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Army Educational Outreach Program

Undergraduate Research Apprenticeship Program (URAP)

2017 Annual Program Evaluation Report

PART 2: Evaluation Findings

February 2018

AEOP
ARMY EDUCATIONAL OUTREACH PROGRAM

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Report URAP_02_02142018 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.

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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 of one of the AEOP elements, the Undergraduate Research Apprentice Program (URAP). URAP is managed by the U.S. Army Research Office (ARO) and 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

The Undergraduate Research Apprentice Program (URAP), managed by the U.S. Army Research Office (ARO) and the Academy of Applied Science (AAS), is an AEOP commuter program for undergraduate students who demonstrate an interest in science, technology, engineering, or mathematics (STEM) to gain research experience as an apprentice in an Army-funded university or college research laboratory. URAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced Army-funded scientists and engineers (S&Es, herein called mentors) full-time during the summer or part-time during the school year.

Apprentices receive an educational stipend equivalent to $15 per hour, and are allowed to work up to 300 hours total. The apprentices contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives apprentices a broader view of their fields of interest and shows apprentices what kinds of work awaits them in their future careers. At the end of the program, the apprentices prepare final reports for submission to the U.S. Army Research Office's Youth Science Programs office. In 2017, URAP was guided by the following priorities:

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

Table 1 contains an overview of demographic information for 2017 URAP apprentices. URAP surpassed its 2017 goal of 55 apprentice participants, enrolling a total of 59 apprentices, a 12% increase compared to the 52 apprentices enrolled in 2016. These apprentices were selected from among 239 applicants, a 25% increase from 2016 when 177 applications were received. A substantial percentage of enrolled apprentices (44%) attended Historically Black Colleges and Universities or other Minority Serving institutions (HBCUs/MSIs). Over half (58%) of participants were female, a group historically underrepresented in some STEM fields; this is an increase from 2016 when 42% of participants were female. Over half (53%) of apprentice were White, a slight decrease from 2016 when 58% were White. The program also served students from racial/ethnic groups historically underserved and underrepresented in STEM fields. Of the 59 apprentices, 8% were Black or African American (compared to 10% in 2016) and 15% were Hispanic or Latino (compared to 13% in 2016). Nearly a quarter (24%) of apprentices met the AEOP definition of underserved students.[1]

[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.

Table 1. 2017 URAP Apprentice Participant Profile		
Demographic Category		
Participant Gender (n = 59)		
Female	34	58%
Male	25	42%
Not Reported	0	0%
Respondent Race/Ethnicity (n = 59)		
Asian	8	14%
Black or African American	5	8%
Hispanic or Latino	9	15%
Native American or Alaska Native	0	0%
White	31	53%
Other race or ethnicity	2	3%
Choose not to report	3	5%
Underserved (n =59)		
Yes	14	24%
No	45	76%

Apprenticeships were completed at 39 Army-funded university and college research laboratories (herein called URAP sites) in 23 U.S states, summarized in Table 2; 17 of the 39 institutions have Historically Black College and University (HBCU) or Minority-serving Institution (MSI) status (denoted with an asterisk below), an increase from the 14 HBCUs/MSIs participating in 2016. In 2017, URAP provided outreach to 59 apprentices, a 12% increase from 2016 when 52 apprentices were enrolled.

Table 2. 2017 URAP Sites			
2017 URAP Site	**City**	**State**	**No. of Participants**
Arizona State University*	Tempe	Arizona (AZ)	3
City University of New York*	New York	New York (NY)	2
Clarkson University	Potsdam	New York (NY)	1
Clemson University	Clemson	South Carolina (SC)	1
Duke University	Durham	North Carolina (NC)	1
Florida International University*	Miami	Florida (FL)	2
Johns Hopkins University	Baltimore	Maryland (MD)	2
Louisiana State University*	Baton Rouge	Louisiana (LA)	1
NC A&T*	Greensboro	North Carolina (NC)	4
Northwestern University	Evanston	Illinois (IL)	1
Oklahoma State University	Stillwater	Oklahoma (OK)	2
Rutgers, State University – Camden*	Camden	New Jersey (NJ)	1
Rutgers, State University - New Jersey*	New Brunswick	New Jersey (NJ)	2
San Jose State University*	San Jose	California (CA)	1
St. John's University, NY	Jamaica	New York (NY)	1

Table 2. 2017 URAP Sites			
2017 URAP Site	**City**	**State**	**No. of Participants**
Texas State University*	San Marcos	Texas (TX)	1
Tufts University	Medford	Massachusetts (MA)	2
University of Alabama	Tuscaloosa	Alabama (AL)	1
University of Arizona*	Tucson	Arizona (AZ)	1
University of California - Berkley	Berkley	California (CA)	1
University of California – Irvine*	Irvine	California (CA)	1
University of California – Los Angeles*	Los Angeles	California (CA)	1
University of Colorado	Boulder	Colorado (CO)	1
University of Delaware*	Newark	Delaware (DE)	2
University of Maryland - College Park*	College Park	Maryland (MD)	2
University of Massachusetts - Amherst	Amherst	Massachusetts (MA)	1
University of Michigan	Ann Arbor	Michigan (MI)	1
University of Minnesota	Minneapolis	Minnesota (MN)	3
University of New Hampshire	Durham	New Hampshire (NH)	1
University of North Carolina - Charlotte*	Charlotte	North Carolina (NC)	1
University of Notre Dame	Notre Dame	Indiana (IN)	2
University of Pennsylvania	Philadelphia	Pennsylvania (PA)	1
University of Rochester	Rochester	New York (NY)	2
University of South Carolina	Columbia	South Carolina (SC)	1
University of South Florida	Tampa	Florida (FL)	1
University of Texas - Arlington*	Arlington	Texas (TX)	1
University of Texas - El Paso*	El Paso	Texas (TX)	2
Washington State University	Pullman	Washington (WA)	1
Yale University	New Haven	Connecticut (CT)	1

**Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI)*

The total cost of 2017 URAP was $236,014 including $172,525 for participant stipends. The average cost per 2017 URAP participant taken across all URAP sites was $4,000. Table 3 summarizes these and other 2017 URAP program costs.

Table 3. 2017 URAP Program Costs	
2017 URAP - Cost Per Student Participant	
Total Student Participants (Apprentices)	52 (51 funded by AEOP and ARO)
Total Cost	$251,679
Total Stipends	$199,843
AAS Administrative Costs	$49,512
Other Operational Costs	$2,324
Cost Per Student Participant	$4,000

4 | Evidence-Based Program Change

All AEOP apprenticeship programs are administered by the Academy of Applied Science and 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.
    - Approximately 300 universities posted apprenticeship opportunities on career assistance pages.
    - University host directors distributed flyers to college students to promote URAP and CQL, as well as mentorship.
- 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 CAM 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
    - e-Cybermission 9th 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 CAM 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.
- Worked with the 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 participations. 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 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.
- Disseminated information about the AEOP Travel Award and received several interests.

5 | Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• ARO and AEOP co-sponsorship • ARO providing administration of program • Operations conducted by 39 Army-funded university/ college labs • 59 apprentices participating in URAP apprenticeships • 49 university/college S&Es serving as URAP mentors • Apprenticeship funds administered to university/college research labs to support apprentice participation • Centralized branding and comprehensive marketing • Centralized evaluation	• Apprentices engage in authentic STEM research experiences through hands-on summer apprenticeships at Army-funded university/college labs • University/college S&Es supervise and mentor apprentices' research • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of apprentice participants engaged in URAP • Number and diversity of university / college S&Es engaged in URAP • Apprentices, university / college S&Es, and ARO contributing to evaluation	• Increased apprentice STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased apprentice interest in future STEM engagement • Increased apprentice awareness of and interest in other AEOP opportunities • Increased apprentice awareness of and interest in STEM research and careers • Increased apprentice awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve URAP programs	• Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased apprentice pursuit of STEM degrees • Increased apprentice pursuit of STEM careers • Increased apprentice pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of URAP

The URAP evaluation gathered information from multiple participant groups about URAP processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and URAP program objectives.

Key Evaluation Questions

- What aspects of URAP motivate participation?
- What aspects of URAP structure and processes are working well?
- What aspects of URAP could be improved?
- Did participation in URAP:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for URAP included apprentice and mentor questionnaires as well as 8 individual interviews with apprentices and 5 interviews with mentors. Tables 4-7 outline the information collected in apprentice and mentor questionnaires and interviews.

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 URAP, satisfaction with and suggestions for improving URAP 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 URAP, motivating factors for participation, awareness of implications of research topics, satisfaction with and suggestions for improving URAP 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 URAP, benefits to participants suggestions for improving URAP 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 URAP

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan, provided in Part 3 of the URAP evaluation report. The reader is strongly encouraged to review Appendix A 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. Part 3 of the Evaluation Report provides protocols and instruments relevant to the evaluation: focus group protocols are provided in Appendix B (students) and Appendix C (mentors); the apprentice questionnaire is provided in Appendix D and the mentor questionnaire is provided in Appendix E; and the tool used for the new assessment of apprentices' 21st Century Skills that was piloted in 2017 is included in Appendix F. Major trends in data and analyses are reported herein.

Study Sample

Table 8 provides an analysis of apprentice and mentor participation in the URAP questionnaires, the response rates, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). It is notable that over half of participants (54% of apprentices and 69% of mentors) responded to the questionnaire, a substantial increase over 2016 response rates when 35% of apprentices and 30% of mentors responded to the questionnaire.

Table 8. 2017 URAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[2]
Apprentices	32	59	54%	±11.82%
Mentors	34	49	69%	±9.4%

Eight phone interviews were conducted with apprentices and 5 phone interviews were conducted with mentors. Interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice questionnaire data. They add to the overall narrative of URAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Apprentice Demographics

Demographic data collected from URAP apprentices who responded to the questionnaire respondents are summarized in Table 9. Slightly more males (58%) than females (42%) completed the questionnaire. More responding apprentices identified with the racial/ethnic category of White (49%) than any other single race/ethnicity. Demographics of responding apprentices are generally similar to those of all enrolled apprentices, although a somewhat larger percentage of males (58%) responded to the questionnaire than are represented in the overall population (42% males).

[2] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, 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.

Table 9. 2017 URAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 31)		
Female	13	42%
Male	18	58%
Respondent Race/Ethnicity (n = 31)		
Asian	4	13%
Black or African American	2	6.5%
Hispanic or Latino	5	16%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	1	3%
White	15	48.5%
Other race or ethnicity	2	6.5%
Choose not to report	2	6.5%
Respondent Grade Level (n = 32)		
First-Year college student (13)	1	3%
College sophomore (14)	5	16%
College junior (15)	11	34%
College senior (16)	11	34%
Graduate program (17)	0	0%
Choose not to report	1	3%
Other	3	10%

Apprentices were asked to report on their previous participation in AEOPs (Table 10). No URAP apprentices reported previous participation in any other AEOP programs although approximately 10% said they had participated in another STEM program that was not part of AEOP.

Table 10. Apprentice Participation in AEOP Programs (n=31)		
Choice	**Response Percent**	**Response Total**
Camp Invention	0.00 %	0
eCYBERMISSION	0.00 %	0
Junior Solar Sprint (JSS)	0.00 %	0
Gains in the Education of Mathematics and Science (GEMS)	0.00 %	0
UNITE	0.00 %	0
Junior Science & Humanities Symposium (JSHS)	0.00 %	0
Science & Engineering Apprenticeship Program (SEAP)	0.00 %	0
Research & Engineering Apprenticeship Program (REAP)	0.00 %	0
High School Apprenticeship Program (HSAP)	0.00 %	0
College Qualified Leaders (CQL)	0.00 %	0
Undergraduate Research Apprenticeship Program (URAP)	0.00 %	0

I've never participated in any AEOP programs	90.32 %	28
Other STEM Program	9.68 %	3

Mentor Demographics

Table 11 summarizes URAP demographics for mentors who responded to the questionnaire. More responding mentors were female (82%) than male (18%). The vast majority of responding mentors self-identified as being either Asian (44%) or White (44%) with very few other ethnic/racial minorities (9%) responding. Mentors primarily identified as university educators (76%), and 82% reported that they served as research mentors (82%).

