allow for student collaboration, better articulation of attendance requirements, providing funding throughout the school year for apprentices, and improving the application process.

Four mentors did not comment positively upon their REAP experience and offered a range of suggestions for program improvement including comments that there was not enough for students to do, that the attendance policy was too strict (i.e., did not allow for illnesses and emergencies), requests for verification of student qualifications, more AEOP information, more information about REAP for mentors, and a comment about the length of the survey.

Mentors were asked to identify the three most important strengths of REAP. The 52 mentors who responded cited strengths of REAP that were similar to the benefits cited by apprentices. The most frequently cited strength was the exposure to STEM research and opportunity for hands-on laboratory experiences (mentioned in 40 comments). Other strengths included the STEM knowledge and skills apprentices gain (mentioned in 15 comments); the program coordination and skills of the program administrators (mentioned in 11 comments); the focus on underserved students (mentioned in 9 comments); the mentor-apprentice relationship (mentioned in 9 comments), the student stipend (mentioned in 8 comments); the college information and exposure apprentices receive (mentioned in 8 comments); and the networking opportunities for apprentices (mentioned in 8 comments).

When asked to provide three ways in which REAP should be improved for future participants, the 37 mentors who responded provided a wide range of suggestions. Fifteen comments focused on the administration and/or organization of REAP, including suggestions for requiring contracts with apprentices, selecting more serious students, providing applicant transcripts, and clarifying registration guidelines. Other suggested improvements included providing more information or resources for mentors (mentioned in 6 comments); more mentor pay (mentioned in 6 comments); providing speakers and site visits (mentioned in 6 comments); providing opportunities for student presentations and publishing (mentioned in 5 comments); and expanding the program to accommodate more students (mentioned in 5 comments).

In summary, findings from the Actionable Program Evaluation indicate that REAP actively engages students from underserved backgrounds in authentic STEM experiences, including opportunities to learn important STEM practices. Apprentices and mentors continue to be very satisfied with the program and their overall experiences.

# 7 | Outcomes Evaluation

The FY17 evaluation of REAP included measures of several outcomes relating to AEOP and program objectives, including impacts on apprentices' STEM knowledge and competencies, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[8] STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are necessary for a STEM-literate citizenry; they are important not only for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of REAP included students' self-reported gains in STEM competencies and engagement in opportunities intended to develop skills such as collaboration, teamwork, and communication, that are considered to be critical STEM skills in the 21st century. The FY17 also introduced a mentor observation rubric for students' 21st Century Skills, enabling mentors to assess students' skills both at the beginning and at the end of their Unite experiences.

---

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


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

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

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

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

## STEM Knowledge and Skills

Nearly all responding apprentices reported some level of gain in their STEM knowledge as a result of the REAP program. More than 90% reported some gains or large gains on all items (Table 36). Over three-quarters of apprentices reported large gains in their knowledge of research conducted in a STEM field (75%) and their knowledge of what everyday research in STEM is like (82%). Mentors reported similar impacts on their apprentices' STEM knowledge.

**Table 36. Apprentice Report of Impacts on STEM Knowledge (n=91)**

| | No gain | A little gain | Some gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **In depth knowledge of a STEM topic(s)** | 1.1% | 7.7% | 30.8% | 60.4% | |
| | 1 | 7 | 28 | 55 | **91** |
| **Knowledge of research conducted in a STEM topic or field** | 1.1% | 2.2% | 22.0% | 74.7% | |
| | 1 | 2 | 20 | 68 | **91** |
| **Knowledge of research processes, ethics, and rules for conduct in STEM** | 3.3% | 4.4% | 29.7% | 62.6% | |
| | 3 | 4 | 27 | 57 | **91** |
| **Knowledge of how scientists and engineers work on real problems in STEM** | 2.2% | 5.5% | 26.4% | 65.9% | |
| | 2 | 5 | 24 | 60 | **91** |
| **Knowledge of what everyday research work is like in STEM** | 2.2% | 3.3% | 12.1% | 82.4% | |
| | 2 | 3 | 11 | 75 | **91** |

STEM Knowledge items were combined into a composite variable[9] to test for differential impacts across subgroups of apprentices (based on gender, race/ethnicity). No differences in STEM Knowledge existed by gender. However, minority students reported significantly higher STEM Knowledge impacts after REAP compared to non-minority students (effect size is small with $d = 0.47$).[10]

Apprentices were also asked to report on REAP's impacts on their STEM Competencies—i.e., apprentices' abilities to use STEM practices. A large majority (80-91%) of apprentices reported at least some gains on

[9] The Cronbach's alpha reliability for these 5 STEM Knowledge items was 0.870.
[10] Independent Samples *t*-test for STEM Knowledge by race/ethnicity; $t(72)=2.01$, $p=.048$.

all STEM Competency items (Table 37). For example, 91% of apprentices reported at least some gain in supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge; and 89% in considering different interpretations of data when deciding how the data answer a question. STEM Competencies items were combined into a composite variable[11] to test for differential impacts across subgroups of apprentices (based on gender, race/ethnicity). No significant differences in STEM Competencies were found by gender or race/ethnicity.

[11] The Cronbach's alpha reliability for these 10 STEM Competencies items was 0.952.

**Table 37. Apprentices Reporting Gains in STEM Competencies (n=91)**

| | No gain | A little gain | Some gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Asking a question that can be answered with one or more scientific experiments** | 6.6% | 14.3% | 25.3% | 53.8% | |
| | 6 | 13 | 23 | 49 | **91** |
| **Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation** | 5.5% | 8.8% | 36.3% | 49.5% | |
| | 5 | 8 | 33 | 45 | **91** |
| **Considering different interpretations of data when deciding how the data answer a question** | 5.5% | 5.5% | 27.5% | 61.5% | |
| | 5 | 5 | 25 | 56 | **91** |
| **Supporting an explanation for an observation with data from experiments** | 2.2% | 9.9% | 24.2% | 63.7% | |
| | 2 | 9 | 22 | 58 | **91** |
| **Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge** | 1.1% | 7.7% | 26.4% | 64.8% | |
| | 1 | 7 | 24 | 59 | **91** |
| **Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations** | 3.3% | 9.9% | 34.1% | 52.7% | |
| | 3 | 9 | 31 | 48 | **91** |
| **Defending an argument that conveys how an explanation best describes an observation** | 6.6% | 15.4% | 28.6% | 49.5% | |
| | 6 | 14 | 26 | 45 | **91** |
| **Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts** | 3.3% | 13.2% | 25.3% | 58.2% | |
| | 3 | 12 | 23 | 53 | **91** |
| **Integrating information from technical or scientific texts and other media to support your explanation of an observation** | 3.3% | 13.2% | 28.6% | 54.9% | |
| | 3 | 12 | 26 | 50 | **91** |
| **Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)** | 1.1% | 12.1% | 20.9% | 65.9% | |
| | 1 | 11 | 19 | 60 | **91** |

