Army Educational Outreach Program

Research & Engineering Apprenticeship Program

2016 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

December 2016

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Report REAP_02_12072016 has been prepared to support 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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Executive Summary

REAP is a summer research apprenticeship program focused on the development of high school students' STEM competencies, with particular emphasis on groups historically underrepresented and underserved in STEM. For over 30 years, REAP has placed talented high school students in research apprenticeships at colleges and universities throughout the nation. Each REAP student (herein referred to as apprentice) are provided a minimum of 200 hours (over a 5 to 8 week period) of research experience under the direct supervision of a university scientist or engineer on a hands-on research project. REAP apprentices are exposed to the real world of research, gain valuable mentorship, and learn about education and career opportunities in STEM through a challenging STEM experience that is not readily available in high schools.

This report documents the evaluation of the FY16 REAP program. Purdue University, the evaluation lead, prepared the FY16 evaluation reports, which addressed questions related to program strengths and challenges, benefits to participants, and REAP's overall effectiveness in meeting AEOP and program objectives.

For FY16, there were 120 REAP apprentices at 42 different colleges and universities. This was a slight increase in participation of 3% from FY15 enrollment (117). The FY16 evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The evaluation plan for REAP was comprised of questionnaires for apprentices and mentors, interviews with apprentices and mentors, and review of the FY16 annual program data compiled by the Academy of Applied Science (AAS).

2016 REAP Fast Facts	
Major Participant Group	Rising 10th, 11th, and 12th grade high school students, rising first-year college students
Number of applications (Cvent)	487
Apprentices	120 (100 REAP, 20 UNITE/REAP)
Placement rate	25%
Mentors	121 (including one new mentor who trained with a veteran mentor)
Sites	48
Total Cost	$388,217
Total Stipends (apprentices & mentors)	$250,350
Cost Per Student Participant	$3,235

Summary of Findings

The FY16 evaluation of REAP collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to AEOP's and REAP's objectives and intended outcomes. A summary of findings is provided in the following table.

2016 REAP Evaluation Findings	
Participant Profiles	
REAP continues to have success in serving historically underrepresented and underserved populations.	REAP experienced continued success in recruiting female students at a high rate. In fact, 73% of participants in FY16 were female, a population that is historically underrepresented in STEM fields. There was an increase in female apprentices (from 61% in 2015) for REAP.
	REAP was very successful in meeting the program requirement of providing outreach to students from historically underrepresented and underserved groups as defined in admission requirements using the AEOP definition (students must self-identify as meeting at least two of the following requirements: qualifies for free or reduced-price lunch; is a minority historically underrepresented in STEM (Alaskan Native, Native American, Black or African American, Hispanic, Native Hawaiian, or other Pacific Islander); is a female pursuing research in physical science, computer science, mathematics, or engineering; receives special education services; has a disability; speaks English as a second language; or is a potential first-generation college student). There were a total of 120 apprentices involved in REAP and 73% of the apprentices were female. 46% of apprentices reported their race/ethnicity as African American, 16% Asian/Pacific Islander, 14% Hispanic, 3% Native American, 18% Caucasian, and 3% did not report race/ethnicity.
	REAP continued to implement the bridge with UNITE, another AEOP program that serves students from underrepresented and underserved groups. The percentage of REAP apprentices who have participated in UNITE continues to increase from 2013 to 2016.
REAP mentors are gradually becoming more diverse from year to year.	FY16 mentors were remained predominantly male (68%) and White (41%). However, this did represent a decrease in the percentage of White mentors overall from 2015 and from 2014.
	A comparison of apprentice and mentor demographics suggested that many apprentices of underserved or underrepresented populations are not likely to have mentors sharing the same gender or race/ethnicity. Having a mentor who shares an apprentice's gender or race/ethnicity is a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.
REAP apprentices tend to want to pursue higher education degrees after attending REAP.	Before their experience with REAP, most students were interested in obtaining a Bachelor's degree or higher. Overall the percentages shifted to the apprentices (see Table 25b) wanting to pursue terminal degrees, such as getting a Ph.D. (from 18% before REAP to 32% after REAP) and a combined M.D./Ph.D. (from 8% to 16%).
Actionable Program Evaluation	
REAP apprentices were recruited from a more diverse variety of sources, rather than only at the local level. REAP mentors	Mentors used a variety of methods to recruit apprentices. Many mentors indicated recruiting their apprentice(s) through applications from AAS or AEOP (38%), K-12 teachers at the local schools (34%), and informational materials sent to a K-12 setting (31%). About a quarter indicated colleagues from the workplace (22%). Communications from both a K-12 school (16%) and a university (16%) helped with

continue to learn about the program through personal contacts.	recruitment. About the same amount of students were recruited from organizations that serve underserved or underrepresented populations (16%), and STEM or STEM education conferences (16%).
	The most frequently mentioned source of information about the local REAP program was someone who works at the school or university (19%) followed by school or university newsletter, email, or website (17%) and someone who works with the program (17%). Other sources mentioned relatively frequently were the AEOP website (13%), and past participant (12%).
	The sources that the responding mentors most frequently identified were a supervisor or superior (41%), a colleague (38%), the AEOP website (22%) and a past REAP participant (16%). In 2015 33% of responding mentors stated AAS as a source for learning about REAP as compared to 9% in 2016.
REAP is strongly marketed to students from historically underrepresented and underserved groups.	The RFP specified to university directors/mentors that the targeted participants were underrepresented and underserved high school students. In addition, the REAP administrator worked with all of the directors and mentors to ensure that the students being considered for the apprenticeships identified as coming from an underrepresented and underserved groups.
Participation in REAP helps students identify knowledge and skills for STEM careers.	Some apprentices expressed interest in STEM-related careers both before and after participating in REAP. For example, 24% indicated aspiring to a career in engineering before REAP, with another 23% interested in medicine. After REAP, 31% of apprentices expressed interest in engineering, and 22% in medicine.
	All apprentices expect to use STEM somewhat in their career. A large majority (91%) expects to use STEM 75-100% of the time in their work, 4% expect to use STEM 51-75% of the time, and 5% expect to use STEM 26-50% of the time. None of the apprentices expected never to use STEM in their work at age 30
REAP apprentices engage in meaningful STEM learning through analyzing or interpreting data and carrying out investigations.	86% of responding apprentices indicated analyzing or interpreting data on most days or every day; 76% reported carrying out investigations; and 79% reported posing questions to investigate. In addition, apprentices indicated being integrally involved the work of STEM on most days or every day, including drawing conclusions from an investigation (75%), using laboratory procedures and tools (85%), and carrying out an investigation (76%). However, 61% of apprentices did not build or create a computer model.
REAP mentors are improving efforts to promote AEOP opportunities and DoD STEM careers and some resources to promote other AEOP opportunities are useful.	Participating in REAP was most likely to be rated as impacting their awareness of AEOP "somewhat" or "very much" (82%). Their mentor (66%) was also rated by a majority of apprentices as having at least somewhat of an impact on their awareness of AEOP programs, as well as the AEOP website (70%). This is a change from 2015, when the majority of apprentices did not report that the AEOP website impacted their awareness of AEOPs.
	Participation in REAP (72%), REAP Program administrator or site coordinator (59%), and the AEOP website (41%) were most often rated as "very much" useful. Invited speakers, It Starts Here! Magazine, or "career" events and AEOP social media tended not to be seen as very useful, with large proportions of mentors indicating they did not experience these resources.
Connections between REAP	The percentage (20%) of REAP apprentices who have participated in UNITE continues