Table 11. 2017 URAP Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 34)		
Female	28	82%
Male	6	18%
Respondent Race/Ethnicity (n = 34)		
Hispanic or Latino	1	3%
Asian	15	44%
Black or African American	2	6%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	15	44%
Choose not to report	1	3%
Other race or ethnicity, (specify):	0	0%
Respondent Occupation (n = 34)		
University educator	26	76%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate apprentice, etc.)	5	15%
Scientist, Engineer, or Mathematics professional	2	6%
Other, (specify):	1	3%
Respondent Role in URAP (n = 34)		
Research Mentor	28	82%
Research Team Member but not a Principal Investigator	5	15%
Other, (specify)	1	3%

6 | Actionable Program Evaluation

The Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. This section highlights information outlined in the Satisfaction & Suggestions sections of Tables 4-7.

A focus of the Actionable Program Evaluation is efforts toward the long-term goal of URAP and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technological progress. URAP sites are primarily responsible for local marketing of the program—including any outreach that is done with the specific intention of recruiting apprentices from traditionally underrepresented and underserved populations. Thus, it is important to consider how URAP is marketed and ultimately recruits apprentice participants, the factors that motivate apprentices to participate in URAP, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The following sections report perceptions of apprentices and mentors that pertain to current programmatic efforts and recommend evidence-based improvements to help URAP achieve outcomes related to AEOP programs and objectives. Specifically, this information is intended to help URAP continue to expand participation from and support STEM education for students from underrepresented and underserved groups.

Marketing and Recruiting Underrepresented and Underserved Populations

URAP apprentices are recruited primarily at the site level, using connections or mechanisms available to the university or college site. As a result, the ability of URAP to recruit underserved or under-represented populations of students depends upon the diversity of the universities or colleges in which recruitment takes place. It is noteworthy that URAP has consistently increased participation of HBCUs and MSIs since 2013.

In addition to site-level marketing efforts, AAS conducted a coordinated marketing effort among apprenticeship programs. Marketing was conducted for apprenticeship programs overall rather than for individual programs, a strategy that AAS has reported to be successful. In particular, AAS noted that consistent messaging to directors, mentors, and students continues to be a successful way to keep participants informed of other AEOP programs. According to the annual program report submitted by AAS, a number of strategies were used to disseminate information about the apprenticeship programs to diverse audiences:

- Worked with the Army 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
- Updated the Apprenticeship flyer showing diversity and individual program descriptions.
- Cross marketing and outreach for all AEOP programs, in addition to specific cross promotion, such as:
    - Provided apprenticeship flyers to NSTA and JSHS for distribution at events.
    - Assisted e-Cybermission with virtual judge recruitment by notifying apprenticeship directors and mentors of the opportunity.

In order to understand what apprentice recruitment strategies are most effective, apprentices were asked to report how they learned about AEOP (Table 12). The most frequently mentioned source of information was someone who works at a school or university apprentice attends (57%). Other sources mentioned relatively frequently were someone who works with the program (23%), and a school or university newsletter, email, or website (20%).

Table 12. How Apprentices Learned About AEOP (n=30)		
Choice	**Response Percent**	**Response Total**
Army Educational Outreach Program (AEOP) Website	3%	1
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	20%	6
Past participant of program	7%	2
Friend	17%	5
Family Member	7%	2
Someone who works at the school or university I attend	57%	17
Someone who works with the program	23%	7
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	3%	1
Community group or program	0%	0
Choose Not to Report	0%	0

Factors Motivating Apprentice Participation

Apprentices were also asked about what motivated them to participate in URAP. Table 13 shows that the most common motivators were related to STEM interest and learning, including the desire to learn something new or interesting (93%) and interest in STEM (93%). A large majority of apprentices also reported being motivated to participate in URAP because of the laboratory experience, including the opportunity to use

advanced laboratory technology (87%) and desire to expand laboratory or research skills (80%). Over half of apprentices reported participating in URAP for networking opportunities (57%), to have fun (57%), and learn in ways not possible in school. No apprentices reported that URAP was an academic requirement or grade.

Table 13. Motivating Factors for Participation (n=30)		
Choice	**Response Percent**	**Response Total**
Teacher or professor encouragement	47%	14
An academic requirement or school grade	0%	0
Desire to learn something new or interesting	93%	28
The mentor(s)	37%	11
Building college application or résumé	73%	22
Networking opportunities	57%	17
Interest in science, technology, engineering, or mathematics (STEM)	93%	28
Interest in STEM careers with the Army	40%	12
Having fun	57%	17
Earning stipends or awards for doing STEM	23%	7
Opportunity to do something with friends	3%	1
Opportunity to use advanced laboratory technology	87%	26
Desire to expand laboratory or research skills	80%	24
Learning in ways that are not possible in school	57%	17
Serving the community or country	40%	12
Exploring a unique work environment	60%	18
Figuring out education or career goals	53%	16
Seeing how school learning applies to real life	37%	11
Recommendations of past participants	3%	1
Choose Not to Report	0%	0

Interview participants were also asked about why they chose to participate in URAP. These apprentices' responses also focused on laboratory experience and learning opportunities. Apprentices' interview responses focused on the value of research experience, general work experience, and the opportunity to network.

The URAP Experience

Apprentices were asked to responded to questionnaire items about their experiences in URAP. When asked about the input they had on design of their project (Table 14), a majority (59%) reported having had some degree of decision making ability regarding their project, primarily either choosing among projects suggested by mentors (25%) or working with mentors and members of research teams to design projects (25%). None of the apprentices reported designing their projects entirely on their own, and 38% were assigned a project by their mentor.

Table 14. Apprentice Input on Design of Their Project (n=32)		
Choice	**Response Percent**	**Response Total**
I did not have a project	3.13 %	1
I was assigned a project by my mentor	37.50 %	12
I worked with my mentor to design a project	9.38 %	3
I had a choice among various projects suggested by my mentor	25.00 %	8
I worked with my mentor and members of a research team to design a project	25.00 %	8
I designed the entire project on my own	0.00 %	0

A large majority of apprentices (88%) worked collaboratively to some extent (Table 15). Most commonly, apprentices indicated they worked alone on a project that was closely connected with projects of others in their group (31%). Only four apprentices (13%) reported working alone.

Table 15. Apprentice Participation in a Research Group (n=32)		
Choice	**Response Percent**	**Response Total**
I worked alone (or alone with my research mentor)	12.50 %	4
I worked with others in a shared laboratory or other space, but we work on different projects	21.88 %	7
I worked alone on my project and I met with others regularly for general reporting or discussion	18.75 %	6
I worked alone on a project that was closely connected with projects of others in my group	31.25 %	10
I work with a group who all worked on the same project	15.63 %	5

Since URAP and AEOP are interested in increasing the number and diversity of apprentices who pursue STEM careers, a goal of the program is to introduce apprentices to more STEM jobs/careers, particularly those within the DoD. In order to understand how URAP is informing apprentices about STEM careers, apprentices were asked to report on the number of general STEM jobs and careers and the number DoD STEM jobs and careers they learned about during URAP (Tables 16 and 17). A large majority of apprentices (81%) reported learning

about at least one STEM job during URAP, and 38% reported learning about 4 or more. Fewer apprentices reported hearing about STEM careers within the DoD, with half (50%) learning about no DoD STEM jobs or careers, and half (50%) reporting that they learned about at least one. Only 22% of apprentices reported hearing about 4 or more DoD STEM jobs or careers during URAP.

Table 16. Number of STEM Jobs/Careers Learned About During URAP (n=32)

Choice	Response Percent	Response Total
None	18.75 %	6
1	12.50 %	4
2	25.00 %	8
3	6.25 %	2
4	12.50 %	4
5 or more	25.00 %	8

Table 17. Number of DoD STEM Jobs/Careers Learned About During URAP (n=32)

Choice	Response Percent	Response Total
None	50.00 %	16
1	6.25 %	2
2	12.50 %	4
3	9.38 %	3
4	6.25 %	2
5 or more	15.63 %	5

To assess the impact on resources on apprentices' awareness of DoD STEM careers, apprentices were asked to rate the usefulness of various resources (Table 18). Approximately half or more of apprentices indicated that resources such as participation in URAP (56%) and presentations or information shared during URAP (50%) were at least somewhat helpful in informing them about DoD STEM careers. Nearly half (47%) reported that their mentors were at least somewhat helpful for this purpose. Many apprentices reported that they did not experience AEOP resources such as AEOP on social media (72%) and the AEOP brochure (50%).

Table 18. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	21.9%	15.6%	21.9%	6.3%	34.4%	
	7	5	7	2	11	**32**
AEOP on Facebook, Twitter, Pinterest or other social media	50.0%	21.9%	21.9%	6.3%	0.0%	
	16	7	7	2	0	**32**
Army Research Office (ARO) website	31.3%	12.5%	25.0%	12.5%	18.8%	
	10	4	8	4	6	**32**
AEOP brochure	31.3%	18.8%	21.9%	18.8%	9.4%	
	10	6	7	6	3	**32**
My Apprenticeship Program mentor	18.8%	12.5%	21.9%	21.9%	25.0%	
	6	4	7	7	8	**32**
Presentations or information shared in the Apprenticeship Program	18.8%	12.5%	18.8%	18.8%	31.3%	
	6	4	6	6	10	**32**
Participation in the Apprenticeship Program	15.6%	18.8%	9.4%	21.9%	34.4%	
	5	6	3	7	11	**32**

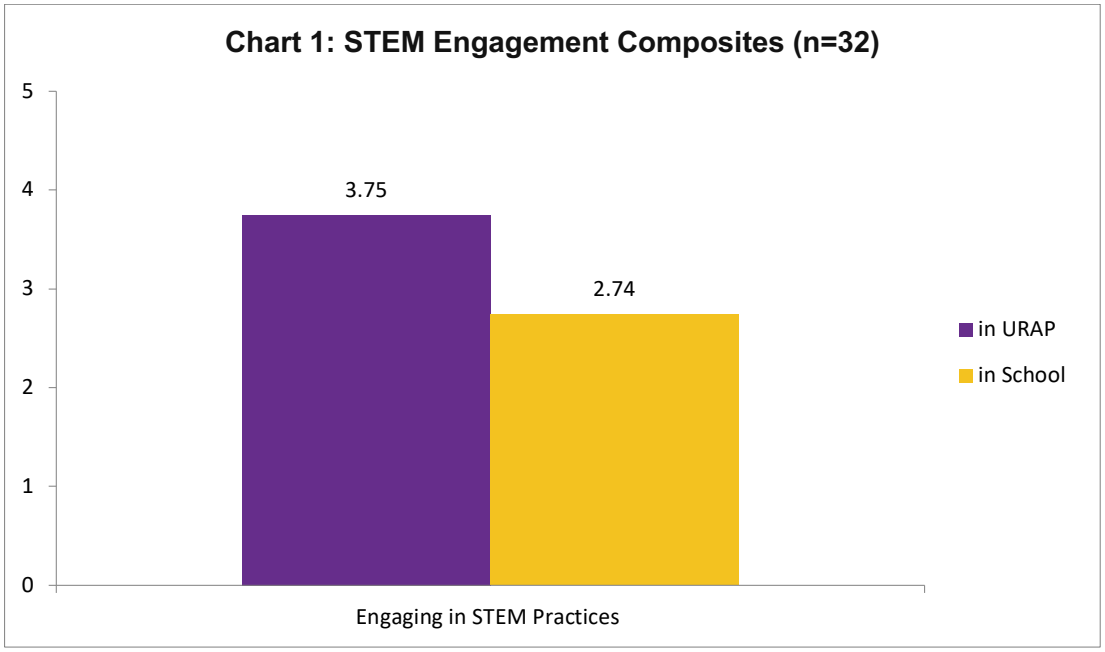
In order to understand the nature of apprentices' activities during URAP, they were asked how often they engaged in various STEM practices during their apprenticeships (Table 19). Apprentices reported engaging in a wide array of STEM practices while in URAP, with more than half reporting that they engaged in all but two of the tasks weekly or every day. The practices most frequently engaged in (weekly or every day) included interacting with STEM researchers (91%) and identifying questions or problems to investigate (91%). Over half of apprentices reported that they did not present their STEM research to a panel of judges from industry or the military (69%) and over a third reported that they did not build a computer model (38%). Mentors were asked to respond to a parallel item, and mentor responses were generally similar to those of apprentices, although mentors were somewhat more likely to report that apprentices engaged in activities such as using laboratory procedures or tools weekly or every day (95% of mentors; 84% or apprentices).