Apprentices were asked to report on the impact of REAP on their 21st Century Skills - those skills that are necessary across a wide variety of fields (Table 38). Approximately 90% of apprentices reported some or large gains in all 21st Century Skills items about which they were asked. The most reported frequently

reported areas of gain (some or large gains) were working well with people from all backgrounds (92%), sticking with a task until it is finished (91%), and communicating effectively with others (90%). A composite score for 21st Century Skills[12] was created for comparison by gender and race/ethnicity. Significant differences were found between subgroups in 21st Century Skills, with males reporting larger gains than females (effect size is moderate with $d$ = .508)[13]. Additionally, minority apprentices reported significantly larger gains in their 21st Century Skills compared to non-minority apprentices (effect size is moderate with $d$ = .585)[14].

**Table 38. Apprentice Report of Impacts on 21st Century Skills (n=91)**

| | No gain | A little gain | Some gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Learning to work independently** | 3.3% | 8.8% | 29.7% | 58.2% | |
| | 3 | 8 | 27 | 53 | **91** |
| **Setting goals and reflecting on performance** | 5.5% | 6.6% | 31.9% | 56.0% | |
| | 5 | 6 | 29 | 51 | **91** |
| **Sticking with a task until it is finished** | 2.2% | 6.6% | 30.8% | 60.4% | |
| | 2 | 6 | 28 | 55 | **91** |
| **Making changes when things do not go as planned** | 2.2% | 6.6% | 23.1% | 68.1% | |
| | 2 | 6 | 21 | 62 | **91** |
| **Working well with people from all backgrounds** | 2.2% | 5.5% | 22.0% | 70.3% | |
| | 2 | 5 | 20 | 64 | **91** |
| **Including others' perspectives when making decisions** | 4.4% | 6.6% | 26.4% | 62.6% | |
| | 4 | 6 | 24 | 57 | **91** |
| **Communicating effectively with others** | 2.2% | 7.7% | 22.0% | 68.1% | |
| | 2 | 7 | 20 | 62 | **91** |
| **Viewing failure as an opportunity to learn** | 1.1% | 8.8% | 23.1% | 67.0% | |
| | 1 | 8 | 21 | 61 | **91** |

## 21st Century Skills Assessment

[12] The Cronbach's alpha reliability for these 8 21st Century items was 0.908.
[13] Independent Samples $t$-test for 21st Century Skills by gender; $t(73)=2.17$, $p=.033$.
[14] Independent Samples $t$-test for 21st Century Skills by race/ethnicity; $t(72)=2.48$, $p=.015$.

A new component of the evaluation in FY17 for REAP was a pilot of the 21st Century Skills Assessment (Johnson & Sondergeld, 2016). Mentors assessed each participant in a pre/post manner. The first assessment was completed in the first days of the program (pre). The second assessment was completed at the end of the program (post). The assessment was used to determine the growth toward mastery for each participant during their time in the REAP program. Mentors rated each participants' skills in six domains of 21st Century Skills: The assessment tool can be found in the Appendix (Section 3 of this report).

1. Creativity and Innovation
2. Critical Thinking and Problem Solving
3. Communication, Collaboration, Social, and Cross-Cultural Skills
4. Information, Media, & Technological Literacy
5. Flexibility, Adaptability, Initiative, and Self-Direction
6. Productivity, Accountability, Leadership, and Responsibility

Between 10 and 31 apprentices were assessed for 24 skills related to each of the domains areas. Table 39 presents an overall summary of mentors' assessment findings for each of the six domains of 21st Century Skills. These are presented graphically in Chart 2. Table 40 presents findings for each of the 24 specific skills associated with the six areas of 21st Century Skills.

There were significant increases in apprentices observed skills from the beginning (pre-) to the end (post-) of their REAP experiences ($p$<.05) for all six skill sets of 21st Century Skills (see Table 39). Apprentices demonstrated the most growth in the skill set of Creativity and Innovation. Chart 2 shows that on average, mentors initially rated apprentices' skills slightly above the Progressing level, and final observations resulted in skill ratings at, on average, an approaching Demonstrates Mastery level (approximately 2.50).

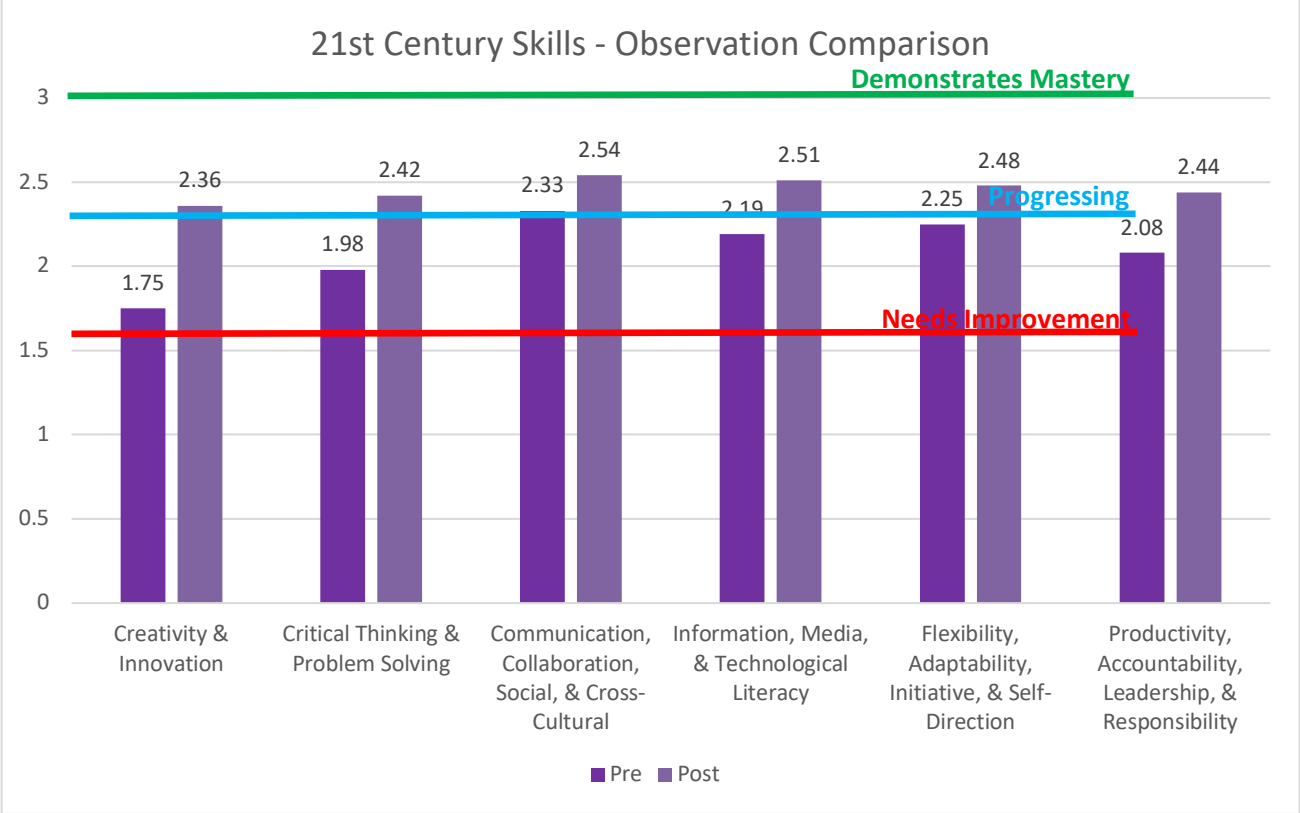
**Table 39. Overall 21st Century Skill Set Assessment Pre-Post Results**