and UNITE continue to grow stronger.	to increase from 2013 to 2016. This represents a continued increased attendance in UNITE by REAP apprentices since 2013.
The REAP program is highly valued by apprentices and mentors.	98% of apprentices were satisfied with the physical location of REAP, 95% were satisfied with the stipends, 97% were satisfied with the registration process, 94% were satisfied with communication with REAP organizers and 85% were satisfied by the variety of STEM topics offered in REAP.
	66% of mentors reported being very much satisfied with support for instruction during program activities, 60% were very much satisfied with communication with REAP organizers and the application process, and 56% were very much satisfied with research abstract preparation requirements.
Outcomes Evaluation	
REAP apprentices reported large or extreme gains in STEM knowledge and competencies.	Nearly all responding apprentices reported gains in their STEM knowledge as a result of the REAP program, with large majorities indicating large or extreme gains in each area. Large or extreme gains were reported by 84% of apprentices on their knowledge of research conducted in a STEM topic/field, and 73% on their knowledge of a STEM topic/field in depth. Similar impacts were reported on knowledge of how professionals work on real problems in STEM (86%), knowledge of what everyday research work is like in STEM (89%), and knowledge of research processes, ethics, and rules for conduct in STEM (76%).
	Apprentices reported large or extreme gains on their ability to support an explanation for an observation with data from experiments (74%), supporting an explanation with STEM knowledge (74%), integrating information from technical or scientific texts (66%), and using knowledge and creativity to suggest a testable explanation for an observation (66%).
	Additionally, 97% of mentors reported supervising students while they were doing STEM research, and 97% provided students with constructive feedback on STEM competencies. The strategies of having students search for and review technical research, demonstrating laboratory techniques, and learning collaboratively was reported by at least 84% of the mentors.
REAP apprentices' reported gains in 21st Century Skills.	81% of responding apprentices reported a large or extreme gain in sense of accomplishing something in STEM. Similarly, substantial proportions of apprentices reported large or greater gain in their desire to build relationships with their mentors (83%), connecting a STEM topic to a personal interest (76%), and feeling prepared for more challenging STEM activities (79%). In addition, 82% reported an increase in their confidence to try out new ideas or procedures, and 65% reported that REAP was influential in deciding on a path to pursue a STEM career.
REAP mentors engaged in best practices and supported students engaged in STEM learning.	Mentors reported finding out about students' backgrounds and interests at the beginning of the program (84%), and most gave students real-life problems to investigate or solve (97%). Over 70% of the mentors reported asking students to relate outside events or activities to topics covered in the program and selecting readings or activities that relate to students' backgrounds. The majority of mentors also reported helping students understand how STEM can help them improve their communities (72%), and encouraging students to suggest new readings, activities, or

	projects (94%). Mentors also suggested other ways that they establish relevance, such as demonstrating how skills learned in the laboratory are pertinent to other fields.
	Mentors indicated having students listen to the ideas of other with an open mind (91%) and had them work on collaborative activities (91%). The vast majority had students explain difficult ideas to other (88%), and tell others about their backgrounds and interests (66%).
	Apprentices were asked to indicate what kind of work they expected to be doing at age 30, and the data were coded as STEM-related or non-STEM-related. The majority of the apprentices were interested in STEM-related careers before participating in REAP, and almost all were interested in STEM-related careers after participating in REAP.
REAP outcomes include apprentice learning about STEM topics that were new to them and applying STEM learning to real-life situations	Apprentices reported that they learned about STEM topics that were new to them (91%), and applied STEM learning to real-life situations (81%). Mentors were asked similar questions about the nature of the apprentices' experiences. Overall, their responses paint a similar picture of the REAP experience.
	Apprentices indicated they were more likely to engage in many of these activities as a result of REAP. For example, 90% reported being more likely to work on a STEM project or experiment in a university or professional setting; 84% to take an elective STEM class; 85% to participate in a STEM camp, club, or competition; and 76% to mentor or teach other students about STEM.
REAP gives apprentices opportunities to participate in STEM that they cannot get in school.	There is a statistically significant difference in student perceptions of STEM Learning and STEM Engagement when comparing these activities in School and REAP. Apprentices report significantly higher STEM Learning and STEM Engagement in REAP over school (Learning effect size is large with d = 2.14; Engagement effect size is large with d = 1.68).

Responsiveness to FY15 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY15 to programs and summarize efforts and outcomes reflected in the FY16 APR toward these areas.

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

Finding: Although the REAP mentor group was more diverse ethnically, there were fewer female mentors than in 2014. Efforts should be made to focus on increasing the number of female mentors, perhaps by encouraging junior faculty (typically more female professors are in the lower ranks in STEM fields) to partner with senior faculty to submit proposal to be a REAP site.

REAP FY16 Efforts and Outcomes: REAP mentor group continues to hold steady with similar numbers reported in 2015. Only 32% of the REAP mentors were female, a slight increase in Hispanic/Latino mentors, from 2% to 4% and a decrease in Black or African American mentors, from 21% to 17%. Conversely, 73% of REAP participants were female. All AEOP programs should be working to attain a mentor population that mirrors their respective participant groups. More targeted efforts should be executed to achieve this in FY17.

Finding: A number of apprentices suggested that the REAP program could be improved by extending the length of the experience. Similar to responses from FY14, many apprentices in FY 15 noted that 5-8 weeks was not enough time to learn about and get involved with a research project.

REAP FY16 Efforts and Outcomes: REAP program administration has been concerned about the continuum of STEM research education once students leave the lab at the end of the summer. REAP program administrators will determine if there are any mentors who are assisting students once the official apprenticeship ends and develop a plan to introduce to other universities.

Finding: Mentors and apprentices are overall not aware of DoD STEM research and careers. Forty-five percent of apprentices reported not learning about any DoD STEM careers during their REAP experience.

REAP FY16 Efforts and Outcomes: In FY16, student awareness of DoD STEM careers was 73%, an increase of 28% over FY15. The increased awareness of DoD STEM careers was due to weekly communication with apprentices and mentors that included the 2016 Guide to STEM Careers and the AEOP newsletters.

Finding: Mentors and apprentices mentioned that the amount of the stipend was too small. One mentor mentioned that they never paid themselves out of the funding, and rather they made sure the students had an appropriate stipend.

REAP FY16 Efforts and Outcomes: Stipend amounts across all apprenticeships seem to be inconsistent. Perhaps, AAS, Battelle and the CAM will discuss at a future date. In the meantime, AAS will continue to provide certificates of recognition/appreciation to students and mentors. AAS will also work with partners to determine if there are other incentives that are being used within the consortium.

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

Finding: REAP should continue to focus on growing the number of mentors participating in the program to work toward a 1:1 mentor/apprentice ratio. One potential strategy for consideration is to increase the amount of the mentor stipend (currently $1,000).

REAP FY16 Efforts and Outcomes: In FY16, REAP achieved a 1:1 mentor/apprentice ratio due to increased communication with directors. AAS also issued certificates of appreciation to all mentors in FY16. AAS will explore ways to provide more incentives for mentors, especially to more diverse population.

Finding: As was found in 2014, REAP apprentices report having little previous experience with AEOP and limited knowledge of other AEOP programs, even after participating in REAP. Given the goal of having apprentices progress from REAP into other AEOP programs, the program may want to have a systematic method to inform mentors in tangible ways to increase apprentices' exposure to AEOP.

REAP FY16 Efforts and Outcomes: In FY16, REAP student awareness of AEOP opportunities was 81%, well above the FY16 target of 60% and a definite increase from FY15. This increase in awareness was largely due to weekly communication to students and mentors that included all AEOP program information, AEOP newsletter, 2016 Guide to STEM Careers and a new social media campaign.

Finding: Exposure to DoD STEM careers and research are also areas targeted for improvement for REAP.

REAP FY16 Efforts and Outcomes: In FY16, REAP student awareness of DoD STEM careers was 73%. The increase in awareness was largely due to weekly communication to students and mentors that included all AEOP program information, AEOP newsletter, 2016 Guide to STEM Careers and a new social media campaign. In FY17, AAS will have more direct contact with mentors. AAS will also work with directors and mentors to develop best practices. AAS will also develop a web-based orientation for students and mentors. Due to the satisfactory results, AAS will continue weekly communication with students and mentors.

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

Finding: No findings tied to recommendations for REAP in this area in FY15.

FY16 Recommendations

Evaluation findings indicate that FY16 was a successful year overall for the REAP program. The REAP program has the goal of broadening the talent pool in STEM fields, and, overall, the program has been successful at attracting students from groups historically underrepresented and underserved in these fields. A primary area of growth for REAP has been in broadening diversity of participants. In particular, there has been a steady increase in the number of female apprentices. Strategies that have been shown to be effective for encouraging historically underserved and underrepresented students in STEM careers include providing role models for students, exposing them to different education and career possibilities, providing guidance on how to pursue specific education and career paths (e.g., what courses they need to take in school, how to navigate the college application process), and providing coaching on the "soft skills" (e.g., time management, communication skills) needed to be successful in STEM careers. This is an encouraging trend and it is expected that having more role models will continue to encourage students from groups historically underrepresented and underserved in STEM to participate in REAP.