Table 19. Apprentice Engagement in STEM Practices in URAP (n=32)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world	6.3%	6.3%	0.0%	12.5%	75.0%	
	2	2	0	4	24	32
Work with a STEM researcher on a research project of your	21.9%	9.4%	3.1%	15.6%	50.0%	
	7	3	1	5	16	32
Design my own research or investigation based on my own	25.0%	9.4%	6.3%	18.8%	40.6%	
	8	3	2	6	13	32
Present my STEM research to a panel of judges from industry	68.8%	15.6%	9.4%	6.3%	0.0%	
	22	5	3	2	0	32
Interact with STEM researchers	6.3%	3.1%	0.0%	12.5%	78.1%	
	2	1	0	4	25	32
Use laboratory procedures and tools	9.4%	3.1%	3.1%	9.4%	75.0%	
	3	1	1	3	24	32
Identify questions or problems to investigate	6.3%	3.1%	0.0%	28.1%	62.5%	
	2	1	0	9	20	32
Design and carry out an investigation	12.5%	0.0%	6.3%	18.8%	62.5%	
	4	0	2	6	20	32
Analyze data or information and draw conclusions	3.1%	12.5%	0.0%	31.3%	53.1%	
	1	4	0	10	17	32
Work collaboratively as part of a team	9.4%	3.1%	3.1%	21.9%	62.5%	
	3	1	1	7	20	32
Build or make a computer model	37.5%	18.8%	6.3%	15.6%	21.9%	
	12	6	2	5	7	32
Solve real world problems	18.8%	18.8%	0.0%	21.9%	40.6%	
	6	6	0	7	13	32

A composite score[3] was calculated for the items focusing on STEM Engagement in URAP.[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 determine whether there were differences in apprentice experiences by gender and race/ethnic group (minority vs. non-minority apprentices). No significant differences by gender or race/ethnicity were found in terms of STEM Engagement in URAP.

In order to understand how the URAP experience compares with apprentices' typical school experience, apprentices were asked how often they engaged in the same STEM practices in school. Responses were combined into a composite variable: STEM Engagement 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 URAP. Students reported significantly higher STEM Engagement while in URAP over school (effect size is large with d = 0.75)[6].



[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 items was 0.907.

[5] The Cronbach's alpha reliability for these 12 items was 0.858.

[6] Dependent Samples t-test for STEM Learning: t(31)=6.33, p<.001.

Apprentices participating in interviews were also asked to reflect on how their URAP experiences compared with their typical school experiences. These apprentices noted that URAP provided them with substantially more hands-on experience than their school lab experiences, that they had more independence in URAP, that they were able to apply their learning to real-world problems in URAP in a way they are unable to do in school, and that they have more opportunity to focus their learning on specific areas. For example,

> *It's a lot more hands-on and flexible. School was really, "This is what you're going to do, and you have to just do it." [URAP] is a lot more, "This is the end result that you want to achieve to figure out how you're going to do it and then do it."* (URAP Apprentice)

Apprentices were asked in an open-ended questionnaire item to list three benefits of URAP. The 32 apprentices who provided at least 1 response mentioned a variety of benefits. The most frequently mentioned benefits were the opportunity to gain laboratory and/or research experience (mentioned 26 times); and the opportunity to gain various workplace skills, or 21st Century Skills, including problem solving, perseverance, critical thinking, writing and communication skills, and teamwork (mentioned in 23 comments). Another 11 comments focused on the STEM learning apprentices experienced during URAP, 6 comments included networking as a benefit, and several comments (4 - 5) focused on the value of career information, the quality of mentors, and the value of independent work.

Apprentices participating in interviews were also asked to reflect on the benefits of URAP. Participants' comments echoed the themes mentioned above, focusing on the value of the laboratory experience, STEM learning, networking, and education and career information. For example,

> *[Participating in URAP has] given me a boost over some of my peers when it comes to working in a lab, and working with different equipment and different cells, and stuff like that… I've been able to learn and research for myself.* (URAP Apprentice)

> *I got a real look into what it means to be in grad school. I worked very closely with PhD students in my lab. I got to research and design my own experiments in the realm of what they are doing.* (URAP Apprentice)

> *I feel like I've learned a lot about that and how to use specific technologies and techniques to accomplish what I'm trying to do. I also feel more confident in my research abilities.* (URAP Apprentice)

The Role of Mentors

Mentors play a critical role in URAP. Mentors supervise and support apprentices' work, advise apprentices on educational and career paths, and generally serve as STEM role models for URAP apprentices. The majority of mentors (76%) responding to the mentor questionnaire reported working with 1 apprentice, while 9% of mentors worked with 2 apprentices and 15% reported working with 3 - 5 apprentices.

Mentors were asked whether or not they used a number of strategies when working with their apprentices (note: the questionnaires used the term "students"; consequently, the data in this section are reported using that term as well). 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 reported using most strategies associated with each of the five mentoring areas listed above. Mentor responses for each of the five areas of mentoring are presented in Tables 20 – 25.

Approximately two-thirds or more (65% - 94%) of mentors reported using each strategy to establish the relevance of learning activities in URAP (Table 20). A large majority of mentors reported becoming familiar with their students' backgrounds and interests at the beginning of URAP (94%) and giving students real-life problems to investigate (85%).

[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 20. Mentors Using Strategies to Establish Relevance of Learning Activities (n=34)

	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 URAP experience	94.1%	5.9%	
	32	2	**34**
Giving students real-life problems to investigate or solve	85.3%	14.7%	
	29	5	**34**
Selecting readings or activities that relate to students' backgrounds	79.4%	20.6%	
	27	7	**34**
Encouraging students to suggest new readings, activities, or projects	79.4%	20.6%	
	27	7	**34**
Helping students become aware of the role(s) that STEM plays in their everyday lives	79.4%	20.6%	
	27	7	**34**
Helping students understand how STEM can help them improve their own community	64.7%	35.3%	
	22	12	**34**
Asking students to relate real-life events or activities to topics covered in URAP	64.7%	35.3%	
	22	12	**34**

Likewise, nearly two-thirds or more (65% - 91%) of responding mentors also reported using all strategies related to supporting the diverse needs of students as learners (Table 21). A large majority of mentors reported using a variety of teaching and/or mentoring activities to meet needs of all students (94%) and directing students to other individuals or programs for additional support as needed (91%). Nearly two-thirds of mentors (65%) reported highlighting the underrepresentation of women and racial and ethnic minority population in STEM; this is an increase in the use of this strategy compared to past years (38% in 2015; 46% in 2016).

Table 21. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=34)

	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 URAP experience	76.5%	23.5%	
	26	8	**34**
Interact with students and other personnel the same way regardless of their background	79.4%	20.6%	
	27	7	**34**

Use a variety of teaching and/or mentoring activities to meet the needs of all students	94.1%	5.9%	
	32	2	**34**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	55.9%	44.1%	
	19	15	**34**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	88.2%	11.8%	
	30	4	**34**
Directing students to other individuals or programs for additional support as needed	91.2%	8.8%	
	31	3	**34**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	64.7%	35.3%	
	22	12	**34**

Mentors were also asked to report which strategies they used to support apprentices' development of collaboration and interpersonal skills (Table 22). More than three-quarters (77% - 91%) of mentors reported using all strategies presented in this domain. Strategies used by nearly all mentors included having students work on collaborative activities as a member of a team (94%), having students listen to the ideas of others with an open mind (91%), and having students explain difficult ideas to others (91%).

Table 22. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=34)

	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	82.4%	17.6%	
	28	6	**34**
Having my student(s) explain difficult ideas to others	91.2%	8.8%	
	31	3	**34**
Having my student(s) listen to the ideas of others with an open mind	91.2%	8.8%	
	31	3	**34**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	76.5%	23.5%	
	26	8	**34**
Having my student(s) give and receive constructive feedback with others	88.2%	11.8%	
	30	4	**34**
	94.1%	5.9%	

Having students work on collaborative activities or projects as a member of a team	32	2	**34**
Allowing my student(s) to resolve conflicts and reach agreement within their team	76.5%	23.5%	
	26	8	**34**

Nearly all (88% - 94%) mentors indicated they used all strategies to support student engagement in authentic STEM activities. All but one mentor reported supervising their students while they practiced STEM research skills (97%), and providing their students with constructive feedback to improve their STEM competencies (97%).

Table 23. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=34)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	88.2%	11.8%	
	30	4	**34**
Having my student(s) search for and review technical research to support their work	88.2%	11.8%	
	30	4	**34**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	94.1%	5.9%	
	32	2	**34**
Supervising my student(s) while they practice STEM research skills	97.1%	2.9%	
	33	1	**34**
Providing my student(s) with constructive feedback to improve their STEM competencies	97.1%	2.9%	
	33	1	**34**
Allowing students to work independently to improve their self-management abilities	91.2%	8.8%	
	31	3	**34**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	94.1%	5.9%	
	32	2	**34**
Encouraging students to seek support from other team members	94.1%	5.9%	
	32	2	**34**

The final group of mentoring strategies were focused on providing support for student STEM educational and career pathways (Table 24). In general, fewer mentors reported using these strategies than those associated with the other four areas of effective mentoring, although over half of mentors (56% - 97%) reported

using each strategy. Nearly all mentors reported asking their students about their educational and/or career goals (97%) and providing guidance about educational pathways that will prepare students for a STEM career (94%). Fewer mentors (56%) reported using strategies such as recommending AEOPs that align with students' goals and recommending extracurricular programs that align with students' goals. There was, however, an increase in the use of strategies related to communicating with apprentices about AEOP and DoD STEM career opportunities as compared to 2016. In 2016, only 39% of mentors recommended other AEOP programs to apprentices while 56% did so in 2017. Likewise, in 2016 a little more than half of the responding mentors (57%) reported discussing STEM careers within the DOD or government with apprentices, while nearly three-quarters (74%) reported doing this in 2017.

Table 24. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=34)

	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	97.1%	2.9%	
	33	1	**34**
Recommending extracurricular programs that align with students' goals	55.9%	44.1%	
	19	15	**34**
Recommending Army Educational Outreach Programs that align with students' goals	55.9%	44.1%	
	19	15	**34**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	94.1%	5.9%	
	32	2	**34**
Discussing STEM career opportunities within the DoD or other government agencies	73.5%	26.5%	
	25	9	**34**
Discussing STEM career opportunities in private industry or academia	79.4%	20.6%	
	27	7	**34**
Discussing the economic, political, ethical, and/or social context of a STEM career	50.0%	50.0%	
	17	17	**34**
Recommending student and professional organizations in STEM to my student(s)	61.8%	38.2%	
	21	13	**34**
Helping students build a professional network in a STEM field	61.8%	38.2%	
	21	13	**34**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	61.8%	38.2%	
	21	13	**34**

During the phone interviews, mentors were asked about the value that URAP added to their own experiences as well as the value that URAP has for apprentices. Mentor responses focused on the benefits to their own and their graduate students' teaching strategies, the perspective on their projects that URAP apprentices provide, the value of the work the apprentices perform, the value of research experience for apprentices, and the value of being able to pay apprentices for their work. For example,

> *[Having a URAP apprentice is] useful to clarify thinking - It's easy when you talk to people, for example at the graduate level, but for you to explain it to [an] undergrad takes a lot of practice.* (URAP Mentor)

> *I think it's a good opportunity for me to have this undergraduate apprentice program so that we have more research coming to the lab. It's really helpful, the undergraduates, they're really able to contribute meaningful research.* (URAP Mentor)

> *I've gotten the last three summers running [students] that didn't have a great background in directly the area we're doing. It really turns my grad students from the learning mentality into the teaching mentality.* (URAP Mentor)

> *If it's a choice between working only a few hours a week and having to have an income in the summer, working at McDonald's or the gardening center, or working to do science, then it's no competition. I think, it's actual primary [that] we can pay students so that they can learn and work.* (URAP Mentor)

Mentors were asked which of the AEOP programs they explicitly discussed with their apprentices during URAP (Table 25). The most frequent response, reported by 77% of mentors, was that they discussed AEOP with apprentices without reference to any specific program. Of the programs, which were explicitly discussed, the most commonly mentioned was NDSEG (discussed by 32% of mentors), followed by SMART (discussed by 24% of mentors).