| Skill Set | *n* | Observation Time | | Pre-Post Change | *t*-stat |
|---|---|---|---|---|---|
| | | Pre - *M*(*SD*) | Post - *M*(*SD*) | | |
| Creativity & Innovation | 29 | 1.75(.36) | 2.36(.55) | +0.61 | 6.14*** |
| Critical Thinking & Problem Solving | 31 | 1.98(.39) | 2.42(.49) | +0.44 | 4.59*** |
| Communication, Collaboration, Social, & Cross-Cultural | 31 | 2.33(.49) | 2.54(.45) | +0.21 | 2.19* |

| | | | | | |
|---|---|---|---|---|---|
| Information, Media, & Technological Literacy | 31 | 2.19(.55) | 2.51(.61) | +0.32 | 2.54* |
| Flexibility, Adaptability, Initiative, & Self-Direction | 32 | 2.25(.51) | 2.48(.51) | +0.23 | 2.06* |
| Productivity, Accountability, Leadership, & Responsibility | 29 | 2.08(.52) | 2.44(.45) | +0.36 | 5.36*** |

***NOTE.*** Statistical significance levels for one-tailed tests provided in table by asterisks with *$p$<.05, **$p$<.01, ***$p$<.001

**Chart 2. 21st Century Skill Set Assessment Pre-Post Comparison with Criteria Indicators**




**Findings by Specific Skills Assessed**

Table 40 displays findings for each of the 24 specific skills associated with the six areas of 21st Century Skills. All but one of the 24 specific skills observed showed an increase from pre- to post-observations (95.8%), and three-quarters of the specific skills observed (75%) significantly increased from pre- to post-observation. While apprentices improved in all 21st Century Skills over time, skills associated with creativity, communication, and critical thinking/problem solving saw the largest increases from pre- to post- observations. Mentors reported no change from the pre- to post-observation in apprentices' ability to be flexible.

**Table 40. Overall 21st Century Skill Set Assessment Pre-Post Results**

| Overall Skill Set<br>*Item (Specific Skill Observed)* | *n* | Observation Time<br>Pre - *M*(*SD*) | Observation Time<br>Post - *M*(*SD*) | Pre-Post Change | *t*-stat |
|---|---|---|---|---|---|
| **Creativity & Innovation** | | | | | |
| *Think creatively* | 23 | 1.83(.58) | 2.30(.64) | +.48 | 3.45** |
| *Work creatively with others* | 27 | 2.15(.53) | 2.52(.58) | +.37 | 3.06** |
| *Implement innovations* | 26 | 1.27(.60) | 2.31(.62) | +1.04 | 6.08*** |
| **Critical Thinking & Problem Solving** | | | | | |
| *Reason effectively* | 30 | 1.97(.49) | 2.37(.56) | +.40 | 2.85** |
| *Use systems thinking* | 25 | 2.00(.50) | 2.44(.58) | +.44 | 3.09** |
| *Make judgments and decisions* | 20 | 2.05(.51) | 2.50(.61) | +.45 | 3.33** |
| *Solve problems* | 28 | 1.93(.54) | 2.39(.57) | +.46 | 4.26*** |
| **Communication, Collaboration, Social, & Cross-Cultural** | | | | | |
| *Communicate clearly* | 30 | 2.17(.59) | 2.40(.62) | +.23 | 1.88* |
| *Communicate with others* | 22 | 2.36(.66) | 2.64(.58) | +.27 | 1.82* |
| *Interact effectively with others* | 31 | 2.45(.57) | 2.65(.55) | +.19 | 1.65 |
| **Information, Media, & Technological Literacy** | | | | | |
| *Access and evaluate information* | 26 | 2.15(.61) | 2.62(.64) | +.46 | 3.09** |
| *Use and manage information* | 24 | 2.00(.59) | 2.58(.65) | +.58 | 3.44** |
| *Analyze media* | 17 | 2.35(.70) | 2.71(.47) | +.35 | 2.40* |
| *Create media products* | 14 | 2.14(.77) | 2.57(.51) | +.43 | 2.12* |
| *Apply technology effectively* | 28 | 2.36(.56) | 2.61(.63) | +.25 | 1.66 |
| **Flexibility, Adaptability, Initiative, & Self-Direction** | | | | | |
| *Adapt to change* | 24 | 2.42(.50) | 2.50(.72) | +.83 | 0.57 |
| *Be flexible* | 29 | 2.62(.49) | 2.62(.64) | .00 | 0.00 |
| *Manage goals and time* | 27 | 2.22(.64) | 2.52(.58) | +.30 | 2.84** |
| *Work independently* | 31 | 2.19(.54) | 2.58(.62) | +.39 | 2.68** |
| *Be a self-directed learner* | 28 | 1.93(.72) | 2.21(.69) | +.29 | 1.77* |
| **Productivity, Accountability, Leadership, & Responsibility** | | | | | |
| *Manage projects* | 22 | 2.18(.59) | 2.45(.60) | +27 | 1.82* |
| *Produce results* | 27 | 1.93(.47) | 2.44(.51) | +.52 | 4.19*** |
| *Guide and lead others* | 10 | 1.70(.68) | 2.10(.57) | +.40 | 1.31 |
| *Be responsible to others* | 24 | 2.38(.58) | 2.42(.58) | +.04 | .57 |

***NOTE.*** Statistical significance levels for one-tailed tests provided in table by asterisks with *$p$<.05, **$p$<.01, ***$p$<.001

## STEM Identity and Confidence

STEM knowledge and skills are important for increasing the likelihood that REAP apprentices will pursue STEM further in their education and/or careers. However, they are unlikely to do so if they do not see themselves as capable of succeeding in STEM.[15] The apprentice survey therefore included a series of items intended to measure the impact of REAP on apprentices' STEM identities (Table 41). Apprentices reported that REAP had a substantial impact on their STEM identities, with 80-90% reporting some to large gains on all items in this section. For example, 90% reported some to large gains in their feelings of being prepared for more challenging STEM activities and in their desire to build relationships with mentors who work in STEM.