Another area of strength for REAP is reported meaningful STEM learning in the REAP program. Both mentors and apprentices reported increased confidence in pursuing STEM activities. Most of the REAP apprentices intend to continue to pursue STEM activities outside of school, and outreach to these apprentices about other opportunities is essential. One example of a positive trend is the UNITE/REAP partnership, which continues to increase apprentices participating in both programs consistently since 2013.

While these successes for REAP are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY16 and beyond:

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

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

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

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

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

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

Introduction

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

AEOP Goals

Goal 1: STEM Literate Citizenry.

- Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators.

- Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure.

- Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

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

Program Overview

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

REAP is guided by the following objectives:

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

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

A total of 487 students applied for the REAP program in 2016, which shows a slight decrease of 9% in student applications. REAP provided funding for 120 apprentices under the supervision of 121 mentors (2 mentors shared an apprentice) at 42 colleges and universities in 25 states and US territories (shown in Table 1). This is a slight increase as compared to the 2015 data: 101 apprenticeships under the supervision of 68 mentors at 37 colleges and universities in 29 states and US territories. Of the 42 colleges and universities involved in REAP, 19 institutions identified as historically black colleges and universities (HBCUs) or minority serving institutions (MSIs). As part of a pipeline pilot program, REAP funded 33 apprenticeships for UNITE alumni at 8 universities. UNITE is an AEOP-sponsored pre-collegiate summer program for talented high school students from historically underrepresented and underserved groups. There was a 67% increase of participating mentors from 68 in 2015 to 101 in 2016.

Table 1. 2016 REAP Site Applicant and Enrollment Numbers

2016 REAP Site	No. of Applicants	No. of Enrolled Participants
Alabama State University (REAP/UNITE)	21	8
Ball State University	4	1
California State University - Sacramento	2	2
College of Saint Benedict & Saint John's University	8	2
Colorado State University	7	2
Delaware State University	12	2
Georgia State University	12	2
Iowa State University	3	2
Jackson State University (REAP/UNITE)	7	5
Johns Hopkins University	48	4
Loyola University	30	6
Marshall University	10	2
Michigan Technological University	2	2
Montana State University	6	2
New Jersey Institute of Technology (REAP/UNITE)	18	4
Oakland University	7	4
Purdue School of Engineering & Technology	3	2
Savannah State University (REAP/UNITE)	6	2
South Dakota School of Mines & Technology (REAP/UNITE)	7	3

Texas Southern University (REAP/UNITE)	14	4
Texas Tech	13	5
University of Alabama at Huntsville	18	4
University of Arkansas at Pine Bluff	6	2
University of California – Berkeley	26	2
University of Central Florida	10	1
University of Colorado - Colorado Springs (REAP/UNITE)	13	2
University of Houston	17	4
University of Illinois at Urbana	7	2
University of Iowa	3	1
University of Maryland - Baltimore	41	4
University of Massachusetts - Lowell	5	2
University of Missouri	9	4
University of New Hampshire	4	2
University of New Mexico	19	4
University of North Carolina - Charlotte	24	4
University of Puerto Rico	8	2
University of So. Florida	9	2
University of Texas - El Paso	8	2
University of Texas - Arlington	8	3
University of Utah	6	2
Xavier University of Louisiana (REAP/UNITE)	6	5
TOTAL	**487**	**120**

The total cost of the 2016 REAP program was $388,217. The average cost per apprentice was $3,235. Aligned with the rates of similar AEOP initiatives, REAP provides participants with a stipend of $1500 for the 200 hours. REAP mentors receive a stipend of $1,000 for their participation regardless of the number of students they mentored. Table 2 summarizes these and other 2016 REAP program costs.

Table 2. 2016 REAP Program Costs	
2016REAP - Cost Per Participant	
Total Participants	120
Total Cost	$388,217
Cost Per Participant	**$3,235**
2016 REAP - Cost Breakdown Per Participant	
Average Administrative Cost to AAS	$1,149
Average Apprentice and Mentor Stipends	$2,086
Average Cost Per Participant	**$3,235**

***NOTE:** Universities that host REAP students are provided with $1,000. Often this funding goes to support the mentor. In some cases this funding is reallocated to afford an additional REAP apprenticeship. In 2014, 100 grants were originally provided and 17 additional apprenticeships were supported through this process.*

Evidence-Based Program Change

In FY16 all apprenticeship programs began being administered by the Academy of Applied Science and 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 a more diverse audience. (Supports Priority 1)

- *Collaborate with HBCUs/MSIs and affinity groups on targeted marketing and recruitment in local communities by recruiting current directors/mentor and LPCs to assist in outreach to URM population.*
- *Increase participation from schools with high percentages of free/reduced lunch*
- *Increase number of mentors across all sites to expand program by improving mentor training, creating a peer recruitment effort and offering expanded incentives.*
- *Recruit, identify and heighten awareness of apprenticeship opportunities by working with one or more strategic partners to market/outreach to organizations and schools with high percentage of URM.*

Activities:

- RFPs were sent to over 200 HBCUs/MCIs. University host sites for HBCU/MSIs increased by 90% in 2016 (compared to 2015)
- Published apprenticeship opportunities to high schools and universities located near Army labs and universities using direct mail and email campaigns.
- Developed and distributed new flyers & welcoming narrative to attract participants to the AEOP website and AEOP program information, to over 500 high schools, PTAs and after school programs targeting more diverse population, specifically to those close to host universities and DoD laboratories.
- University host directors assisted with distribution of college level program information by posting at universities.

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

- *Develop and disseminate materials widely through print, social media and virtual presentations*

Activities:

- All directors/mentors, students and lab coordinators received AEOP brochures, AEOP notebooks, flash drives and lab coats to promote all AEOP programs.
- Apprenticeship announcements to over 500 high schools, PTAs and after school programs targeting more diverse population, specifically to those close to host universities and DoD laboratories, also included information about all AEOP programs.
- Directors/mentors, students and lab coordinators received weekly communications addressing the entire AEOP portfolio, program evaluation assistance, abstract tip submissions, AEOP Newsletter, Social Media guidelines and the 2016 Guide to STEM Careers.
- New social media campaign was developed, including an AAS Instagram account and hashtag campaign to engage participants. #AEOPapprentice Executed AEOP's Social Media Guidelines using relevant hashtags, i.e. #edchat, #science, #womeninSTEM, #USAEOP, etc.
- Cross marketing by sharing posts about all AEOP programs.
- Provided photos and newsworthy items to Widmeyer throughout the summer.

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

- *Create opportunities for Army researchers to engage with students, as guest speakers and to visit host university sites, and opportunities for apprentices in university based programs to visit Army sites*
- *Create standardized information on Army STEM career opportunities; distribute to all apprentices*
- *Work with LPCs to obtain success stories and best practices which showcase STEM careers*

Activities:

- Students gain first hand exposure to Army STEM careers through direct engagement with Army scientists and engineers in DoD laboratories.
- Initiated discussions with a university to develop a "meet and greet" for participants of all AEOP programs (at same university), to include an Army speaker. Will expand on this to include REAP, HSAP/URAP, JSHS, UNITE.
- Implemented a scavenger hunt to expose students to DoD STEM careers.
- Developed communications campaign to distribute weekly notices including the new Guide to STEM Careers and AEOP Newsletter, which also showcases Army STEM Career info.
- Coordinated with Widmeyer to develop stories and publicize via AEOP.