Table 25. Mentors Explicitly Discussing AEOPs with Apprentices (n=34)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
College Qualified Leaders (CQL)	5.9%	94.1%	
	2	32	**34**
GEMS Near Peer Mentor Program	2.9%	97.1%	
	1	33	**34**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	23.5%	76.5%	
	8	26	**34**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	32.4%	67.6%	
	11	23	**34**
I discussed AEOP with my student(s) but did not discuss any specific program	76.5%	23.5%	
	26	8	**34**

Mentors were also asked to report about the usefulness of various resources in their efforts to expose apprentices to AEOPs (Table 26). Participation in URAP was perceived to be the most useful resource (91% reported that this was somewhat or very much useful). Mentors also indicated the URAP Program administrator or site coordinator was at least somewhat useful for exposing apprentices to AEOPs (71%). More than half of respondents reported that they did not experience AEOP on social media (71%) and over a third (35%) had not experienced the AEOP brochure.

Table 26. Usefulness of Resources for Exposing Apprentices to AEOPs (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	35.3%	2.9%	5.9%	44.1%	11.8%	
	12	1	2	15	4	**34**
Army Educational Outreach Program (AEOP) website	20.6%	0.0%	8.8%	29.4%	41.2%	
	7	0	3	10	14	**34**
AEOP on Facebook, Twitter, Pinterest or other social media	70.6%	5.9%	5.9%	11.8%	5.9%	
	24	2	2	4	2	**34**
AEOP brochure	35.3%	5.9%	11.8%	29.4%	17.6%	
	12	2	4	10	6	**34**
URAP Program administrator or site coordinator	20.6%	2.9%	5.9%	23.5%	47.1%	
	7	1	2	8	16	**34**
Invited speakers or "career" events	44.1%	5.9%	5.9%	20.6%	23.5%	
	15	2	2	7	8	**34**
Participation in URAP	8.8%	0.0%	0.0%	14.7%	76.5%	
	3	0	0	5	26	**34**

Mentors were asked about the usefulness of the same resources for their efforts to expose apprentices to DoD STEM careers (Table 27). Again, the resource most frequently chosen as somewhat or very much useful was participation in URAP (86%). Other resources reported frequently as being at least somewhat useful included the AEOP website (62%) and the program administrator or site coordinator (62%). More than half of mentors reported that they did not experience AEOP social media (68%).

Table 27. Usefulness of Resources for Exposing Apprentices to DoD STEM Careers (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Research Office (ARO) website	32.4%	2.9%	11.8%	32.4%	20.6%	
	11	1	4	11	7	**34**
Army Educational Outreach Program (AEOP) website	23.5%	2.9%	11.8%	26.5%	35.3%	
	8	1	4	9	12	**34**
AEOP on Facebook, Twitter, Pinterest or other social media	67.6%	2.9%	5.9%	11.8%	11.8%	
	23	1	2	4	4	**34**
AEOP brochure	35.3%	2.9%	11.8%	35.3%	14.7%	
	12	1	4	12	5	**34**
Program administrator or site coordinator	32.4%	2.9%	2.9%	29.4%	32.4%	
	11	1	1	10	11	**34**
Invited speakers or "career" events	44.1%	2.9%	11.8%	23.5%	17.6%	
	15	1	4	8	6	**34**
Participation in URAP	11.8%	0.0%	2.9%	20.6%	64.7%	
	4	0	1	7	22	**34**

Satisfaction with URAP

Participant satisfaction with URAP can influence the number and quality of future apprentices and mentors, factors central to the success of the program. To gain insight into participant satisfaction with URAP, both apprentices and mentors were asked to respond to questionnaire items about their satisfaction with various components of the program (Tables 28-31).

Apprentices reported high levels of satisfaction with all URAP program features about which they were asked (Table 28). Approximately two-thirds or more of apprentices indicated being "somewhat" or "very much" satisfied with all features. All apprentices were at least somewhat satisfied with the physical location of URAP (100%), and nearly all were at least somewhat satisfied with their communication with their host site organizers (97%). Few apprentices expressed dissatisfaction with any program features, although 4 apprentices (13%) indicated that they were dissatisfied with the timeliness of stipend payments.

Table 28. Apprentice Satisfaction with URAP Program Features (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	0.0%	3.1%	43.8%	53.1%	
	0	0	1	14	17	**32**
Other administrative tasks (in-processing, network access, etc.)	3.1%	0.0%	6.3%	46.9%	43.8%	
	1	0	2	15	14	**32**
Communicating with your host site organizers	3.1%	0.0%	0.0%	21.9%	75.0%	
	1	0	0	7	24	**32**
The physical location(s) of Apprenticeship Program activities	0.0%	0.0%	0.0%	12.5%	87.5%	
	0	0	0	4	28	**32**
The variety of STEM topics available to you in the Apprenticeship Program	3.1%	6.3%	12.5%	25.0%	53.1%	
	1	2	4	8	17	**32**
Teaching or mentoring provided during Apprenticeship Program activities	6.3%	6.3%	3.1%	12.5%	71.9%	
	2	2	1	4	23	**32**
Amount of stipend (payment)	6.3%	6.3%	18.8%	37.5%	31.3%	
	2	2	6	12	10	**32**
Timeliness of payment (stipend)	6.3%	12.5%	18.8%	28.1%	34.4%	
	2	4	6	9	11	**32**
Research abstract preparation requirements	3.1%	6.3%	18.8%	46.9%	25.0%	
	1	2	6	15	8	**32**

Apprentices' regular access to mentors is crucial in developing effective mentoring relationships. Table 29 shows that 72% of responding apprentices indicated their mentors were always available, and 16% that their mentors were available more than half of the time. Few apprentices (6%) indicated that their mentors were available half of the time or less.

Table 29. Apprentice Reports of Availability of Mentors (n=32)

Choice	Response Percent	Response Total
I did not have a mentor	0.00 %	0
The mentor was never available	3.13 %	1
The mentor was available less than half of the time	3.13 %	1

The mentor was available about half of the time of my project	6.25 %	2
The mentor was available more than half of the time	15.63 %	5
The mentor was always available	71.88 %	23

In addition to the frequency of their mentors' availability, apprentices were asked to rate their satisfaction with various elements of their research experiences (Table 30). Approximately 85% or more of apprentices indicated they were somewhat or very much satisfied with all aspects of their mentor relationships, suggesting that strong mentor-apprentice relationships are built in URAP. For example, 97% of apprentices were at least somewhat satisfied with their working relationship with their mentors, and 91% with the amount of time they spent with their mentors. Apprentices also reported high levels of satisfaction with other components of their research experiences. For example, 94% were at least somewhat satisfied with their research experience overall and 91% with the amount of time they spent doing meaningful research.

Table 30. Apprentice Satisfaction with Their Experience (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	0.0%	3.1%	9.4%	9.4%	78.1%	
	0	1	3	3	25	**32**
My working relationship with the group or team	15.6%	0.0%	0.0%	15.6%	68.8%	
	5	0	0	5	22	**32**
The amount of time I spent doing meaningful research	3.1%	3.1%	3.1%	28.1%	62.5%	
	1	1	1	9	20	**32**
The amount of time I spent with my research mentor	0.0%	6.3%	3.1%	25.0%	65.6%	
	0	2	1	8	21	**32**
The research experience overall	0.0%	3.1%	3.1%	25.0%	68.8%	
	0	1	1	8	22	**32**

Apprentices were asked to respond to open-ended questionnaire items asking them about their experiences in URAP. When apprentices were asked about their overall satisfaction with URAP, all 22 apprentices who provided responses to this question made positive comments about their satisfaction. Some were simple affirmations such as "I loved my experience. It was absolutely sensational." Others provided more details about their experiences. These comments focused on the value of the laboratory experience, positive comments about mentors, the value of the education and career information they received, and the learning they had experienced. For example,

The apprenticeship program was one of the most inspiring and challenging experiences I have had as an engineering student. It will help me to grow as a Mechanical Engineer and also to be a scientist. I learned that we should not be afraid to be wrong during experiments. Not only is knowledge important, but patience, imagination, and creativity are important, too. I would love to be in a program like this again. (URAP Apprentice)

This was my first time doing a summer research program and I found it to be great experience. I was able to work near full time and see how a STEM research jobs work. The URAP website was extremely helpful with information on other DoD scholarships. I'm very much looking forward to applying to the SMART scholarship as I move on to grad school in a year. (URAP Apprentice)

The experience is unforgettable and it not only allowed me to gain experience about the inner workings of a research lab, but the mindset that a researcher has to have to continuously move forward. I am happy that I participated in this program, because I learned a lot from it. (URAP Apprentice)

Four apprentices made positive comments about the program but also offered some caveats. These caveats were focused on mentor availability, communication, and the amount of meaningful work available for apprentices. For example,

Overall, I was happy with my Apprenticeship Program because it enabled me to find work that genuinely interests me and gave me an opportunity to learn new skills in the lab. However, I think my mentor was not accessible and helpful in helping me find a project and ensuring that I truly understood the science, meaning and motivation of the tasks that I was given. (URAP Apprentice)

I'm glad I was able to conduct research through the Apprenticeship Program because I was able to do independent research and learn new concepts on my own. However, there was not much communication with the people from the AEOP since I did not learn of any STEM career paths that are available to me in the Army or DoD. (URAP Apprentice)

Apprentices were asked in an open-ended question to list three ways in which the URAP program could be improved. Among the 30 apprentices who suggested improvements, the most commonly mentioned improvements related to communication with the program (mentioned in 18 comments), including general suggestions for better communication, more information about the apprenticeship requirements, and more information about AEOP. Another 10 comments suggested improvements to stipends, including suggestions for larger stipends, more frequent payment, and on-time payment of stipends. Nine comments focused on mentors, suggesting that mentors be more available, that mentors complete progress reports for apprentices, that there be more diverse research interests represented among mentors, and that mentors be better prepared for apprentices prior to their arrival. Six comments included suggestions focusing on providing presentation opportunities for apprentices, and several comments (4 for each theme) included suggestions to allow apprentices more input into and/or choice of research projects, provide more opportunities for apprentices to interact with one another, and provide more outreach to engage more students.

Mentors were also asked to rate their satisfaction with URAP program features (Table 31). Two-thirds or more (68% - 94%) of mentors reported being somewhat or very much satisfied with all features with the exception of communication with AAS (56% had not experienced this; 35% were at least somewhat satisfied). Nearly all mentors were at least somewhat satisfied with features such as the research abstract preparation

requirements (94%), the application or registration process (91%), and support for instruction or mentorship during program activities (91%). Few mentors expressed dissatisfaction with any URAP program features, although 3 mentors (9%) indicated that they were "not at all" satisfied with stipends.