**Table 41. Apprentice Report of Impacts on STEM Identity (n=91)**

| | No gain | A little gain | Some gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Interest in a new STEM topic** | 4.4% | 11.0% | 28.6% | 56.0% | |
| | 4 | 10 | 26 | 51 | **91** |
| **Deciding on a path to pursue a STEM career** | 2.2% | 17.6% | 20.9% | 59.3% | |
| | 2 | 16 | 19 | 54 | **91** |
| **Sense of accomplishing something in STEM** | 1.1% | 9.9% | 24.2% | 64.8% | |
| | 1 | 9 | 22 | 59 | **91** |
| **Feeling prepared for more challenging STEM activities** | 1.1% | 8.8% | 22.0% | 68.1% | |
| | 1 | 8 | 20 | 62 | **91** |
| **Confidence to try out new ideas or procedures on my own in a STEM project** | 2.2% | 17.6% | 18.7% | 61.5% | |
| | 2 | 16 | 17 | 56 | **91** |
| **Patience for the slow pace of STEM research** | 2.2% | 11.0% | 30.8% | 56.0% | |
| | 2 | 10 | 28 | 51 | **91** |
| **Desire to build relationships with mentors who work in STEM** | 1.1% | 8.8% | 18.7% | 71.4% | |
| | 1 | 8 | 17 | 65 | **91** |
| **Connecting a STEM topic or field to my personal values** | 4.4% | 11.0% | 18.7% | 65.9% | |
| | 4 | 10 | 17 | 60 | **91** |

[15] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.

STEM Identity items were combined[16] and assessed for differences by gender and race/ethnicity. No differences were found by gender. However, there were significant differences in STEM Identity found by race/ethnicity with minority apprentices reporting significantly greater impacts compared to non-minority apprentices (effect size is considered small with $d$ = .481)[17].

## Interest and Future Engagement in STEM

In order to examine the impact of REAP on apprentices' interest in future engagement in STEM, participants were asked to reflect on their intentions to engage in STEM activities outside of regular school classes (Table 42). Apprentices reports of the change in the likelihood that they would engage in activities varied across activities. For example, most apprentices reported that they were more likely or much more likely to engage in working on a STEM project or experiment in a university or professional setting (88%), talk with friends or family about STEM (85%), and participate in a STEM camp, club, or competition (84%) after REAP. On the other hand, half of apprentices reported that there was little change in the likelihood thaty they would watch or read non-fiction STEM, and over a third (34%) reported that the likelihood that they would use a computer to design or program something was about the same before and after REAP. A composite score was created from these items,[18] and composite scores were compared across subgroups of apprentices. No statistically significant differences by race/ethnicity or gender were found.

Apprentices were also asked about their interest level in participating in future AEOP programs (Table 43). Apprentices reported being most interested in participating in SMART (63% somewhat/very much) and URAP (62% somewhat/very much). Few apprentices reported being not at all interested in any of the programs (1-11%), however large proportions of apprentices had not heard of other AEOPs including CQL (50%), eCM (46%), and JSHS (39%).

[16] The Cronbach's alpha reliability for these 8 items was 0.922.
[17] Independent Samples $t$-test for STEM Identity by race/ethnicity; $t(72)=2.04$, $p=.045$.
[18] These 10 STEM Future Interest items had a Cronbach's alpha reliability of 0.922.

**Table 42. Change in Likelihood Apprentice Will Engage in STEM Activities Outside of School (n=91)**

| | Much less likely | Less likely | About the same before and after | More likely | Much more likely | Response Total |
|---|---|---|---|---|---|---|
| **Watch or read non-fiction STEM** | 1.1% | 1.1% | 49.5% | 23.1% | 25.3% | |
| | 1 | 1 | 45 | 21 | 23 | **91** |
| **Tinker (play) with a mechanical or electrical device** | 1.1% | 1.1% | 28.6% | 34.1% | 35.2% | |
| | 1 | 1 | 26 | 31 | 32 | **91** |
| **Work on solving mathematical or scientific puzzles** | 0.0% | 1.1% | 31.9% | 37.4% | 29.7% | |
| | 0 | 1 | 29 | 34 | 27 | **91** |
| **Use a computer to design or program something** | 1.1% | 0.0% | 34.1% | 30.8% | 34.1% | |
| | 1 | 0 | 31 | 28 | 31 | **91** |
| **Talk with friends or family about STEM** | 1.1% | 3.3% | 11.0% | 39.6% | 45.1% | |
| | 1 | 3 | 10 | 36 | 41 | **91** |
| **Mentor or teach other students about STEM** | 0.0% | 2.2% | 22.0% | 30.8% | 45.1% | |
| | 0 | 2 | 20 | 28 | 41 | **91** |
| **Help with a community service project related to STEM** | 0.0% | 1.1% | 23.1% | 27.5% | 48.4% | |
| | 0 | 1 | 21 | 25 | 44 | **91** |
| **Participate in a STEM camp, club, or competition** | 1.1% | 0.0% | 15.4% | 29.7% | 53.8% | |
| | 1 | 0 | 14 | 27 | 49 | **91** |
| **Take an elective (not required) STEM class** | 1.1% | 0.0% | 24.2% | 30.8% | 44.0% | |
| | 1 | 0 | 22 | 28 | 40 | **91** |
| **Work on a STEM project or experiment in a university or professional setting** | 1.1% | 0.0% | 11.0% | 29.7% | 58.2% | |
| | 1 | 0 | 10 | 27 | 53 | **91** |