4. Encourage more students already in the AEOP pipeline to continue with an apprenticeship program (Supports Priority 1 & 3)

- *Use incentive, such as stipends, to retain and attract former AEOP participants*
- *Coordinate with the LO and LPCs to develop and implement marketing/ outreach campaigns to target students in the AEOP pipeline*

- *Improve website & CVENT Interface*

Activities:

- Developed and distributed (US Mail and email) new flyers to over 500 high schools, PTAs and after school programs targeting more diverse population and those close to university host sites and DoD labs.
- Directors assisted with distribution of college level program information by posting at universities.
- Reviewed and updated websites and Cvent to publicize opportunities to students. Reviewed AEOP website pages to ensure accuracy of application deadlines
- Apprenticeship announcement flyers were sent to over 3,000 alumni… GEMS, UNITE, JSS, SEAP, HSAP, REAP, JSHS. Application announcement also requested family and/or friend referral.
- Conducted email outreach campaign to target AEOP alumni and publicize apprenticeship opportunities.
- ALL AEOP program alumni
  57% students participated in an AEOP in prior years. SEAP: 74 CQL: 182 REAP: 34

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

- Encourage peer-to-peer information sessions
- Provide virtual supplemental materials (such as marketing brochures and career testimonials)
- Present information to laboratory coordinators in other programs.

Activities:

- New program flyers were created and distributed to 500 high schools, 3,000 alumni and 80 after school programs located near high schools and DoD laboratories. Email also included a link to the AEOP website outlining other AEOP opportunities.
- Welcome packets were distributed to participants, which included: Lab coats, flash drives, notebooks, pens/pencils, AEOP brochures and all AEOP program opportunities.
- Weekly communication to participants highlighted all AEOP programs and AEOP STEM Career Guide, AEOP Newsletter, AEOP social media info about other AEOP opportunities.

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

- Identify process improvements and best practices as a result of the consolidation effort.
- Improve communications and information exchange between IPAs via virtual seminars or other
- Establish effective incentive and bridging strategies (such as "exit interviews" and next step mentoring) for participants as they move throughout the pipeline. Next steps are being introduced through mentor and apprenticeship exit letters.

Activities:

- The consolidation of marketing efforts for all apprenticeship programs resulted in greater awareness of all AEOP opportunities.
- Centralized supply distribution.
- Created new media release form.

- Centralized application process for all apprenticeship applicants through the use of Cvent.
- Increased mentor recognition with certificates and/or letters of appreciation.
- Worked extensively with lab coordinators to foster better working relationship. Surveyed lab coordinators to improve stipend payment process. Established system to track monthly stipend payments.
- Surveyed each lab coordinator regarding needed program improvements/changes. Prompt response to requests established better communication and trust between the IPA and lab coordinators through weekly email correspondence and telephone contact.
- Announced new AEOP Travel Award to all participants.

FY16 Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • AAS providing oversight of site programming • Operations conducted by 37 universities • Students participating in 101 REAP apprenticeships • STEM professionals and educators serving as REAP mentors • Stipends for apprentices to support meals and travel • Stipends for faculty to support meals and travel • Centralized branding and comprehensive marketing • Centralized evaluation	• Apprentices engage in authentic science and engineering research experiences through hands-on summer apprenticeships at REAP-sponsored colleges and universities • STEM professionals supervise and mentor apprentices' research • Program activities that expose apprentice to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of apprentice participants engaged in programs • Number and diversity of STEM professionals serving as mentors for programs • Number and diversity of Army/DoD scientists and engineers and other military personnel engaged in programs • Number and Title 1 status of high schools served through participant engagement • Apprentices, STEM professionals, site coordinators, and AAS contributing to evaluation	• Increased participation in authentic STEM activities • Increased participant STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in STEM research and careers • Increased participant awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve REAP programs	• Increased apprentice participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased apprentice pursuit of STEM coursework in secondary and post-secondary schooling • 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 REAP

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

Key Evaluation Questions

- What aspects of REAP programs motivate participation?
- What aspects of REAP program structure and processes are working well?
- What aspects of REAP programs could be improved?
- Did participation in REAP programs:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' positive attitudes toward STEM?
  - Increase apprentices' interest in future STEM learning?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM careers?

The assessment strategy for REAP included apprentice and mentor questionnaires, seven interviews with apprentices, five interviews with mentors, and one APR prepared by AAS. Tables 3-8 outline the information collected in apprentice and mentor questionnaires, focus groups, apprentice interviews, and information from the APR that is relevant to this evaluation report.

Questionnaires are the primary method of data collection for AEOP evaluation and collect information about participants' experiences with and perceptions of program resources, structures, and activities; potential benefits to participants; and strengths and areas of improvement for programs.

From FY15 to FY16, questionnaire assessments have been refined while maintaining alignment with:

- Army's strategic plan and AEOP Priorities 1 (STEM Literate Citizenry), 2 (STEM Savvy Educators) and 3 (Sustainable Infrastructure);
- Federal guidance for evaluation of Federal STEM investments (e.g., implementation and outcomes evaluation, outcomes evaluation of STEM-specific competencies, transferrable competencies, identifying with STEM, intentions to engage in STEM-related activities, and educational/career pathways);
- Best practices and published assessment tools in STEM education, informal STEM education, STEM outreach, and evaluation research communities;
- AEOP's vision to improve the quality of the data collected, focusing on changes in intended student outcomes and contributions of AEOPs like REAP effecting those changes.

Table 3. 2015 Apprentice Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Apprentice Experience:** In-school vs. In-program experience; Mentored research experience and products
	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, 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
	Comprehensive Marketing Strategy: How apprentices learn about AEOP, motivating factors for participation, 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 4. 2015 Mentor Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of REAP, motivating factors for participation, satisfaction with and suggestions for improving REAP programs, benefits to participants
AEOP Goal 1	**Capturing the Apprentice 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 apprentices to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice AEOP metrics
	Army/DoD STEM: attitudes toward Army/DoD STEM research and careers, efforts to expose apprentices to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing apprentice Army/DoD career metrics
	Mentor Capacity: Local Educators – Strategies used to establish relevance of learning activities for apprentices, support diverse needs of apprentices as learners, support development if interpersonal skills/collaboration, support engagement in authentic STEM activities, and support STEM education and career pathways
AEOP Goal 2 Program Efforts	**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

Table 5. 2015 Apprentice Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, grade level, past participation in REAP, past participation in other AEOP programs
Satisfaction & Suggestions	Awareness of REAP, motivating factors for participation, involvement in other science competitions in addition to REAP, satisfaction with and suggestions for improving REAP 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 6. 2015 Mentor Focus Groups	
Category	**Description**
Profile	Gender, race/ethnicity, occupation, organization, role in REAP, past participation in REAP, past participation in other AEOP programs
Satisfaction & Suggestions	Perceived value of REAP, benefits to participants suggestions for improving REAP 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 REAP

Table 7. 2015 Apprentice Interviews	
Category	**Description**
Profile	Gender, race/ethnicity, grade level, past participation in REAP, past participation in other AEOP programs
Satisfaction & Suggestions	Motivating factors for participation in REAP, satisfaction with and suggestions for improving REAP programs
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 8. 2015 Annual Program Report (APR)	
Category	**Description**
Program	Description of course content, activities, and academic level (high school or college)
AEOP Goal 1 and 2 Program Efforts	**Underrepresented and Underserved Populations:** mechanisms for marketing to and recruitment of apprentices from underrepresented and underserved populations
	Army STEM: Army/DoD STEM Careers – Career day exposure to Army STEM research and careers; Participation of Army engineers and/or Army research facilities in career day activities
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data 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. Focus group and interview protocols are provided in Appendix B (apprentices) and Appendix C (mentors); survey questions are provided in Appendix D (apprentices) and Appendix E (mentors); the APR template is located in Appendix F. Major trends in data and analyses are reported herein.

Study Sample

A total of 103 apprentices representing all REAP sites responded to questionnaires. There were 32 mentors who completed the survey as well. Table 9 includes the number of apprentice respondents by site.