Table 31. Mentor Satisfaction with URAP Program Features (n=34)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	2.9%	0.0%	5.9%	41.2%	50.0%	
	1	0	2	14	17	**34**
Other administrative tasks (in-processing, network access, etc.)	5.9%	2.9%	5.9%	47.1%	38.2%	
	2	1	2	16	13	**34**
Communicating with Army Research Office (ARO)	8.8%	0.0%	8.8%	17.6%	64.7%	
	3	0	3	6	22	**34**
Communicating with URAP organizers	8.8%	0.0%	5.9%	23.5%	61.8%	
	3	0	2	8	21	**34**
Support for instruction or mentorship during program activities	2.9%	0.0%	5.9%	20.6%	70.6%	
	1	0	2	7	24	**34**
Stipends (payment)	8.8%	8.8%	14.7%	17.6%	50.0%	
	3	3	5	6	17	**34**
Research abstract preparation requirements	0.0%	0.0%	5.9%	35.3%	58.8%	
	0	0	2	12	20	**34**
Communicating with Academy of Applied Science (AAS)	55.9%	2.9%	5.9%	14.7%	20.6%	
	19	1	2	5	7	**34**

Like apprentices, mentors were asked to reflect on their overall satisfaction with URAP in an open-ended questionnaire item. Mentor responses were overwhelmingly positive, with 20 of the 21 respondents offering positive comments about URAP. Mentors' responses focused on the motivation and information apprentices gain for graduate school and careers, their research experience, and the opportunity to attract talented students into research fields. For example,

> *This program is very beneficial for undergraduate students interesting in exploring STEM research. This also gives them a chance to think and work independently, as well as in collaboration with other researchers, thereby preparing them for a future career in STEM research. I am very satisfied with this program and I hope it continues to benefit many more future STEM researchers.* (URAP Mentor)

I had a great experience. The students were excellent, very engaged and responsive to the larger research goal. All students will continue on working with me over the next year to finish the project and submit to conferences and peer reviewed journals or proceedings. URAP was a fantastic collaboration between research, professionalization and exposure for the students. I would be excited to do the program again in the future. (URAP Mentor)

Of the 21 mentors who made positive comments about the program, 3 offered caveats to their overall satisfaction. These caveats included comments about the burden of administrative details, lack of DoD exposure, the stipend ("the stipend is too little to ask for a student to work full-time"), and the quality of students applying to the program.

Mentors were asked to identify the three most important strengths of URAP in another open-ended questionnaire item. The 25 mentors who responded included a variety of program strengths. The most frequently described URAP strength (mentioned in 23 comments) was apprentices' opportunities to gain laboratory experience and work on real-world research problems. Other strengths noted included the opportunity for apprentices to work independently (mentioned in 7 comments), the experience of working in teams (mentioned in 7 comments), the learning apprentices experience (mentioned in 7 comments), the mentor-apprentice relationship (mentioned in 6 comments), and the career information apprentices gain during URAP (mentioned in 5 comments).

The questionnaire also asked mentors to note three ways in which URAP should be improved for future participants. The 23 mentors who responded offered a variety of suggestions. The most commonly mentioned suggestions were to provide opportunities for apprentices to present their research (mentioned in 9 comments), and suggestions for a longer program and/or more program opportunities throughout the year (mentioned in 5 comments). Other suggestions (mentioned in 4 or fewer comments) included increasing the apprentice stipend, providing travel funds for apprentices, providing visits to DoD labs, instituting a more rigorous selection process, providing more writing opportunities for students, and modifying the application/contracting process (for example, starting earlier to ensure timely funding, having earlier acceptance for apprentices, and having a later application deadline).

Overall, apprentices and mentors expressed high levels of satisfaction with their URAP experiences. Apprentices and mentors particularly valued apprentices' laboratory experiences and exposure to real world research. Furthermore, there is evidence that apprentices actively engage in in STEM practices during URAP in ways not typically available to them in their school experiences. The data suggest that URAP mentors employ evidence-based mentoring strategies that enhance apprentices' learning experiences and result in productive apprentice-mentor relationships.

7 | Actionable Program Evaluation

The evaluation of URAP included measurement of several outcomes relating to AEOP and program objectives, including impacts on apprentices' STEM knowledge and skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes toward research, and knowledge of and interest in participating in additional AEOP opportunities.[8] STEM competencies include foundational knowledge, skills, and abilities in STEM, coupled with the confidence to apply them appropriately. These competencies 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 URAP included apprentices' 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.

STEM Knowledge and Skills

When asked to rate the impacts of URAP on their STEM knowledge, more than 80% of apprentices reported medium or large gains in each area (Table 32). Large majorities of apprentices reported medium or large gains in areas such as knowledge of what everyday research work is like in STEM (88%), knowledge of what everyday research work is like in STEM (88%), and knowledge of research conducted in a STEM topic or field (85%).

[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.

Table 32. Apprentice Report of Impact on STEM Knowledge (n=32)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	9.4%	9.4%	21.9%	59.4%	
	3	3	7	19	**32**
Knowledge of research conducted in a STEM topic or field	6.3%	9.4%	18.8%	65.6%	
	2	3	6	21	**32**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.1%	12.5%	21.9%	62.5%	
	1	4	7	20	**32**
Knowledge of how scientists and engineers work on real problems in STEM	3.1%	12.5%	21.9%	62.5%	
	1	4	7	20	**32**
Knowledge of what everyday research work is like in STEM	3.1%	9.4%	21.9%	65.6%	
	1	3	7	21	**32**

A composite score[8] was calculated for this set of five STEM Knowledge items[9]. Response categories were converted to a scale of 1 = "No gain" to 4 = "Large gain" and the average across all items in the scale was calculated. The composite scores were used to determine whether there were differences in apprentice experiences by gender and race/ethnic group (minority vs. non-minority apprentices). No statistically significant differences by gender or race/ethnicity were found.

Apprentices were asked to report on their gains in STEM competencies as a result of their participation in URAP (Table 33). Over three-quarters (75% - 84%) of apprentices reported medium to large gains for all items. For example, large majorities of apprentices reported medium or large gains in designing procedures for an experiment (84%), carrying out procedures for an experiment and recording data accurately (84%), communicating about experiments in different ways (84%), and supporting an explanation for an observation with an experiment (84%). The STEM Competency items were combined into a composite variable[10] to test for differential impacts across subgroups of apprentices. There were no significant differences between minority

[8] 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.

[9] The Cronbach's alpha reliability is 0.904 for these 5 items.

[10] The Cronbach's alpha reliability for these 10 items was .954.

and non-minority apprentices. However, males reported significantly greater gains across STEM competency items compared to females (large effect size; d = 1.16)[11].

Table 33. Apprentices Reporting Gains in Their STEM Competencies (n=32)

	No gain	Small gain	Medium gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	6.3%	18.8%	34.4%	40.6%	
	2	6	11	13	**32**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	6.3%	18.8%	18.8%	56.3%	
	2	6	6	18	**32**
Making a model of an object or system showing its parts and how they work	3.1%	18.8%	21.9%	56.3%	
	1	6	7	18	**32**
Designing procedures for an experiment that are appropriate for the question to be answered	3.1%	12.5%	31.3%	53.1%	
	1	4	10	17	**32**
Identifying the limitations of the methods and tools used for data collection	0.0%	18.8%	31.3%	50.0%	
	0	6	10	16	**32**
Carrying out procedures for an experiment and recording data accurately	0.0%	15.6%	34.4%	50.0%	
	0	5	11	16	**32**
Using computer models of objects or systems to test cause and effect relationships	6.3%	18.8%	31.3%	43.8%	
	2	6	10	14	**32**
Organizing data in charts or graphs to find patterns and relationships	6.3%	15.6%	12.5%	65.6%	
	2	5	4	21	**32**
Considering different interpretations of data when deciding how the data answer a question	6.3%	15.6%	15.6%	62.5%	
	2	5	5	20	**32**
Supporting an explanation for an observation with data from experiments	9.4%	6.3%	28.1%	56.3%	
	3	2	9	18	**32**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	6.3%	18.8%	34.4%	40.6%	
	2	6	11	13	**32**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	6.3%	18.8%	18.8%	56.3%	
	2	6	6	18	**32**
Defending an argument that conveys how an explanation best describes an observation	3.1%	18.8%	21.9%	56.3%	
	1	6	7	18	**32**

[11] Independent Samples t-test results for gender differences in STEM competencies: $t(27)=3.01$, p=.006.

	No gain	Small gain	Medium gain	Large gain	Response Total
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	3.1%	12.5%	31.3%	53.1%	
	1	4	10	17	**32**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	0.0%	18.8%	31.3%	50.0%	
	0	6	10	16	**32**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	0.0%	15.6%	34.4%	50.0%	
	0	5	11	16	**32**

Apprentices were also asked to rate the impact of URAP on their "21st Century Skills" – those skills that are necessary across a wide variety of fields (Table 34). More than three-quarter of apprentices reported medium to large gains on all items associated with their 21st Century Skills. For example, large majorities of apprentices reported medium or large gains in making changes when things do not go as planned (97%), and setting goals and reflecting on performance (94%). Items from the 21st century skills section of the survey were combined into a composite variable[12]. Apprentices reported similarly high levels of gains in their 21st Century Skills regardless of their gender or race/ethnicity.

[12] The Cronbach's alpha reliability was .858 for the 8 items in the 21st Century Skills set.

Table 34. Apprentice Reports of Impacts on 21st Century Skills (n=32)

	No gain	Small gain	Medium gain	Large gain	Response Total
Learning to work independently	3.1%	9.4%	28.1%	59.4%	
	1	3	9	19	**32**
Setting goals and reflecting on performance	3.1%	3.1%	40.6%	53.1%	
	1	1	13	17	**32**
Sticking with a task until it is finished	3.1%	6.3%	25.0%	65.6%	
	1	2	8	21	**32**
Making changes when things do not go as planned	0.0%	3.1%	28.1%	68.8%	
	0	1	9	22	**32**
Working well with people from all backgrounds	6.3%	15.6%	15.6%	62.5%	
	2	5	5	20	**32**
Including others' perspectives when making decisions	6.3%	18.8%	18.8%	56.3%	
	2	6	6	18	**32**
Communicating effectively with others	0.0%	15.6%	25.0%	59.4%	
	0	5	8	19	**32**
Viewing failure as an opportunity to learn	3.1%	6.3%	28.1%	62.5%	
	1	2	9	20	**32**

A new component of the evaluation in FY17 for URAP 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 Unite program. The assessment tool can be found in the Appendix (Section 3 of this report). Mentors rated each participant's skills in six domains of 21st Century Skills:

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

Mentors were asked in the pilot to assess their participants in each of the domains that they felt applied to the work apprentices had completed with them over the course of the program. As a result, between 4 and 19 apprentices were assessed for 24 skills related to each of the six areas. Table 35 presents an overall summary of the findings for each of the six domains of 21st Century Skills. These are presented graphically in Figure 2. Table 36 presents findings for each of the 24 specific skills associated with the six areas of 21st Century Skills.

Overall Findings

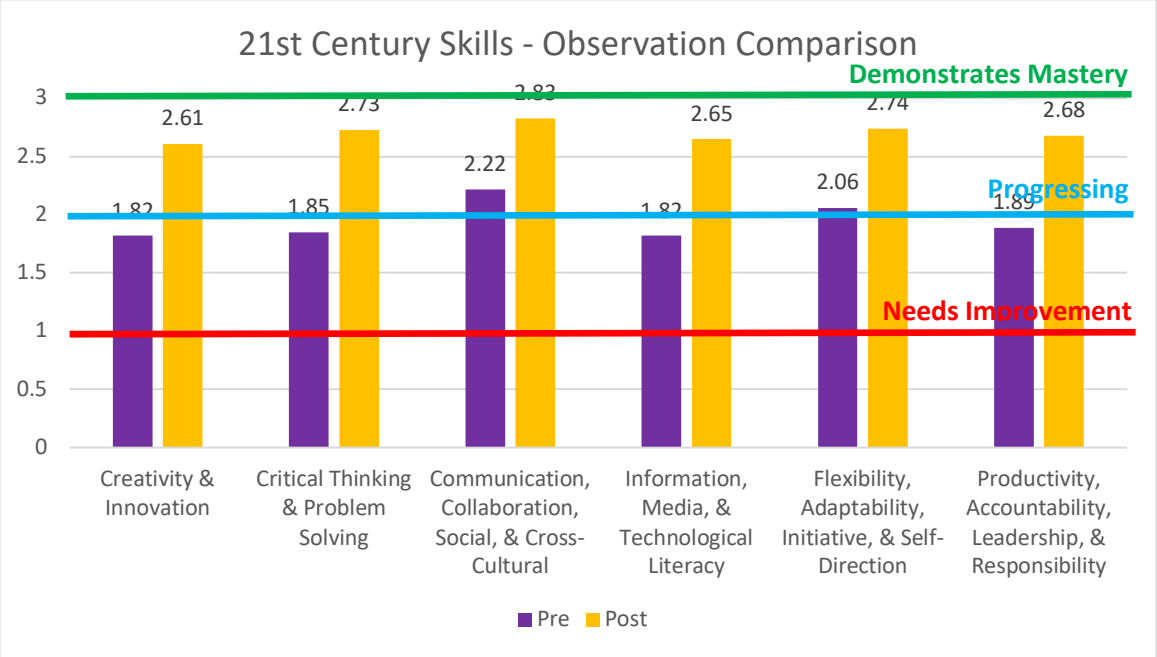
Significant increases were found from pre-post (p<.001) assessment in all skill sets (see Table 35). The skill set of Creativity and Innovation showed the most growth for apprentices. Chart 2 shows that, on average, students were rated slightly above or approaching the Progressing level and their skills increased to an approaching Demonstrates Mastery level (approximately 2.50) or higher by the end of their program.