**Table 43. Apprentice Interest in Future AEOP Programs (n=90-91)**

| | I've never heard of this program | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **College - College Qualified Leaders (CQL)** | 49.5% | 1.1% | 8.8% | 11.0% | 29.7% | |
| | 45 | 1 | 8 | 10 | 27 | **91** |
| **College - Undergraduate Research Apprenticeship Program (URAP)** | 29.7% | 3.3% | 5.5% | 20.9% | 40.7% | |
| | 27 | 3 | 5 | 19 | 37 | **91** |
| **College - Science Mathematics, and Research for Transformation (SMART) College Scholarship** | 27.5% | 2.2% | 7.7% | 15.4% | 47.3% | |
| | 25 | 2 | 7 | 14 | 43 | **91** |
| **College - National Defense Science & Engineering Graduate (NDSEG) Fellowship** | 36.3% | 4.4% | 17.6% | 6.6% | 35.2% | |
| | 33 | 4 | 16 | 6 | 32 | **91** |
| **High School and College - GEMS Near Peer Mentor Program** | 36.3% | 5.5% | 12.1% | 9.9% | 36.3% | |
| | 33 | 5 | 11 | 9 | 33 | **91** |
| **High School - Junior Science and Humanities Symposium (JSHS)** | 38.9% | 11.1% | 8.9% | 15.6% | 25.6% | |
| | 35 | 10 | 8 | 14 | 23 | **90** |
| **High School - eCYBERMISSION** | 45.6% | 10.0% | 13.3% | 8.9% | 22.2% | |
| | 41 | 9 | 12 | 8 | 20 | **90** |

In order to understand what resources are most effective for providing AEOP information, apprentices were asked about the impact of various resources on their awareness of AEOPS. As can be seen in Table 44, participating in REAP was most likely to be rated as impacting apprentice awareness of AEOP somewhat or very much (84%). Mentors (64%) and the AEOP website (64%) were also frequently reported as being somewhat or very much impactful on apprentice awareness of AEOPs. Most apprentices (52%) reported not having experienced AEOP on social media,

**Table 44. Impact of Resources on Apprentice Awareness of AEOPs (n=91)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 12.1% | 2.2% | 22.0% | 17.6% | 46.2% | |
| | 11 | 2 | 20 | 16 | 42 | **91** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 51.6% | 11.0% | 17.6% | 11.0% | 8.8% | |
| | 47 | 10 | 16 | 10 | 8 | **91** |
| **AEOP brochure** | 15.4% | 6.6% | 18.7% | 26.4% | 33.0% | |
| | 14 | 6 | 17 | 24 | 30 | **91** |
| **My Apprenticeship Mentor** | 11.0% | 3.3% | 22.0% | 16.5% | 47.3% | |
| | 10 | 3 | 20 | 15 | 43 | **91** |
| **Presentations or information shared through the Apprenticeship Program** | 22.0% | 8.8% | 19.8% | 11.0% | 38.5% | |
| | 20 | 8 | 18 | 10 | 35 | **91** |
| **Participation in the Apprenticeship Program** | 6.6% | 2.2% | 7.7% | 15.4% | 68.1% | |
| | 6 | 2 | 7 | 14 | 62 | **91** |

## Attitudes toward DoD Research

A focus of the AEOP apprenticeship programs is to raise awareness of and interest in DoD research. In order to gauge apprentices' attitudes, apprentices were asked their opinions of what DoD researchers do and the value of DoD research more broadly (Table 45). Apprentice perceptions were very positive, with more than 85% agreeing or strongly agreeing with all statements about DoD research and researchers such as "DoD research is valuable to society" (89% agreed or strongly agreed) and "DoD researchers advance science and engineering fields" (87% agreed or strongly agreed).

**Table 45. Apprentice Opinions about DoD Researchers and Research (n=91)**

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree | Response Total |
|---|---|---|---|---|---|---|
| **DoD researchers advance science and engineering fields** | 1.1% | 0.0% | 12.1% | 42.9% | 44.0% | |
| | 1 | 0 | 11 | 39 | 40 | **91** |
| **DoD researchers develop new, cutting edge technologies** | 1.1% | 0.0% | 12.1% | 40.7% | 46.2% | |
| | 1 | 0 | 11 | 37 | 42 | **91** |
| **DoD researchers solve real-world problems** | 1.1% | 0.0% | 12.1% | 37.4% | 49.5% | |
| | 1 | 0 | 11 | 34 | 45 | **91** |
| **DoD research is valuable to society** | 1.1% | 0.0% | 9.9% | 35.2% | 53.8% | |
| | 1 | 0 | 9 | 32 | 49 | **91** |

## Education and Career Aspirations

The REAP program, like the other AEOP programs, is focused on positively impacting apprentices' future educational aspirations. Apprentices were therefore asked to indicate what their educational aspirations were after participating in REAP (Table 46). All apprentices reported wanting to, at a minimum, obtain a bachelor's degree. A large majority of apprentices reported wanting to earn a master's degree or higher (85%), and nearly two-thirds of apprentices (64%) reported wanting to obtain a terminal degree (PhD, MD, etc.).

**Table 46. Apprentice Education Aspirations After REAP (n=91)**

| Choice | Response Percent | Response Total |
|---|---|---|
| Go to a trade or vocational school | 0.00 % | 0 |
| Go to college for a little while | 0.00 % | 0 |
| Finish college (get a Bachelor's degree) | 8.79 % | 8 |
| Get more education after college | 6.59 % | 6 |
| Get a master's degree | 20.88 % | 19 |
| Get a Ph.D. | 28.57 % | 26 |
| Get a medical-related (M.D.), veterinary (D.V.M), or dental degree (D.D.S) | 12.09 % | 11 |
| Get a combined M.D. / Ph.D. | 19.78 % | 18 |
| Get another professional degree (law, business, etc.) | 3.30 % | 3 |

## Overall Impact

Apprentices were asked about the overall impacts of participating in REAP. Table 47 shows that REAP had a considerable impact on apprentices, with two-thirds or more of the apprentices reporting that REAP contributed or was the primary reason for each of the items listed. For example, large majorities of apprentices indicated that REAP contributed or was the primary reason for increases in their confidence in their STEM knowledge, skills, and abilities (93%); interest in participating in STEM activities outside of school requirements (85%); awareness of other AEOPs (84%); and interest in participating in other AEOPs (83%).

The overall REAP Impact items were combined into a composite variable[19] to test for differences among subgroups of apprentices. Significant differences in Overall Impact were found by gender (males higher; effect size is moderate with $d$ = .536) and race/ethnicity (minority higher; effect size is moderate with $d$ = .514).