Table 9. Survey Respondent 2016 REAP Site	Apprentices	
	No. of Participants	No. of Survey Respondents
Alabama State University (UNITE/REAP)	8	10
Ball State University	1	1
California State University - Sacramento	2	2
College of Saint Benedict and Saint John's University	2	2
Colorado State University	2	2
Delaware State University	2	2
Georgia State University	2	2
Iowa State University	2	1
Jackson State University (REAP/UNITE)	5	5
Johns Hopkins University	4	3
Loyola University	6	7
Marshall University	2	2
Michigan Technological University	2	1
Montana State University	2	2
New Jersey Institute of Technology (REAP/UNITE)	4	2
Oakland University (Michigan)	4	4
Purdue School of Engineering & Technology	2	1
Savannah State University(REAP/UNITE)	2	2
South Dakota School of Mines & Technology (REAP/UNITE)	3	2
Texas Southern University (REAP/UNITE)	4	4
Texas Tech	5	4
University of Alabama at Huntsville	4	3
University of Arkansas at Pine Bluff	2	2
University of California – Berkeley	2	0
University of Central Florida	1	1
University of Colorado – Colorado Springs (REAP/UNITE)	2	2
University of Houston	4	2
University of Illinois at Urbana	2	1
University of Iowa	1	1
University of Maryland – Baltimore	4	3

University of Massachusetts – Lowell	2	2
University of Missouri	4	1
University of New Hampshire	2	1
University of New Mexico	4	4
University of North Carolina – Charlotte	4	3
University of Puerto Rico	2	2
University of South Florida	2	2
University of Texas – El Paso	2	2
University of Texas – Arlington	3	1
University of Utah	2	1
Xavier University of Louisiana (REAP/UNITE)	5	4
No site indicated	0	1
TOTAL	**120**	**103**

Table 10 provides an analysis of apprentice and mentor participation in the REAP questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). The margin of error for both the mentor surveys is larger than generally acceptable, indicating that the sample may not be representative of their respective populations. Communication about completing the mentor questionnaire was delivered through site directors – which may have resulted in inconsistent messaging about completing the survey.

Table 10. 2015 REAP Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[1]
Apprentices	103	120	85%	±3.65%
Mentors	32	121	26%	±14.92%

Phone interviews were also conducted with 10 apprentices from rising grades 10, 11, 12, and entering college. Three phone interviews were completed with mentors. The mentors were all university faculty members. The focus groups and interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of apprentice and mentor questionnaire data. They add to the overall narrative of REAP's efforts and impact, and highlight areas for future exploration in programming and evaluation.

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

Respondent Profiles

Apprentice Demographics

Demographic information collected from REAP questionnaire respondents is summarized in Table 11.[2] More females (73%) than males (27%) completed the questionnaire. More responding apprentices identified with the race/ethnicity category of Black or African American (46%) than any other single race/ethnicity category, and there is substantial Asian (16%) representation, as well as Hispanic/Latino(a) (14%) . The race/ethnicity and gender proportions of respondents is very similar to the population of participating apprentices reported in the 2015 REAP Evaluation. For the 2016 year, there were a total of 120 apprentices involved in REAP and 73% of the apprentices were female. 46% of apprentices reported their race/ethnicity as African American, 16% Asian/Pacific Islander, 14% Hispanic, 3% Native American, 18% White, and 3% did not report race/ethnicity. Almost half of the apprentices in REAP reported Free or Reduced Price Lunch status (45%), which is an indicator that REAP is reaching students from underrepresented groups.

Fifty-seven percent of respondents were rising 12th graders; the remaining apprentices who answered this item were rising 10th (6%) and 11th (25%) graders, as well as rising college freshmen (12%). Almost half of the respondents (38%) reported qualifying for free or reduced-price lunch (FRL)—a common indicator of low-income status which was similar to the 2015 report (45%). There percentage of female respondents in 2015 than in 2016 remained the same (73%). The largest percentage of respondents were Black or African American (48%), with only 19% of participants who reported being White.

In summary, REAP was successful in attracting participation from female students—a population that is historically underrepresented in some STEM fields. REAP also had success in providing outreach to students from historically underrepresented and underserved race/ethnicity and low-income groups. REAP served students who regularly attended school in a variety of settings, including urban and rural, which historically have lower or limited resources than suburban schools.

[2] In FY15 the AEOP developed and implemented a new application tool through the vendor, Cvent. This centralized tool facilitated accurate and improved collection of demographic information from participants across the portfolio of AEOP initiatives.

Table 11. 2016 REAP Apprentice Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 102)		
Female	74	73%
Male	25	25%
No Response	2	2%
Respondent Race/Ethnicity (n = 102)		
Asian	14	14%
Black or African American	49	48%
Hispanic or Latino	13	13%
Native American or Alaska Native	2	2%
Native Hawaiian or Other Pacific Islander	1	1%
White	19	19%
No Response	1	1%
Respondent Grade Level (n = 102)		
Rising 10th	6	6%
Rising 11th	25	25%
Rising 12th	58	57%
Rising first-year college students	12	12%
No Response	0	0%
Respondent Eligible for Free/Reduced-Price Lunch (n = 102)		
Yes	39	38%
No	57	56%
No Response	6	6%

In addition, apprentices were asked how many times they participated in each of the AEOP programs. As can be seen in Chart 13, only 4% of responding apprentices reported participating in REAP at least once, which is down from 77% that was reported in 2015. The majority of apprentices did not participate in any other AEOP program before REAP (54%), but 25% had participated in other STEM programs outside of AEOP. Few apprentices (20%) reported participating in any of the other AEOP programs. The program that REAP apprentices most attended was the UNITE program, establishing evidence for the communication between the two programs. Additionally, the percentage of REAP apprentices who have participated in UNITE continues to increase from 2013 to 2016. This represents a continued increased attendance in UNITE by REAP apprentices since 2013.

Table 13. Apprentice Participation in AEOP Programs (n=81)

Choice	Response Percent	Response Total
Camp Invention	2.17 %	2
eCYBERMISSION	1.09 %	1
Junior Solar Sprint (JSS)	0.00 %	0
Gains in the Education of Mathematics and Science (GEMS)	2.17 %	2
UNITE	9.78 %	9
Junior Science & Humanities Symposium (JSHS)	0.00 %	0
Science & Engineering Apprenticeship Program (SEAP)	1.09 %	1
Research & Engineering Apprenticeship Program (REAP)	4.35 %	4
High School Apprenticeship Program (HSAP)	0.00 %	0
College Qualified Leaders (CQL)	0.00 %	0
Undergraduate Research Apprenticeship Program (URAP)	0.00 %	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.00 %	0
I've never participated in any AEOP programs	54.35 %	50
Other STEM Program	25.00 %	23

Mentor Demographics

Table 14 summarizes demographic data on 2016 participating mentors. There were a total of 121 mentors (2 shared one apprentice), and 32% of the mentors were female. 17% of mentors reported their race/ethnicity as African American, 25% Asian/Pacific Islander, 4% Hispanic, 41% White, and 3% did not report race/ethnicity.

Table 14. 2016 REAP Participating Mentor Profiles		
Demographic Category	**Questionnaire Respondents**	
Gender (n = 121)		
Female	39	32%
Male	82	68%
Race/Ethnicity (n = 110)		
Asian	30	25%
Black or African American	21	17%
Hispanic or Latino	5	4%
Native American or Alaska Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	50	41%
Other race or ethnicity, (specify):	0	0%
Choose not to report	4	3%
Primary Area of Research (n = 121)		
Physical science (physics, chemistry, astronomy, materials science, etc.)	29	24%
Biological science	21	17%
Earth, atmospheric, or oceanic science	5	4%
Environmental science	15	12%
Computer science	6	5%
Technology	0	0%
Engineering	20	17%
Mathematics or statistics	7	6%
Medical, health, or behavioral science	2	2%
Social Science (psychology, sociology, anthropology)	0	0%
Other, (specify):	16	13%

Actionable Program Evaluation

The intent of the Actionable Program Evaluation is to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. This section highlights information outlined in the Satisfaction & Suggestions sections of Tables 3-7.

The Actionable Program Evaluation examines the long-term goal of REAP and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. REAP sites reach out to students from traditionally underrepresented and underserved populations. Thus, it is important to consider how REAP is marketed and ultimately recruits student participants, the factors that motivate students to participate in REAP, apprentices perceptions of and satisfaction with activities, what value apprentices place on program activities, and what

recommendations apprentices have for program improvement. The following sections report perceptions of apprentices and mentors that pertain to current programmatic efforts and recommend evidence-based improvements to help REAP achieve outcomes related to AEOP programs and objectives. Specifically, to help REAP continue to expand participation from and support STEM education for students from underrepresented and underserved groups.