Table 35. Overall 21st Century Skill Set Observation Pre-Post Results

Skill Set	*n*	Assessment Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	19	1.82(.59)	2.61(.41)	+0.79	6.93***
Critical Thinking & Problem Solving	17	1.85(.43)	2.73(.31)	+0.88	11.45***
Communication, Collaboration, Social, & Cross-Cultural	18	2.22(.49)	2.83(.29)	+0.61	5.04***
Information, Media, & Technological Literacy	17	1.82(.58)	2.65(.46)	+0.83	6.36***
Flexibility, Adaptability, Initiative, & Self-Direction	18	2.06(.50)	2.74(.25)	+0.68	7.21***
Productivity, Accountability, Leadership, & Responsibility	17	1.89(.51)	2.68(.27)	+0.79	6.22***

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 Observation Pre-Post Comparison with Criteria Indicators



Findings by Specific Skills Observed

Table 36 shows findings for specific skills assessed by overall skill set. All of the 24 specific skills observed showed an increase from pre-post observation (100%). Furthermore, all but two of the 24 specific skills observed (91.7%) significantly increased from pre-post observation. While all of apprentices' 21st Century Skills improved over time, the skills associated with creativity, communication, and critical thinking/problem solving saw the largest increases from pre-post observation.

Table 36. Overall 21st Century Skill Set Assessment Pre-Post Results

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time Pre - *M*(*SD*)	 Post - *M*(*SD*)	Pre-Post Change	*t*-stat
Creativity & Innovation					
Think creatively	16	1.88(.72)	2.63(.50)	+0.75	4.39***
Work creatively with others	17	1.82(.64)	2.71(.47)	+0.88	6.06***
Implement innovations	14	1.93(.62)	2.64(.50)	+0.71	5.70***
Critical Thinking & Problem Solving					
Reason effectively	14	2.07(.62)	2.79(.43)	+0.71	4.37***
Use systems thinking	14	1.64(.50)	2.71(.47)	+1.07	8.45***
Make judgments and decisions	14	1.86(.53)	2.86(.36)	+1.00	9.54***
Solve problems	13	1.92(.28)	2.77(.44)	+0.85	8.12***
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	19	2.32(.58)	2.89(.32)	+0.58	4.16***
Communicate with others	15	2.20(.68)	2.87(.35)	+0.67	3.57**

Interact effectively with others	14	2.14(.66)	2.79(.43)	+0.74	3.23**
Information, Media, & Technological Literacy					
Access and evaluate information	16	1.81(.75)	2.63(.50)	+0.66	4.96***
Use and manage information	13	1.92(.64)	2.62(.51)	+0.63	3.96**
Analyze media	5	1.80(.45)	2.60(.55)	+0.45	4.00**
Create media products	4	2.00(.82)	2.75(.50)	+0.96	1.57
Apply technology effectively	11	2.09(.70)	2.82(.40)	+0.65	3.73**
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	11	2.18(.60)	2.64(.50)	+0.45	2.89
Be flexible	16	2.25(.68)	2.81(.40)	+0.56	3.58**
Manage goals and time	16	2.06(.68)	2.69(.48)	+0.63	3.48**
Work independently	18	2.00(.59)	2.78(.43)	+0.78	6.02***
Be a self-directed learner	16	1.88(.81)	2.69(.48)	+0.81	4.33***
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	14	1.79(.70)	2.71(.47)	+0.93	4.76***
Produce results	16	1.88(.62)	2.69(.48)	+0.81	4.33***
Guide and lead others	10	2.00(.67)	2.70(.48)	+0.70	3.28**
Be responsible to others	14	2.14(.66)	2.64(.50)	+0.50	2.19*

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

STEM Identity and Confidence

Since STEM identity, or seeing oneself as capable of succeeding in STEM, has been linked to future interest and participation in STEM as a field of study and career choice,[12] URAP and other programs in the AEOP portfolio emphasize supporting participants' STEM identities. Because of this, the apprentice survey included a series of items intended to measure URAP's impact on apprentices' STEM identities (Table 37). Nearly three-quarters or more (72% - 88%) of apprentices reported medium or large gains on all items associated with STEM identity. For example, large majorities of apprentices reported at least medium gains on their confidence to try out new ideas or procedures on their own in a STEM project (88%) and their desire to build relationships with mentors who work in STEM (88%). These items were also combined into a composite variable. There were no differences in impact based on gender or race/ethnicity[13].

[12] 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.

[13] The Cronbach's alpha reliability for the 8 items in the STEM Identity set was 0.904.

Table 37. Apprentice Report of Impacts on STEM Identity (n=32)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	0.0%	18.8%	37.5%	43.8%	
	0	6	12	14	**32**
Deciding on a path to pursue a STEM career	6.3%	15.6%	31.3%	46.9%	
	2	5	10	15	**32**
Sense of accomplishing something in STEM	3.1%	15.6%	25.0%	56.3%	
	1	5	8	18	**32**
Feeling prepared for more challenging STEM activities	3.1%	12.5%	18.8%	65.6%	
	1	4	6	21	**32**
Confidence to try out new ideas or procedures on my own in a STEM project	0.0%	12.5%	31.3%	56.3%	
	0	4	10	18	**32**
Patience for the slow pace of STEM research	6.3%	21.9%	21.9%	50.0%	
	2	7	7	16	**32**
Desire to build relationships with mentors who work in STEM	3.1%	9.4%	21.9%	65.6%	
	1	3	7	21	**32**
Connecting a STEM topic or field to my personal values	0.0%	15.6%	28.1%	56.3%	
	0	5	9	18	**32**

Interest and Future Engagement in STEM

Another key goal of the AEOP is to develop a STEM-literate citizenry. In order to examine the impact of URAP on apprentices' interest in future engagement in STEM, the questionnaire asked them to reflect on whether the likelihood of their engaging in STEM activities outside of typical school activities changed as a result of their URAP experiences (Table 38). Approximately two-thirds or more (63% - 91%) of apprentices reported being more likely or much more likely to participate in all activities. For example, apprentices reported being more, or much more, likely to work on a STEM project or experiment in a university or professional setting (91%), take a STEM elective (81%), and talk with family or friends about STEM (78%).

Table 38. Change in Likelihood Apprentices Will Engage in STEM Activities Outside of School (n=32)

	Much less likely	Less likely	About the same before and	More likely	Much more likely	Response Total

Watch or read non-fiction STEM	3.1%	0.0%	34.4%	40.6%	21.9%	
	1	0	11	13	7	**32**
Tinker (play) with a mechanical or electrical device	0.0%	0.0%	31.3%	31.3%	37.5%	
	0	0	10	10	12	**32**
Work on solving mathematical or scientific puzzles	0.0%	0.0%	34.4%	43.8%	21.9%	
	0	0	11	14	7	**32**
Use a computer to design or program something	0.0%	6.3%	25.0%	43.8%	25.0%	
	0	2	8	14	8	**32**
Talk with friends or family about STEM	0.0%	0.0%	21.9%	43.8%	34.4%	
	0	0	7	14	11	**32**
Mentor or teach other students about STEM	0.0%	3.1%	15.6%	43.8%	37.5%	
	0	1	5	14	12	**32**
Help with a community service project related to STEM	0.0%	0.0%	31.3%	40.6%	28.1%	
	0	0	10	13	9	**32**
Participate in a STEM camp, club, or competition	0.0%	3.1%	25.0%	37.5%	34.4%	
	0	1	8	12	11	**32**
Take an elective (not required) STEM class	3.1%	0.0%	15.6%	46.9%	34.4%	
	1	0	5	15	11	**32**
Work on a STEM project or experiment in a university or	3.1%	0.0%	6.3%	31.3%	59.4%	
	1	0	2	10	19	**32**

Apprentices reported similar gains in this area regardless of gender or race/ethnicity on the composite variable created from the Future Engagement in STEM items[14].

When asked how about their interest in participating in AEOPs in the future (Table 39), a majority of apprentices (63%) indicated being at least somewhat interested in participating in URAP again. Fewer apprentices reported interest in other programs, although 41% indicated they were at least somewhat interested in NDSEG and SMART. Relatively large proportions of apprentices reported not having heard of programs for which they are currently, or will soon be, eligible. For example, 50% had not heard of CQL, 63% had not heard of GEMS Near Peer Mentors, and 44% had not heard of NDSEG and SMART.

Table 39. Apprentice Interest in Future AEOP Programs (n=32)

	I've never heard of	Not at all	A little	Somewhat	Very much	Response Total

[14] The Cronbach's alpha reliability was .886 for these 10 items.

	this program					
College - College Qualified Leaders (CQL)	50.0%	6.3%	15.6%	12.5%	15.6%	
	16	2	5	4	5	32
College - Undergraduate Research Apprenticeship Program (URAP)	3.1%	9.4%	25.0%	12.5%	50.0%	
	1	3	8	4	16	32
College - Science Mathematics, and Research for Transformation (SMART) College Scholarship	43.8%	6.3%	9.4%	12.5%	28.1%	
	14	2	3	4	9	32
College - National Defense Science & Engineering Graduate (NDSEG) Fellowship	43.8%	9.4%	6.3%	12.5%	28.1%	
	14	3	2	4	9	32
High School and College - GEMS Near Peer Mentor Program	62.5%	12.5%	6.3%	9.4%	9.4%	
	20	4	2	3	3	32

In order to understand the usefulness of resources, apprentices were asked to rate the impact of various resources on their awareness of AEOPs (Table 40). Participating in the program (72%) and URAP mentors (72%) were most likely to be rated as impacting apprentices' awareness "somewhat" or "very much." More than half of participants (56%) indicated they had not experienced AEOP on social media while 31% had not experienced the AEOP brochure.

Table 40. Impact of Resources on Apprentice Awareness of AEOPs (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	18.8%	6.3%	25.0%	21.9%	28.1%	
	6	2	8	7	9	32
AEOP on Facebook, Twitter, Pinterest or other social media	56.3%	15.6%	21.9%	6.3%	0.0%	
	18	5	7	2	0	32
AEOP brochure	31.3%	15.6%	28.1%	15.6%	9.4%	
	10	5	9	5	3	32
My Apprenticeship Mentor	6.3%	12.5%	9.4%	21.9%	50.0%	
	2	4	3	7	16	32
Presentations or information shared through the Apprenticeship Program	18.8%	6.3%	31.3%	25.0%	18.8%	
	6	2	10	8	6	32

Participation in the Apprenticeship Program	9.4%	6.3%	12.5%	12.5%	59.4%	
	3	2	4	4	19	**32**

Attitudes toward DoD Research

Apprentices' attitudes about the importance of DoD research are an important prerequisite to their continued interest in the field and potential involvement in the future. In order to examine attitudes in this area, apprentices were asked to report their opinions of what DoD researchers do and the value of DoD research more broadly (Table 41). More than 80% of participants agreed or strongly agreed with all items in this section and no apprentices disagreed with any. For example, 91% agreed that DoD research is valuable to society and 88% agreed that DoD researchers solve real-world problems.