Apprentices participating in interviews expressed that REAP had substantial impacts on them in a variety of areas including their confidence, their research skills and abilities, their teamwork skills, their understanding of STEM careers, their critical thinking and problem-solving skills, and their overall STEM knowledge. For example,

> *I learned how to think like a scientist - look at a problem and try to solve it through different angles and if that doesn't work, just keep moving on, keep testing. I learned how to study and make data readable for people and try to communicate what I have learned.* (REAP Apprentice)

[19] The Cronbach's alpha reliability for these 10 items was 0.913.

**Table 47. Apprentice Opinions of REAP Impacts (n=91)**

| | Disagree - This did not happen | Disagree - This happened but not because of REAP | Agree - REAP contributed | Agree - REAP was primary reason | Response Total |
|---|---|---|---|---|---|
| **I am more confident in my STEM knowledge, skills, and abilities** | 2.2% | 4.4% | 61.5% | 31.9% | |
| | 2 | 4 | 56 | 29 | **91** |
| **I am more interested in participating in STEM activities outside of school requirements** | 1.1% | 14.3% | 56.0% | 28.6% | |
| | 1 | 13 | 51 | 26 | **91** |
| **I am more aware of other AEOPs** | 12.1% | 4.4% | 42.9% | 40.7% | |
| | 11 | 4 | 39 | 37 | **91** |
| **I am more interested in participating in other AEOPs** | 13.2% | 4.4% | 45.1% | 37.4% | |
| | 12 | 4 | 41 | 34 | **91** |
| **I am more interested in taking STEM classes in school** | 2.2% | 19.8% | 53.8% | 24.2% | |
| | 2 | 18 | 49 | 22 | **91** |
| **I am more interested in earning a STEM degree** | 2.2% | 19.8% | 52.7% | 25.3% | |
| | 2 | 18 | 48 | 23 | **91** |
| **I am more interested in pursuing a career in STEM** | 3.3% | 18.7% | 52.7% | 25.3% | |
| | 3 | 17 | 48 | 23 | **91** |
| **I am more aware of Army or DoD STEM research and careers** | 16.5% | 6.6% | 40.7% | 36.3% | |
| | 15 | 6 | 37 | 33 | **91** |
| **I have a greater appreciation of Army or DoD STEM research** | 14.3% | 7.7% | 35.2% | 42.9% | |
| | 13 | 7 | 32 | 39 | **91** |
| **I am more interested in pursuing a STEM career with the Army or DoD** | 24.2% | 9.9% | 36.3% | 29.7% | |
| | 22 | 9 | 33 | 27 | **91** |

# 8 | Findings and Recommendations

## Summary of Findings

The 2017 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 48.

| Table 48. 2017 REAP Evaluation Findings | |
|---|---|
| **Participant Profiles** | |
| **REAP continues to serve students from populations historically underserved in STEM.** | Over half of REAP participants (67%) were female, a population underserved in some STEM fields. This is a slight decrease from the 73% of participants in FY16 who were female. The percentage of female mentors increased 12% in FY17. |
| | There is evidence that REAP was successful in meeting the program requirement of providing outreach to students from historically underserved groups. Over a third of participants (38%) identified themselves as Black or African American, a decrease compared to FY16 when 46% of participants identified with this racial group. The proportion of Hispanic/Latino students increased in FY17, with 23% identifying with this racial/ethnic group as compared to 14% in FY16. REAP continued to serve a majority of female participants in FY17 (61%). More than half (51%) of participants reported receiving free and/or reduced-price lunch and 33% of participants identified as English Language Learners. 23% of participants are potential future first-generation college students. |
| **Few apprentices had participated in AEOPs other than Unite and REAP.** | Nearly a quarter (23%) of questionnaire respondents had previously participated in Unite, suggesting that efforts to create a bridge between the programs has been successful. A small number of students (16%) had previously participated in REAP. |
| | 40% of REAP participants had never participated in any other AEOPs. |
| **Actionable Program Evaluation** | |
| **REAP apprentices were recruited in various ways, although apprentices and mentors continue to learn about the program largely through personal contacts and interactions.** | While 29% of mentors did not know how apprentices were recruited, 50% reported that apprentices were recruited using applications from the AEOP. Mentors also reported that a variety of other methods were used to recruit apprentices including K-12 teachers at local schools (39%), colleagues in their workplace (30%), and personal acquaintances outside the workplace (24%). |
| | Apprentices were most likely to have learned about AEOP through someone who works at the school or university they attend (43%); a school or university |

| | |
|---|---|
| | newsletter, email, or website (35%); someone who works with the program (28%); or a past participant (22%). Few apprentices reported learning about REAP through AEOP social media (4%) or the AEOP website (11%). |
| | Mentors were most likely to learn about AEOP from a supervisor or superior (39%), a colleague (26%), and the REAP site host or director (23%). Fewer reported learning about REAP through organizational websites such as AAS (10%) or AEOP (19%) and none had learned about AEOP through social media. |
| **REAP apprentices are motivated to participate by a variety of factors although most apprentices cited internal motivations for participation.** | The most frequently reported motivators for participating in REAP were apprentices' interest in STEM (94%), desire to learn something new or interesting (86%), desire to expand research or laboratory skills (81%), and the opportunity to learn in new ways that are not possible in school (78%). Over half of apprentices also cited as motivators the opportunity to use advanced laboratory technology (69%), have fun (65%), build college applications or résumés (64%), see how school learning applies to real life (61%), and network (53%). |
| **Apprentices learned about STEM jobs and careers and, to a lesser extent, DoD STEM jobs and careers through various resources during REAP.** | Nearly all apprentices (96%) reported learning about at least one STEM job/career during REAP, and almost half of apprentices (48%) reported learning about four or more STEM jobs/careers. |
| | Fewer apprentices had learned about DoD STEM jobs and careers than about STEM careers more generally, although over two-thirds (69%) reported that they had learned about at least one STEM job/career in the Army or DoD, and about 30% of students reported learning about 4 or more of these careers. |
| | Over three-quarters of apprentices (77%) reported being more aware of Army and DoD STEM careers as a result of REAP. |
| | More than half of apprentices reported that their awareness of DoD STEM jobs and careers was somewhat or very much impacted by participating in REAP (61%), the AEOP website (58%), and their mentors (54%). Many apprentices reported not experiencing resources such as AEOP social media (55%) and the ARO website (47%) as resources to learn about DoD STEM jobs and careers. |
| **REAP apprentices engage in STEM practices with more frequency than they typically engage in these practices in school.** | Half or more (49%-95%) of apprentices engaged in all STEM practices about which they were asked weekly or every day with the exception of building or making a computer model (54% had not done this during their apprenticeships). Apprentices reported greatest engagement (engaged in weekly or every day) in practices such as interacting with STEM researchers (95%), analyzing data or information and drawing conclusions (91%), working with a STEM researcher or company on a real-world STEM research project (89%), and working collaboratively as part of a team (89%). |
| | Apprentices engaged in STEM practices significantly more frequently in REAP than they did in school (large effect size with d = 1.77). |
| **REAP mentors use a variety of mentoring strategies with apprentices.** | More than two-thirds of mentors (70%-94%) reported using all strategies to increase the relevance of learning activities. |
| | More than half (60%-97%) of mentors used all strategies to support the diverse needs of students as learners. |