Marketing and Recruiting Underrepresented and Underserved Populations

The focus for REAP for FY16, in addition to continuing ongoing efforts to market the program to underrepresented and underserved populations, was to focus specifically on expanding REAP opportunities in cooperation with HBCUs and MSIs. Specifically, REAP collaborated with UNITE program managers to place former UNITE students in REAP. There was a secondary focus on increasing participation in REAP for students from schools with high percentages of free/reduced lunch. Data were collected from mentors and apprentices to determine REAP progress in this area.

The mentor questionnaire included an item asking how students were recruited for apprenticeships. As can be seen in Table 15, mentors used a variety of methods to recruit apprentices. Many mentors indicated recruiting their apprentice(s) through applications from AAS or AEOP (38%), K-12 teachers at the local schools (34%), and informational materials sent to a K-12 setting (31%). About a quarter indicated colleagues from the workplace (22%). Communications from both a K-12 school (16%) and a university (16%) helped with recruitment. About the same amount of students were recruited from organizations that serve underserved or underrepresented populations (16%), and STEM or STEM education conferences (16%).

Table 15. Mentor Reports of Recruitment Strategies (n=32)

Choice	Response Percent	Response Total
Applications from Academy of Applied Science (AAS) or the AEOP	37.50 %	12
Personal acquaintance(s) (friend, family, neighbor, etc.)	6.25 %	2
Colleague(s) in my workplace	21.88 %	7
K-12 school teacher(s) outside of my workplace	34.38 %	11
University faculty outside of my workplace	9.38 %	3
Informational materials sent to K-12 schools or Universities outside of my workplace	31.25 %	10
Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)	15.63 %	5
Communication(s) generated by a university or faculty (newsletter, email blast, website)	15.63 %	5
STEM or STEM Education conference(s) or event(s)	15.63 %	5
Organization(s) that serve underserved or underrepresented populations	15.63 %	5
The student contacted me (the mentor) about the program	6.25 %	2

Online questionnaires and phone interviews all included items addressing how apprentices originally learned about REAP, including any personal connections that led them to the program or to the university site, and past experience participating in the program. Table 16 summarizes apprentices' questionnaire responses. The most frequently mentioned source of information about the local REAP program was someone who works at the school or university (19%) followed by school or university newsletter, email, or website (17%) and someone who works with the program (17%). Other sources mentioned relatively frequently were the AEOP website (13%), and past participant (12%).

Table 16. How Apprentices Learned about REAP (n=81)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	13.33 %	16
AEOP on Facebook, Twitter, Instagram, or other social media	1.67 %	2
School or university newsletter, email, or website	16.67 %	20
Past participant of program	11.67 %	14
Friend	5.83 %	7
Family Member	6.67 %	8
Someone who works at the school or university I attend	19.17 %	23
Someone who works with the program	15.83 %	19
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	1.67 %	2
Community group or program	5.00 %	6
Choose Not to Report	2.50 %	3

Mentors were also asked how they learned about REAP (see Table 17). The sources that the responding mentors most frequently identified were a supervisor or superior (41%), a colleague (38%), the AEOP website (22%) and a past REAP participant (16%). In 2015 33% of responding mentors stated AAS as a source for learning about REAP as compared to 9% in 2016.

Table 17. How Mentors Learned about REAP (n=32)

Choice	Response Percent	Response Total
Academy of Applied Science (AAS)	9.38 %	3
Army Educational Outreach Program (AEOP) website	21.88 %	7
AEOP on Facebook, Twitter, Pinterest, or other social media	3.13 %	1
A STEM conference or STEM education conference	0.00 %	0
An email or newsletter from school, university, or a professional organization	6.25 %	2
Past REAP participant	15.63 %	5
A student	3.13 %	1
A colleague	37.50 %	12
My supervisor or superior	40.63 %	13
A REAP site host or director	15.63 %	5
Workplace communications	3.13 %	1
Someone who works with the Department of Defense (Army, Navy, Air Force)	0.00 %	0
Other, (specify):	3.13 %	1

Factors Motivating Apprentice Participation

Apprentice questionnaires, interviews, and focus groups included questions to explore what motivated the apprentices to participate in REAP. Specifically, the questionnaire asked how motivating a number of factors were in their decision to participate. Apprentices chose several options, and the percentage responses were calculated by total survey respondents, not by proportion of answers. As can be seen in Table 18, 75 out of 80 responding apprentices indicated that interest in STEM, 73 out of 80 reported a desire to learn something new or interesting, 69 out of 80 reported a desire to expand laboratory or research skills, 69 out of 80 reported being motivated by learning in ways that are not possible in school, and 61 out of 80 reported that they were “very much” motivated to participate in REAP by a need to figure out education or career goals. The opportunity to use advanced laboratory technology was reported by 61 out of 80 apprentices, and having fun and building a college resume was reported by 48 out of 80 apprentices.

Table 18. Factors Motivating Apprentices to Participate in REAP (n=80)

Choice	Response Percent	Response Total
Teacher or professor encouragement	3.33 %	27
An academic requirement or school grade	0.12 %	1
Desire to learn something new or interesting	9.00 %	73
The mentor(s)	2.47 %	20
Building college application or résumé	5.92 %	48
Networking opportunities	4.69 %	38
Interest in science, technology, engineering, or mathematics (STEM)	9.25 %	75
Interest in STEM careers with the Army	3.58 %	29
Having fun	5.92 %	48
Earning stipends or awards for doing STEM	4.19 %	34
Opportunity to do something with friends	0.86 %	7
Opportunity to use advanced laboratory technology	7.52 %	61
Desire to expand laboratory or research skills	8.51 %	69
Learning in ways that are not possible in school	8.51 %	69
Serving the community or country	4.93 %	40
Exploring a unique work environment	6.78 %	55
Figuring out education or career goals	7.52 %	61
Seeing how school learning applies to real life	5.67 %	46
Recommendations of past participants	1.11 %	9
Choose Not to Report	0.12 %	1

The apprentices in the focus group and phone interviews mentioned being encouraged to participate in REAP by personal interactions. As two apprentices explained:

> *I actually ended up hearing about it through a professor that I had met through a camp, completely unrelated to REAP, the year before.* (REAP Apprentice)

> *The coordinator of the REAP Program at Texas Tech, Dr. Steven Bayne, came to our school. He talked to all the people who were interested in engineering, any slight interest. That's how I heard about it. I went ahead and applied. I just wanted to see what it was all about.* (REAP Apprentice)

The REAP Experience

In order to gather data on the overall program experience for REAP participants, several items focused on the nature of apprentices' experience in REAP, and how that experience compared to their STEM learning opportunities in school. As can be seen in Table 19, about half indicated that they were assigned a project for the experience by their mentor (48%), 21% worked with their mentor and members of a research team to design a project, and 20% had a choice among various projects suggested by their mentor. The remaining apprentices reported working with their mentor to design a project (9%), designing a project on their own (2%), or not having a project at all (1%). These data are similar to the ones reported in 2015.

Table 19. Apprentice Input on Design of Their Project (n=102)

Choice	Response Percent	Response Total
I did not have a project	0.98 %	1
I was assigned a project by my mentor	48.04 %	49
I worked with my mentor to design a project	8.82 %	9
I had a choice among various projects suggested by my mentor	19.61 %	20
I worked with my mentor and members of a research team to design a project	20.59 %	21
I designed the entire project on my own	1.96 %	2

Apprentices were asked about the configuration of their collaboration on a project. Roughly a third of apprentices worked with a group on the same project during the REAP experience (see Table 20). Apprentices tended to work independently on their projects, with 32% reporting working in a shared laboratory/space with others, but on different projects. Similarly, 8% indicated working alone (or alone with their research mentor), while 17% reported working alone on a project closely connected to other projects in their group, and 8% reported working alone on a project and meeting regularly with others for general reporting or discussion.