Table 41. Apprentice Opinions about DoD Researchers and Research (n=32)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	0.0%	12.5%	37.5%	50.0%	
	0	0	4	12	16	**32**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	15.6%	31.3%	53.1%	
	0	0	5	10	17	**32**
DoD researchers solve real-world problems	0.0%	0.0%	12.5%	40.6%	46.9%	
	0	0	4	13	15	**32**
DoD research is valuable to society	0.0%	0.0%	9.4%	37.5%	53.1%	
	0	0	3	12	17	**32**

Educational Aspirations

Apprentices were asked about their educational aspirations after participating in URAP (Table 42). All apprentices indicated they wanted to earn Bachelor's degree, and a large majority (91%) reported aspiring to earn a graduate degree (master's or higher) after their URAP experiences. Over a third (34%) reported that they aspired to a Ph.D.

Table 42. Apprentice Education Aspirations After URAP (n=32)

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)	3.13 %	1
Get more education after college	6.25 %	2
Get a master's degree	28.13 %	9
Get a Ph.D.	34.38 %	11
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	6.25 %	2
Get a combined M.D. / Ph.D.	15.63 %	5
Get another professional degree (law, business, etc.)	6.25 %	2

Overall Impact

Finally, apprentices were asked to report the impacts of participating in URAP on their confidence and interest in STEM, their awareness of and interest in participating in AEOPs in the future, and their awareness of and interest in STEM careers (Table 43). More than half of apprentices (57% - 88%) agreed that URAP contributed or was the primary reason for gains in each area. For example, large majorities of apprentices indicated that URAP resulted in increases in their confidence in STEM knowledge, skills, and abilities (88%) and their interest in participating in other AEOPs (88%). Over half reported that participating in URAP increased their awareness of DoD STEM careers (72%), interest in pursuing STEM careers (63%), and interest in pursuing DoD STEM careers (69%).

Table 43. Apprentice Opinions of URAP Impacts (n=32)

	Disagree - This did not happen	Disagree - This happened but not	Agree - URAP contributed	Agree - URAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	0.0%	12.5%	65.6%	21.9%	
	0	4	21	7	**32**
I am more interested in participating in STEM activities outside of school	3.1%	12.5%	68.8%	15.6%	
	1	4	22	5	**32**
I am more aware of other AEOPs	15.6%	0.0%	53.1%	31.3%	
	5	0	17	10	**32**
I am more interested in participating in other AEOPs	9.4%	3.1%	59.4%	28.1%	
	3	1	19	9	**32**
I am more interested in taking STEM classes in school	0.0%	31.3%	59.4%	9.4%	
	0	10	19	3	**32**
I am more interested in earning a STEM degree	0.0%	43.8%	43.8%	12.5%	
	0	14	14	4	**32**

I am more interested in pursuing a career in STEM	3.1%	34.4%	50.0%	12.5%	
	1	11	16	4	**32**
I am more aware of Army or DoD STEM research and careers	21.9%	6.3%	46.9%	25.0%	
	7	2	15	8	**32**
I have a greater appreciation of Army or DoD STEM research	6.3%	9.4%	53.1%	31.3%	
	2	3	17	10	**32**
I am more interested in pursuing a STEM career with the Army or DoD	15.6%	15.6%	46.9%	21.9%	
	5	5	15	7	**32**

A composite score was created from the overall impact items[15] and no significant differences were found by gender or race/ethnicity.

Overall, outcomes data suggest that URAP apprentices' experiences impacted them positively in several areas. Apprentices not only experienced growth in their STEM learning, skills, and identities, but both mentors and apprentices reported that apprentices grew in their 21st Century Skills during their URAP experiences. Apprentices had increased interest in other AEOPs, DoD STEM careers, and were more likely to engage in STEM activities after participating in URAP.

[15] Cronbach's alpha for the 10 Overall Impact items was 0.872.

8 | Findings and Recommendations

Summary of Findings

The 2017 evaluation of URAP collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 44.

Table 44. 2017 URAP Evaluation Findings	
Participant Profiles	
URAP continues to serve students from groups traditionally underrepresented and underserved in STEM.	A substantial percentage of enrolled apprentices (44%) attended Historically Black Colleges and Universities or other Minority Serving institutions (HBCUs/MSIs). Seventeen of the 39 participating institutions were HBCUs/MSIs, an increase from the 14 HBCUs/MSIs that participated in 2016.
	Over half (53%) of apprentice were White, a slight decrease from 2016 when 58% were White. The program also served students from racial/ethnic groups historically underserved and underrepresented in STEM fields. Of the 59 apprentices, 8% were Black or African American (compared to 10% in 2016) and 15% were Hispanic or Latino (compared to 13% in 2016). Nearly a quarter (24%) of apprentices met the AEOP definition of underserved students.
URAP received a substantially larger number of applications than in 2016 and exceeded its 2017 goal for apprentice enrollment.	URAP surpassed its 2017 goal of 55 apprentice participants, enrolling a total of 59 apprentices (a 12% increase compared to the 52 apprentices enrolled in 2016). These apprentices were selected from among 239 applicants, a 25% increase from 2016 when 177 applications were received.
Actionable Program Evaluation	
URAP apprentices learned about AEOP in a variety of ways	The most frequently mentioned way that participants learned about URAP and/or AEOP was someone who works at a school or university apprentice attends (57%). Other sources mentioned relatively frequently were someone who works with the program (23%), and a school or university newsletter, email, or website (20%).
URAP participants were motivated to participate by the opportunities to gain experience and learn.	The most common motivators for participating in URAP were related to STEM interest and learning, including the desire to learn something new or interesting (93%) and interest in STEM (93%). A large majority of apprentices also reported being motivated to participate in URAP because of the laboratory experience, including the opportunity to use advanced laboratory technology (87%) and desire to expand laboratory or research skills (80%).
URAP apprentices learned about STEM careers, both in general and, to a lesser extent, within the DoD, during their apprenticeships.	A large majority of apprentices (81%) reported learning about at least one STEM job during URAP, and 38% reported learning about 4 or more. Although 72% of apprentices reported being more aware of DoD STEM careers as a result of URAP, fewer apprentices reported hearing about STEM careers within the DoD during their apprenticeships, with half (50%) learning about no DoD STEM jobs or careers, and half (50%) reporting that they learned about at least one. Only 22% of apprentices reported hearing about 4 or more DoD STEM jobs or careers during URAP.

	Approximately half or more of apprentices indicated that participation in URAP (56%) and presentations or information shared during URAP (50%) were at least somewhat helpful in informing them about DoD STEM careers. Nearly half (47%) reported that their mentors were at least somewhat helpful for this purpose.
	A large majority of mentors (86%) indicated that participation in URAP somewhat or very much useful to inform students about DoD STEM careers. Other resources reported frequently as being at least somewhat useful included the AEOP website (62%) and the program administrator or site coordinator (62%). More than half of mentors reported that they did not experience AEOP social media (68%).
URAP apprentices engaged in a variety of STEM practices and reported significantly higher levels of engagement in STEM practices in URAP as compared to their typical school experiences.	Apprentices reported engaging in a wide array of STEM practices while in URAP. The practices most frequently engaged in (weekly or every day) included interacting with STEM researchers (91%) and identifying questions or problems to investigate (91%). Over half of apprentices reported that they did not present their STEM research to a panel of judges from industry or the military (69%) and over a third reported that they did not building a computer model (38%). Students reported significantly higher STEM Engagement while in URAP over school (effect size is large with d = 0.75).
URAP mentors used strategies to establish the relevance of the apprenticeship with students' backgrounds.	Mentors helped make learning activities relevant to students by using strategies such as becoming familiar with their students' backgrounds and interests at the beginning of URAP (94%) and giving students real-life problems to investigate (85%). Approximately two-thirds or more (65% - 94%) of mentors reported using each strategy to establish the relevance of learning activities in URAP.
Mentors utilized strategies to support diversity and grow apprentice understanding of issues regarding underrepresentation in STEM areas.	Mentors supported the diverse needs of students as learners by using strategies such as using a variety of teaching and/or mentoring activities to meet needs of all students (94%) and directing students to other individuals or programs for additional support as needed (91%). Nearly two-thirds of mentors (65%) reported highlighting the underrepresentation of women and racial and ethnic minority population in STEM; this is an increase in the use of this strategy compared to past years (38% in 2015; 46% in 2016). Nearly two-thirds or more (65% - 91%) of responding mentors also reported using all strategies related to supporting the diverse needs of students as learners.
Mentor reported use of strategies to develop collaboration and other skills as well as engaging students in authentic STEM activities was frequent.	Mentors supported students' development of collaboration and interpersonal skills by using strategies such as having students work on collaborative activities as a member of a team (94%), having students listen to the ideas of others with an open mind (91%), and having students explain difficult ideas to others (91%). More than three-quarters (77% - 91%) of mentors reported using all strategies presented in this domain. Mentors supported students' engagement in authentic STEM activities by using strategies such as supervising their students while they practiced STEM research skills (97%), and providing their students with constructive feedback to improve their STEM competencies (97%). Nearly all (88% - 94%) mentors

	indicated they used all strategies to support student engagement in authentic STEM activities.
Mentors reported frequent use of strategies to develop apprentice career aspirations and to learn more about DoD STEM careers.	Mentors supported students' STEM educational and career pathways by using strategies such as asking their students about their educational and/or career goals (97%) and providing guidance about educational pathways that will prepare students for a STEM career (94%). Fewer mentors (56%) reported using strategies such as recommending AEOPs that align with students' goals and recommending extracurricular programs that align with students' goals. There was, however, an increase in the use of strategies related to communicating with apprentices about AEOP and DoD STEM career opportunities as compared to 2016. In 2016, only 39% of mentors recommended other AEOP programs to apprentices while 56% did so in 2017. Likewise, in 2016 a little more than half of the responding mentors (57%) reported discussing STEM careers within the DOD or government with apprentices, while nearly three-quarters (74%) reported doing this in 2017.
Apprentices reported high levels of satisfaction with their experience in URAP.	Approximately two-thirds or more of apprentices indicated being "somewhat" or "very much" satisfied with all URAP features about which they were asked. All apprentices were at least somewhat satisfied with the physical location of URAP (100%), and nearly all were at least somewhat satisfied with their communication with their host site organizers (97%). Approximately 85% or more of apprentices indicated they were somewhat or very much satisfied with all aspects of their mentor relationships, suggesting that strong mentor-apprentice relationships are built in URAP. For example, 97% of apprentices were at least somewhat satisfied with their working relationship with their mentors, and 91% with the amount of time they spent with their mentors. Apprentices also reported high levels of satisfaction with other components of their research experiences. For example, 94% were at least somewhat satisfied with their research experience overall and 91% with the amount of time they spent doing meaningful research.
Mentors reported high levels of satisfaction with their experience in URAP.	Two-thirds or more (68% - 94%) of mentors reported being somewhat or very much satisfied with all features with the exception of communication with AAS (56% had not experienced this; 35% were at least somewhat satisfied). Nearly all mentors were at least somewhat satisfied with features such as the research abstract preparation requirements (94%), the application or registration process (91%), and support for instruction or mentorship during program activities (91%). Few mentors expressed dissatisfaction with any URAP program features, although 3 mentors (9%) indicated that they were "not at all" satisfied with stipends.
Apprentices and mentors had some suggestions for improving URAP.	Apprentices' most commonly suggested areas of improvements included: communication with the program, including general suggestions for better communication, more information about the apprenticeship requirements, and more information about AEOP; improvements to stipends, including suggestions for larger stipends, more frequent payment, and on-time payment of stipends; and mentors, including suggestions that mentors be more available, that mentors complete progress reports for apprentices, that