| | |
|---|---|
| | More than three-quarters (79%-93%) of mentors reported using all strategies to support student development of collaboration and interpersonal skills. |
| | Over 90% (91%-96%) of mentors reported using all strategies to support student engagement in authentic STEM activities. |
| | Over half of mentors reported using all strategies to support students' STEM educational and career pathways, although there was wide variation in the use of specific strategies (53%-96%). For example, just over half of mentors (53%) reported helping students with their resume, application, personal statement, and/or interview preparations while 96% asked students about their educational and/or career goals. |
| **Most mentors did not discuss specific AEOPs other than REAP with their apprentices, and relied on site coordinators and the AEOP website as resources for apprentices.** | Some mentors (39%) reported discussing AEOP in general with apprentices, but without reference to any specific programs. Around a quarter of mentors discussed Unite (27%) and URAP (23%) with their apprentices. |
| | Participation in REAP (80%), the REAP Program administrator or site coordinator (69%), and the AEOP website (54%) were most often rated somewhat or very much useful for exposing students to AEOPs. On the other hand, a majority of mentors reported not experiencing AEOP on social media (70%), and invited speakers or "career" events (63%). |
| **Many apprentices had not heard of many other AEOPs, although they were interested in participating in AEOPs in the future.** | Relatively large proportions of apprentices had not heard of other AEOPs including CQL (50%), eCM (46%), and JSHS (39%), however a large majority of apprentices (84%) reported that REAP impacted their awareness of AEOPs. |
| | A large majority (82%) of apprentices reported increased interest in participating in other AEOPs in the future, with, for example, interest in participating in SMART (63% somewhat/very much interested), URAP (62% somewhat/very much interested), JSHS (42% somewhat/very much interested), and CQL (41% somewhat/very much interested). |
| | Resources impacting apprentice awareness of AEOP somewhat or very much included participating in REAP (84%), their mentors (64%), and the AEOP website (64%). |
| **Apprentices and mentors reported high levels of satisfaction with REAP.** | Apprentices were highly satisfied with REAP program features they had experienced with 75% or more indicating they were somewhat or very much satisfied with each feature listed. For example, large majorities of apprentices were at least somewhat satisfied with the physical location of activities (92%), the application process (91%), the teaching or mentoring they experienced (87%), and communication with host site organizers (85%). |
| | More than 80% of apprentices reported being somewhat or very much satisfied with all aspects of their research experience including the overall research experience (95%), the mentor relationship (92%), and the group/team relationship (93%). |
| | Over half of mentors reported being somewhat or very much satisfied with all REAP program features that they had experienced. For example, over three-quarters of mentors were at least somewhat satisfied with features such as |

| | |
|---|---|
| | support for instruction or mentorship during program activities (80%), communication with REAP organizers (78%), and research abstract preparation requirements (77%). |
| **Apprentices and mentors offered various suggestions for program improvements.** | The most frequently suggested improvements by apprentices included suggestions that apprentices have a choice of project, and suggestions for mentor improvements that focused on improved communication between mentors and apprentices and improving the guidance apprentices receive from mentors. |
| | The most frequently suggested improvements by mentors focused on the administration and/or organization of REAP, including suggestions for requiring contracts with apprentices, selecting more serious students, providing applicant transcripts, and clarifying registration guidelines. |
| **Outcomes Evaluation** | |
| **REAP apprentices reported gains in their STEM knowledge and competencies.** | Nearly all responding apprentices reported some level of gains in their STEM knowledge as a result of the REAP program with more than 90% reporting some gains or large gains on all items of STEM knowledge and over three-quarters of apprentices reporting large gains in areas such as knowledge of research conducted in a STEM field (75%) and knowledge of what everyday research in STEM is like (82%). |
| | Minority students reported significantly higher STEM Knowledge impacts after REAP compared to non-minority students (effect size is small with $d$ = 0.47). |
| | A large majority (80-91%) of apprentices reported at least some gains on all STEM competency items. For example, 91% of apprentices reported at least some gain in supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge; and 89% in considering different interpretations of data when deciding how the data answer a question. |
| **REAP apprentices reported gains in 21st Century Skills, and mentors observed significant gains in these skills.** | Approximately 90% of apprentices reported some gains or large gains in all 21st Century Skills items about which they were asked. The most reported frequently reported areas of gain (some or large gains) were working well with people from all backgrounds (92%), sticking with a task until it is finished (91%), and communicating effectively with others (90%). |
| | Significant differences were found between subgroups in apprentices' self-reported gains in 21st Century Skills, with males reporting larger gains than females (effect size is moderate with $d$ = .508). Additionally, minority apprentices reported significantly larger gains their 21st Century Skills compared to non-minority apprentices (effect size is moderate with $d$ = .585). |
| | There were significant increases in mentors' assessments of apprentices' 21st Century Skills from the beginning (pre-) to the end (post-) of the Unite experience. On average, mentors initially rated apprentices' skills slightly above the Progressing level, and final observations resulted in skill ratings at, on average, an approaching Demonstrates Mastery level (approximately 2.50). While apprentices improved in all 21st Century Skills over time, skills associated |