Table 20. Apprentice Participation in a Research Group (n=102)

Choice	Response Percent	Response Total
I worked alone (or alone with my research mentor)	7.84 %	8
I worked with others in a shared laboratory or other space, but we work on different projects	32.35 %	33
I worked alone on my project and I met with others regularly for general reporting or discussion	7.84 %	8
I worked alone on a project that was closely connected with projects of others in my group	16.67 %	17
I work with a group who all worked on the same project	35.29 %	36

As can be seen in Table 21, respondents indicated learning about new STEM topics, communicating with other students about STEM, and interacting with STEM professionals most day or every day during the REAP program. Apprentices reported that they learned about STEM topics that were new to them (91%), and applied STEM learning to real-life situations (81%). Mentors were asked similar questions about the nature of the apprentices' experiences. Overall, their responses paint a similar picture of the REAP experience.

Table 21. Nature of Apprentice Activities in REAP (n=102)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	0.0%	2.9%	6.9%	27.5%	62.7%	
	0	3	7	28	64	**102**
Apply STEM learning to real-life situations	1.0%	2.0%	13.7%	28.4%	54.9%	
	1	2	14	29	56	**102**
Learn about new discoveries in STEM	1.0%	2.0%	21.6%	38.2%	37.3%	
	1	2	22	39	38	**102**
Learn about different careers that use STEM	2.9%	4.9%	27.5%	28.4%	36.3%	
	3	5	28	29	37	**102**
Interact with scientists or engineers	2.0%	3.9%	8.8%	14.7%	70.6%	
	2	4	9	15	72	**102**
Communicate with other students about STEM	2.9%	5.9%	10.8%	28.4%	52.0%	
	3	6	11	29	53	**102**

Aligned with the focus of REAP to increase the number and diversity of students who pursue STEM careers, the questionnaire also asked apprentices to share how many jobs/careers in STEM in general, and STEM jobs/careers in the DoD more specifically, apprentices learned about during their experience. Table 22 provides the data related to this item. In fact, nearly all apprentices reported learning about at least one STEM job/career, and the majority (73%) reported learning about three or more.

Table 22. Number of STEM Jobs/Careers Apprentices Learned about During REAP (n=100)

Choice	Response Percent	Response Total
None	1.00 %	1
1	9.00 %	9
2	17.00 %	17
3	24.00 %	24
4	5.00 %	5
5 or more	44.00 %	44

There are many resources provided to REAP participants focused on increasing their awareness of DoD STEM careers. REAP apprentices reported that participation in REAP (63%), mentors (55%), AEOP website (57%) and AEOP instructional supplies (47%) were somewhat or very much responsible for their growing awareness of AEOP (see Table 23). Conversely, 49% did not experience awareness of DoD STEM careers from the AAS website, 55% did not experience on social media, and 61% reported not experiencing DoD STEM careers from It Starts Here! Magazine. These data are similar to those reported in 2015.

Table 23. Impact of Resources on Apprentice Awareness of DoD STEM Careers (n =101)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	48.5%	7.9%	14.9%	15.8%	12.9%	
	49	8	15	16	13	101
Army Educational Outreach Program (AEOP) website	19.8%	5.9%	17.8%	16.8%	39.6%	
	20	6	18	17	40	101
AEOP on Facebook, Twitter, Pinterest or other social media	53.5%	8.1%	18.2%	11.1%	9.1%	
	53	8	18	11	9	99
AEOP brochure	25.7%	7.9%	18.8%	17.8%	29.7%	
	26	8	19	18	30	101
It Starts Here! Magazine	61.4%	7.9%	15.8%	5.9%	8.9%	
	62	8	16	6	9	101
My REAP mentor(s)	19.0%	12.0%	14.0%	15.0%	40.0%	
	19	12	14	15	40	100
Invited speakers or "career" events during REAP	46.0%	12.0%	12.0%	13.0%	17.0%	
	46	12	12	13	17	100
Participation in REAP	16.0%	8.0%	13.0%	20.0%	43.0%	
	16	8	13	20	43	100

The evaluation of REAP included a comparison of engagement in STEM during the program – as compared to their typical experience at school. Results indicate that apprentices were very actively engaged in doing STEM during the program (see Table 24). For example, 86% of responding apprentices indicated analyzing or interpreting data on most days or every day; 76% reported carrying out investigations; and 79% reported posing questions to investigate. In addition, apprentices indicated being integrally involved the work of STEM on most days or every day, including drawing conclusions from an investigation (75%), using laboratory procedures and tools (85%), and carrying out an investigation (76%). However, 61% of apprentices did not build or create a computer model.

Table 24. Apprentice Engagement in STEM Practices in REAP (n=102)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Use laboratory procedures and tools	2.0%	4.9%	7.8%	27.5%	57.8%	
	2	5	8	28	59	**102**
Participate in hands-on STEM activities	1.0%	2.0%	10.8%	20.6%	65.7%	
	1	2	11	21	67	**102**
Work as part of a team	2.9%	1.0%	9.8%	18.6%	67.6%	
	3	1	10	19	69	**102**
Identify questions or problems to investigate	2.0%	2.9%	15.7%	26.5%	52.9%	
	2	3	16	27	54	**102**
Design an investigation	4.9%	11.8%	25.5%	17.6%	40.2%	
	5	12	26	18	41	**102**
Carry out an investigation	2.9%	2.9%	17.6%	18.6%	57.8%	
	3	3	18	19	59	**102**
Analyze data or information	1.0%	4.9%	7.8%	25.5%	60.8%	
	1	5	8	26	62	**102**
Draw conclusions from an investigation	4.0%	2.0%	18.8%	26.7%	48.5%	
	4	2	19	27	49	**101**
Come up with creative explanations or solutions	0.0%	7.9%	27.7%	20.8%	43.6%	
	0	8	28	21	44	**101**
Build or make a computer model	39.2%	21.6%	17.6%	6.9%	14.7%	
	40	22	18	7	15	**102**

A composite score[3] was calculated for each of these two sets of items, the first titled "Learning about STEM in REAP,"[4] and the second "Engaging in STEM Practices in REAP."[5] Response categories were converted to a scale of 1 = "Not at all"

[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

to 5 = "Every day," and the average across all items in the scale was calculated. The composite scores were used to test whether there were differences in apprentice experiences by gender and race/ethnic group (minority vs. non-minority). There were no significant differences between gender and race/ethnicity for any of these composites.

To examine how the REAP experience compares to their typical school experience, apprentices were asked how often they engaged in the same activities in school (individual item responses can be found in Appendix B). These responses were also combined into two composite variables: "Learning about STEM in School,"[6] and "Engaging in STEM Practices in School"[7] that are parallel to the ones asking about REAP. As can be seen in Chart 10, there is a statistically significant difference in student perceptions of STEM Learning and STEM Engagement when comparing these activities in School and REAP[8]. There is a statistically significant difference in student perceptions of STEM Learning and STEM Engagement when comparing these activities in School and REAP. Apprentices report significantly higher STEM Learning and STEM Engagement in REAP over school (Learning effect size is large with d = 2.13; Engagement effect size is large with d = 1.82).

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.