	there be more diverse research interests represented among mentors, and that mentors be better prepared for apprentices prior to their arrival. Mentors' most commonly suggested improvements included providing opportunities for apprentices to present their research and suggestions for a longer program and/or more program opportunities throughout the year.
Outcomes Evaluation	
URAP had a positive impact on apprentices' STEM knowledge and competencies, with males reporting higher gains in STEM competencies than females.	More than 80% of apprentices reported medium or large gains in each area (of STEM knowledge. Large majorities of apprentices reported medium or large gains in areas such as knowledge of what everyday research work is like in STEM (88%), knowledge of what everyday research work is like in STEM (88%), and knowledge of research conducted in a STEM topic or field (85%). Over three-quarters (75% - 84%) of apprentices reported medium to large gains for all areas of STEM competencies. For example, large majorities of apprentices reported medium or large gains in designing procedures for an experiment (84%), carrying out procedures for an experiment and recording data accurately (84%), communicating about experiments in different ways (84%), and supporting an explanation for an observation with an experiment (84%). Males reported significantly greater gains across STEM competency items compared to females (large effect size; d = 1.16).
URAP apprentices demonstrated observable gains in their 21st Century Skills, and apprentices self-reported growth in these skills.	Participants in URAP demonstrated significant gains in their 21st Century Skills assessment from pre-to post as assessed by their mentors in the domains of Creativity & Innovation (0.79 gain); Critical Thinking and Problem Solving (0.88 gain); Communication, Collaboration, Social and Cross-Cultural skills (0.61 gain); Flexibility, Adaptability, Initiative, and Self-Direction (0.68 gain), and Productivity, Accountability, Leadership, and Responsibility (0.79 gain). These findings were also supported by apprentice self-reports on the questionnaire. More than three-quarter of apprentices reported medium to large gains on all items associated with their 21st Century Skills. For example, large majorities of apprentices reported medium or large gains in making changes when things do not go as planned (97%), and setting goals and reflecting on performance (94%).
URAP apprentices experienced gains in their STEM identities and confidence as a result of their apprenticeship experiences.	Nearly three-quarters or more (72% - 88%) of apprentices reported medium or large gains on all items associated with STEM identity. For example, large majorities of apprentices reported at least medium gains on their confidence to try out new ideas or procedures on their own in a STEM project (88%) and their desire to build relationships with mentors who work in STEM (88%).
URAP apprentices were more likely to engage in STEM activities outside of regular school activities as a result of their apprenticeship experiences.	Approximately two-thirds or more (63% - 91%) of apprentices reported being more likely or much more likely to participate in all STEM activities about which they were asked. For example, apprentices reported being more, or much more, likely to work on a STEM project or experiment in a university or professional setting (91%), take a STEM elective (81%), and talk with family or friends about STEM (78%).

Apprentices expressed interest in participating in AEOPs in the future, although many had not heard of AEOPs for which they currently are or will soon be eligible.	A large majority of apprentices (88%) reported being more interested in participating in other AEOPs in the future, and a majority of apprentices (63%) indicated being at least somewhat interested in participating in URAP again. Fewer apprentices reported specific interest in other programs, although 41% indicated they were at least somewhat interested in NDSEG and SMART. In spite of the fact that a large majority of apprentices (84%) reported being more aware of other AEOPs after URAP, relatively large proportions of apprentices reported not having heard of programs for which they are currently, or will soon be, eligible. For example, 50% had not heard of CQL, 63% had not heard of GEMS Near Peer Mentors, and 44% had not heard of NDSEG and SMART.
URAP participation and mentors were the most useful resources for apprentices to learn about AEOPs, however few mentors discussed specific AEOPs with their apprentices.	Participating in URAP (72%) and URAP mentors (72%) were most likely to be rated as impacting apprentices' awareness of AEOPs "somewhat" or "very much." More than half of participants (56%) indicated they had not experienced AEOP on social media while 31% had not experienced the AEOP brochure.
	Over three-quarters (77%) of mentors discussed AEOP with their apprentices, but without reference to any specific program. Of the programs, which were explicitly discussed, the most commonly mentioned was NDSEG (discussed by 32% of mentors), followed by SMART (discussed by 24% of mentors).
	Mentors reported that participation in URAP was the most useful resource for exposing apprentices to AEOPs (91% reported that this was somewhat or very much useful). Mentors also indicated the URAP Program administrator or site coordinator was at least somewhat useful for exposing apprentices to AEOPs (71%). More than half of mentors reported that they did not experience AEOP on social media (71%) and over a third (35%) had not experienced the AEOP brochure.
URAP apprentices had positive opinions about DoD research and DoD researchers.	A large majority (84%) of apprentices reported that they had a greater appreciation of Army or DoD STEM research as a result of their URAP apprenticeships.
	More than 80% of participants agreed or strongly agreed with various positive statements about DoD STEM research and researchers. For example, 91% agreed that DoD research is valuable to society and 88% agreed that DoD researchers solve real-world problems.
URAP positively impacted apprentices' aspirations for STEM careers and education.	A large majority (91%) of apprentices reported aspiring to earn a graduate degree (master's or higher) after their URAP experiences, and over a third (34%) reported that they aspired to a Ph.D. after URAP. Over half (57%) reported being more interested in earning a STEM degree after URAP. Over half (63%) of apprentices reported being more interested in pursuing a career in STEM after URAP and 69% indicated that they were more interested in pursuing a STEM career with the Army or DoD as a result of their URAP experiences.

Responsiveness to FY17 Evaluation Recommendations

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

FY16 Finding: AEOP objectives include expanding participation of historically underrepresented and underserved populations. URAP has made some progress in this area, as it was noted as an area for improvement, particularly in recruiting female mentors, in the FY16 evaluation report. Between 2014 and 2016, URAP has engaged more female mentors, which is a positive trend. Future marketing efforts could focus on the need for a more diverse pool of STEM professionals, and take the opportunity to showcase the diversity of mentors in electronic and printed materials.

URAP FY17 Efforts and Outcomes: The number of HBCU/MSI universities participating in URAP in FY17 is 19, an increase of 11 from FY16. The apprenticeship flyer has been updated and reflects more diversity, and will be distributed in FY18. Initial meetings have been held with ARO program managers to assist in this effort.

FY16 Finding: A second area that was noted for improvement in FY14 and FY15 was the need to focus more on recruiting students from underrepresented populations. Similar to past years in URAP, recruitment of apprentices is largely accomplished with personal interactions, either by knowing a professor, peer who attended URAP previously, using professional or academic connections, or mechanisms available to the university or college site. However, in 2016 there was a slight increase in recruitment through websites, which is promising in encouraging a more diverse apprentice pool. It should be noted that URAP was successful in recruiting more Historically Black Colleges and Universities and other Minority Serving Institutions as research sites. Continued efforts in recruiting mentors from HBCUs and MSIs in addition to maintaining communications through websites could offer more diversity in the future.

URAP FY17 Efforts and Outcomes: The apprenticeship flyer has been updated and reflects more diversity, and will be distributed in FY18. Initial meetings have been held with ARO program managers to assist in this effort.

FY16 Finding: Only a few mentors were aware of specific AEOP programs and even fewer mentors explicitly discussed other AEOP opportunities with their apprentices. This lack of awareness is a barrier in communicating about other AEOP opportunities. It would be beneficial to create a resource that profiles AEOP opportunities and the relationship they have to ongoing education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about AEOP programs and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific AEOP opportunities.

URAP FY17 Efforts and Outcomes: Approximately 300 universities posted apprenticeship opportunities on career assistance pages for all apprenticeship programs. Program specific mentor assistance in this effort will enhance mentor recruitment efforts.

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

FY16 Finding: URAP is very effective in giving apprentices authentic opportunities to engage in STEM professional activities, and for mentors to build the next generation of STEM professionals. Given the goal of exposing apprentices to Army/DoD STEM research and careers, the program may want to build in systematic opportunities to provide this information to their apprentices. Most of the apprentices who completed the survey reported that they did not learn about any DoD STEM jobs/careers during URAP. In an effort to increase and standardize the information provided to apprentices, it would be beneficial to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about Army STEM careers and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific Army/DoD STEM research and careers.

URAP FY17 Efforts and Outcomes: A DoD STEM Career flyer was created in FY16, and updated in FY17. The flyer was sent to mentors and students with website links and descriptions of career opportunities. Mentors and students participated in a newly created DoD STEM Career webinar to gain first-hand knowledge from Army scientists and researchers.

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

FY16 Finding: Efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the apprentice and mentor questionnaires raise questions about the representativeness of the results. Low response rates were also a concern during the 2013, 2014, 2015 and 2016 questionnaire administration. The evaluation instruments may need to be streamlined as the questionnaires are quite lengthy (estimated response time 45 minutes) and response burden can affect participation. It is recommended that program sites provide time on-site for participants to complete the AEOP evaluation survey.

URAP FY17 Efforts and Outcomes: Several contacts were made to increase evaluation participation. Mentors were sent an email with a link to register for the 21st Century Skills Assessment webinar, which informed them on how to complete the 21st Century pre-and post-survey. The mentors were also sent calendar appointments and email reminders. Apprentices and mentors were also sent promotional materials with links to surveys in communications during the program.

Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that FY17 was a successful year for the URAP program. There was an increase in participation from 52 in FY16 to 59 apprentices in FY17. URAP had nearly 50% participation from HBCU/MSI sites (17 of 39) an increase of three sites from FY16. Participants and mentors reported their satisfaction with the program and apprentices reported growth in their STEM knowledge, interests, and competencies. Mentors indicated they consistently use innovative and research-based strategies to engage apprentices in STEM activities, and the apprentices similarly report increased ability to engage in STEM activities and have STEM habits of mind, due to the URAP experience. URAP participants increased their mastery of 21st Century Skills as assessed by their mentors during the FY17 program.

While the successes for URAP detailed above 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

1. AEOP Priority #1 is focused on growing the diversity of the pool of STEM talent in deep and meaningful ways. AEOP programs are charged with making this a primary focus of their recruitment and enrollment for the program. In FY17, the URAP program had only 24% of participants that were from underrepresented groups as defined by the AEOP. Additionally, while participation of White students decreased slightly, African American participation decreased by 2% (8% of total in FY17) while Hispanic/Latino apprentices grew to 15% in FY17 (from 13% in FY16). It is recommended that URAP invest considerable effort in FY18 in continuing to reach out to underrepresented populations to encourage their applications and participation in the program. It may be worthwhile to work with REAP, another AEOP apprentice program that has had great results in reaching diverse participant groups.

2. Findings from the FY16 evaluation suggested that URAP develop a resource for mentors to utilize to promote AEOP opportunities, as well as other resources within the DoD. It does not appear that URAP followed this guidance, as the only mention of activities aligned with this was having universities post apprenticeship opportunities on their career assistance pages, which isn't related at all. In FY17, mentors did not report going beyond discussing AEOP in general with

apprentices (77%). Only 32% of mentors discussed NDSEG and only 24% shared information about SMART. Therefore, it is again recommended that URAP (or apprenticeship programs collectively) develop tools for mentors to use to teach or inform their participants about AEOP programs including specific information on each opportunity.

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

In FY17, URAP apprentices and mentors both echoed findings that have been prevalent across the AEOP portfolio. Only a very few number of participants and mentors are accessing and/or utilizing AEOP social media, including the website. In regards to URAP, 68% of mentors and 56% of apprentices did not experience AEOP social media at all. Therefore, the evaluation team recommends that URAP work with the consortium members to determine a plan for the future utilization and marketing of AEOP social media and the website.

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

1. The FY17 evaluation findings indicate collective desire of the apprentices and mentors to improve communication across the program. This includes improving the delivery of information from the program leadership to the mentors and site directors, as well as information (program requirements, stipend payments, that is transmitted between AAS/ARO and the apprentices directly. It is recommended that AAS and ARO take steps to examine communication channels and determine how communication can be improved for URAP.

2. URAP participants were not made cognizant of other applicable AEOP opportunities during the program in FY17. In fact, 50% of URAP apprentices had not heard of CQL, the other college level apprenticeship program within AEOP. Further, less than 50% had been made aware of important scholarship programs including NDSG and SMART. It is strongly recommended that URAP work with their staff and the consortium to develop a plan for marketing and informing participants frequently about other AEOP opportunities and resources.