| | |
|---|---|
| | with creativity, communication, and critical thinking/problem solving saw the largest increases from pre- to post- observations. |
| **REAP impacted apprentices' STEM identities and the likelihood that they will engage in STEM activities in the future.** | Apprentices reported that REAP had a substantial impact on their STEM identities, with 80-90% reporting some to large gains on all items in this section. For example, 90% reported some to large gains in their feelings of being prepared for more challenging STEM activities and in their desire to build relationships with mentors who work in STEM. |
| | Minority apprentices reported significantly greater impacts on their STEM identities compared to non-minority apprentices (effect size is considered small with $d$ = .481) |
| | Although apprentices generally indicated that they would be more likely to engage in STEM activities after REAP, the impacts varied across activities. For example, most apprentices reported that they were more likely or much more likely to engage in working on a STEM project or experiment in a university or professional setting (88%) and talk with friends or family about STEM (85%), however half of apprentices reported that there was little change in the likelihood that they would watch or read non-fiction STEM, and over a third (34%) reported that the likelihood that they would use a computer to design or program something was about the same before and after REAP. |
| **Apprentices had positive opinions of DoD Research and Researchers and had an increased interest in STEM careers in the Army or DoD after participating in REAP.** | More than 85% of apprentices agreed or strongly agreed with statements such as "DoD research is valuable to society (89% agreed or strongly agreed) and "DoD researchers advance science and engineering fields" (87% agreed or strongly agreed). Over three-quarters of students (78%) reported that REAP had contributed to their greater appreciation of Army or DoD STEM research. |
| | Two-thirds (66%) of apprentices reported that they are more interested in pursuing STEM careers with the Army or DoD after participating in REAP and over three-quarters (78%) reported that they are more interested in pursuing a career in STEM after their REAP apprenticeships. |
| **Apprentices reported that REAP had a variety of positive impacts on them.** | Two-thirds or more of the apprentices reported that REAP contributed or was the primary reason for various overall impacts. For example, large majorities of apprentices indicated that REAP contributed to their confidence in their STEM knowledge, skills, and abilities (93%); interest in participating in STEM activities outside of school requirements (85%); and interest in earning a STEM degree (78%). |

## Responsiveness to FY17 Evaluation Recommendations

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

with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

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

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

**FY16 Finding:** Although the REAP mentor group was more diverse ethnically, there still are not enough mentors that represent the diverse group of participants in REAP. Effort should be focused on recruiting more diverse mentors overall. Additionally, since 2014 the number of female mentors continues to decrease. Efforts should be made to focus on increasing the number of female mentors, perhaps by encouraging junior faculty (typically more female professors are in the lower ranks in STEM fields) to partner with senior faculty to submit proposal to be a REAP site. This could be marketed as professional development for both the junior and senior faculty members. Additionally, if each mentor/apprentice pair occasionally met in groups with other mentor/apprentice pairs, not only could they share resources, apprentices would be exposed to a more diverse range of mentor backgrounds.

**REAP FY17 Efforts and Outcomes:** In FY17, 44 (or 37%) of REAP mentors were female, a slight increase of 5 female mentors compared to FY16. However, student female participation decreased from 86 to 78 female, resulting in 56% of REAP's female student population in FY17 had female mentors compared to only 44% in FY16. It is important to note that mentors are chosen by the university director early in the fiscal year - at times, during the RFP process. Mentors are in place before students are selected so they are able to assist in the student selection process.

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

**FY16 Finding:** Although REAP has seen some success with informing both mentors and apprentices about DoD STEM careers, efforts should be made to help mentors and apprentices become more aware of opportunities to pursue DoD STEM careers. The program should continue to provide mentors and apprentices with new materials and resources (website links, articles, etc.) that describe current DoD STEM research and careers which can be easily passed on to all REAP apprentices. Creating a network for mentors to form a community of practice where mentors can share their research activities with other mentors could be a first step to informing apprentices about other Army/DoD STEM careers. Some apprentices and mentors made suggestions that DoD STEM researchers visit REAP sites or hold a webinar to inform and inspire REAP apprentices to pursue work in this avenue.

**REAP FY17 Efforts and Outcomes:** AAS worked with the Army to develop a DoD STEM Career webinar where Army scientists and engineers talked about DoD Careers. REAP continues to work with universities and students in creating awareness of DoD opportunities. To facilitate this, directors and

mentors received AEOP materials including, flyers, brochures, and information about DoD careers and were encouraged to have open discussion with their apprentices about these opportunities.

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

**FY16 Finding:** REAP mentors and apprentices are more often using newsletters and websites to become aware of other AEOP programs. However, as was found in 2014 and 2015, there are still many REAP apprentices and mentors who report having little previous experience with AEOP and limited knowledge of other AEOP programs. Given the goal of having apprentices progress from REAP into other AEOP programs, the program may want to have a systematic method to inform mentors in tangible ways to increase apprentices' exposure to AEOP. Only 50% of mentors recommended other AEOPs to apprentices. For example, mentors mentioned that they were only generally aware of other. However, they could not name the programs or provide information that might lead an interested student to a website. The program should work with each site to ensure that all apprentices have access to structured opportunities—such as invited speakers, presentations, and career events—that both describe the other AEOPs and provide information to apprentices on how they can apply to them.

**REAP FY17 Efforts and Outcomes:** AAS collaborated with directors and mentors to create a Best Practice document, which gave them a sense of ownership, therefore, becoming more involved throughout the summer. Ongoing communication with directors/mentors was successful in FY17, as we received feedback as the program progressed. Students also received a welcome & orientation document outlining expectations. Universities were also introduced to the Meet & Greet concept and many were successful in providing speakers and career-like events. Such events bring students and mentors from other AEOP programs together to talk about their experiences.

## Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that FY17 was a successful year overall for the REAP program. REAP continues to serve as an exemplar for the AEOP in regards to engaging underserved students in the program and producing positive gains in their STEM knowledge, skills, and identity. Additionally, REAP mentors reported use of effective strategies for working with apprentices and 84% of REAP participants reported that the program had impacted their awareness of AEOPs. The percentage of female mentors grew 12% for FY17. While these successes for REAP are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY18 and beyond:

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

REAP has experienced great success with reaching underserved students in the program. However, in FY17 REAP experienced a slight decrease in female participants (61% compared to 73% in FY16), as well as Black/African-American participants (29% compared to 46% in FY16). REAP should continue to invest effort in this area to strengthen representation from these groups in FY18.

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

REAP apprentices reported an overall positive experience in the program in FY17. Participants did share some suggestions for improving the program for the future. Suggestions included providing apprentices with more choice in the project they work on. Additionally, there were suggestions to improved communication and guidance received from the mentors. Similarly, mentors suggested considering having a contract with apprentices for accountability, and "selecting more serious students". It is unclear how much of this feedback can be integrated into the REAP model. However, it is recommended that REAP consider developing supports for students and mentors in these areas.

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

Despite continued efforts to integrate more resources into REAP for promoting other AEOPs, this remains an area of need for additional effort in FY18. Less than half of mentors (39%) reported discussing AEOP in general with participants. Similarly, only a small percentage of mentors reported discussing Unite (27%) and URAP (23%) with participants. As a result, participants had little knowledge of other AEOPs, as 50% had heard of CQL, 46% eCM, and 39% JSHS. It is recommended that REAP focus on establishing additional supports for local programs to emphasize the AEOP pipeline frequently in the apprenticeship program – in meaningful ways.