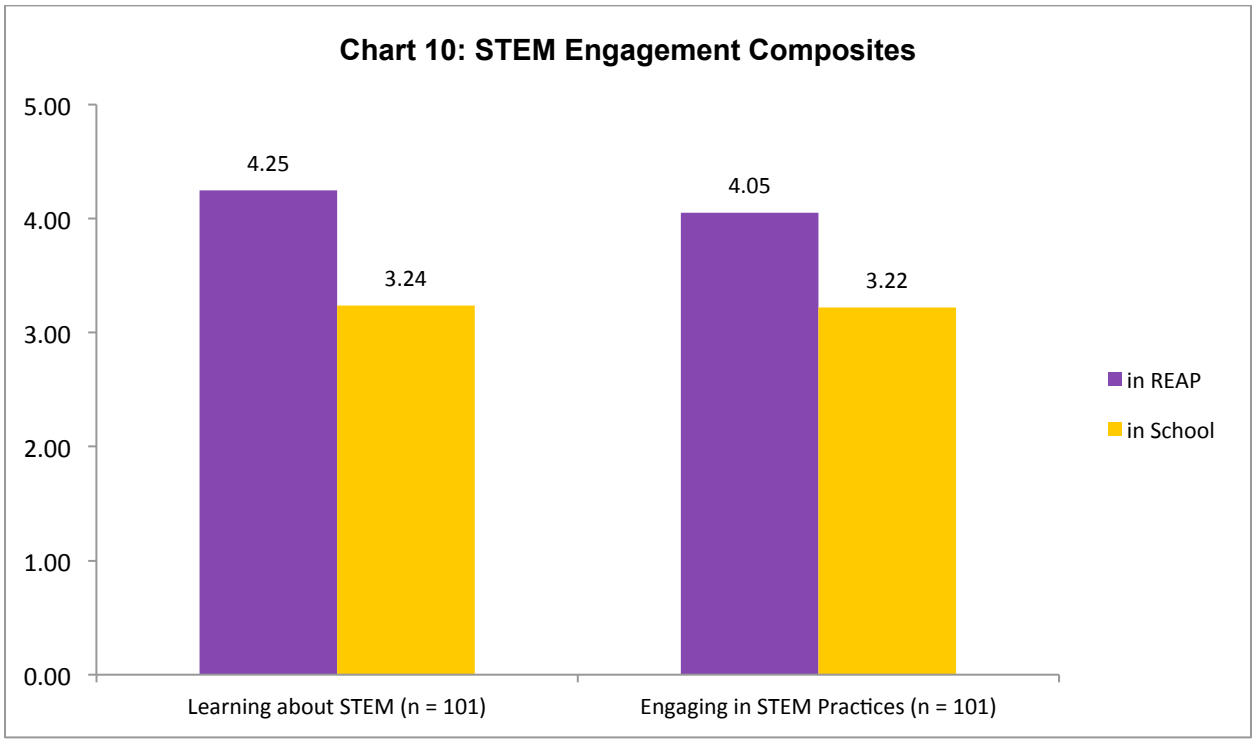
[4] The Cronbach's alpha reliability for these 6 items was 0.823.

[5] The Cronbach's alpha reliability for these 10 items was 0.906.

[6] Cronbach's alpha reliability of 0.795.

[7] Cronbach's alpha reliability of 0.878.

[8] Dependent Samples t-test for STEM Learning: $t(100)=10.67$, $p<.001$; Dependent Samples t-test for STEM Engagement: $t(100)=9.06$, $p<.001$.



The Role of Mentors

A key component of the REAP and other apprenticeship programs in the AEOP are mentors. The nature and quality of mentoring is an important factor in maximizing apprentice participation in these opportunities, and sustaining or inspiring their interest in future STEM work. Consequently, both the apprentice and mentor questionnaires asked about the role of mentors in the program.

Mentors were questioned regarding their use of strategies when working with apprentices (referred to as students in the mentor questionnaire items and in the descriptions of those items throughout this section of the report). These strategies comprised five main areas of effective mentoring:

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.

Several strategies were reportedly used by mentors to help make the learning activities relevant to students (see Table 25). For example, the majority of mentors reported using all of the relevant learning activities. Finding out about students' backgrounds and interests at the beginning of the program (84%), and most gave students real-life problems

to investigate or solve (97%). Over 70% of the mentors reported asking students to relate outside events or activities to topics covered in the program and selecting readings or activities that relate to students' backgrounds. The majority of mentors also reported helping students understand how STEM can help them improve their communities (72%), and encouraging students to suggest new readings, activities, or projects (94%). Mentors also suggested other ways that they establish relevance, such as demonstrating how skills learned in the laboratory are pertinent to other fields.

Table 25. Mentors Using Strategies to Establish Relevance of Learning Activities (n=32)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the REAP experience	84.4%	15.6%	
	27	5	32
Giving students real-life problems to investigate or solve	96.9%	3.1%	
	31	1	32
Selecting readings or activities that relate to students' backgrounds	71.9%	28.1%	
	23	9	32
Encouraging students to suggest new readings, activities, or projects	93.8%	6.3%	
	30	2	32
Helping students become aware of the role(s) that STEM plays in their everyday lives	84.4%	15.6%	
	27	5	32
Helping students understand how STEM can help them improve their own community	71.9%	28.1%	
	23	9	32
Asking students to relate real-life events or activities to topics covered in REAP	68.8%	31.3%	
	22	10	32

Mentors also reported using a variety of strategies to support the diverse needs of students as learners. As can be seen in Table 26, 81% of mentors reported treating all students the same way, regardless of gender or race/ethnicity, 81% indicated using diverse teaching/mentoring activities that meet the needs of all students. Many also helped students find additional support if needed (59%). Other strategies mentioned included having students participate in meetings and seminars and accommodating students' busy schedules.

Table 26. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=32)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the REAP experience	81.3%	18.8%	
	26	6	32
Interact with students and other personnel the same way regardless of their background	81.3%	18.8%	
	26	6	32
Use a variety of teaching and/or mentoring activities to meet the needs of all students	87.5%	12.5%	
	28	4	32
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	56.3%	43.8%	
	18	14	32
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	84.4%	15.6%	
	27	5	32
Directing students to other individuals or programs for additional support as needed	59.4%	40.6%	
	19	13	32
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	50.0%	50.0%	
	16	16	32

Further, mentors reported using many strategies to support students' development of collaboration and interpersonal skills (see Table 27). For example, nearly all of those responding to the questionnaire indicated having students listen to the ideas of other with an open mind (91%) and had them work on collaborative activities (91%). The vast majority had students explain difficult ideas to other (88%), and tell others about their backgrounds and interests (66%).

Table 27. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n=32)

	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	65.6%	34.4%	
	21	11	32
Having my student(s) explain difficult ideas to others	87.5%	12.5%	
	28	4	32
Having my student(s) listen to the ideas of others with an open mind	90.6%	9.4%	
	29	3	32
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	81.3%	18.8%	
	26	6	32
Having my student(s) give and receive constructive feedback with others	90.6%	9.4%	
	29	3	32
Having students work on collaborative activities or projects as a member of a team	84.4%	15.6%	
	27	5	32
Allowing my student(s) to resolve conflicts and reach agreement within their team	68.8%	31.3%	
	22	10	32

The majority of responding mentors (at least 84%) reported they used all of the practices noted on the survey. For example, 100% reported allowing students to work independently as appropriate for their self-management abilities and STEM competencies. Additionally, 97% of mentors reported supervising students while they were doing STEM research, and 97% provided students with constructive feedback on STEM competencies (see Table 28). The strategies of having students search for and review technical research, demonstrating laboratory techniques, and learning collaboratively was reported by at least 84% of the mentors.

Table 28. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=32)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	90.6%	9.4%	
	29	3	32
Having my student(s) search for and review technical research to support their work	87.1%	12.9%	
	27	4	31
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	87.5%	12.5%	
	28	4	32
Supervising my student(s) while they practice STEM research skills	96.9%	3.1%	
	31	1	32
Providing my student(s) with constructive feedback to improve their STEM competencies	96.8%	3.2%	
	30	1	31
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	32	0	32
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	84.4%	15.6%	
	27	5	32
Encouraging students to seek support from other team members	81.3%	18.8%	
	26	6	32

Mentors also used strategies focused on supporting students' STEM educational and career pathways (see Table 29).[9] 94% of the responding mentors reported asking students about their educational and career interests and 91% reported providing guidance about educational pathways that will prepare their students for a STEM Career. Many also asked their students about their educational and career goals (94%). In addition, given the interest in having students graduate into other AEOP opportunities, it is surprising that only 50% of mentors recommended other AEOP programs to students.

[9] The apprentice questionnaire included subset of these items (found in Appendix B). The apprentices reported lower percentages of use of strategies to support STEM educational and career pathways than did mentors.

Table 29. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=32)

	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	93.8%	6.3%	
	30	2	32
Recommending extracurricular programs that align with students' goals	56.3%	43.8%	
	18	14	32
Recommending Army Educational Outreach Programs that align with students' goals	56.3%	43.8%	
	18	14	32
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	90.6%	9.4%	
	29	3	32
Discussing STEM career opportunities within the DoD or other government agencies	50.0%	50.0%	
	16	16	32
Discussing STEM career opportunities in private industry or academia	62.5%	37.5%	
	20	12	32
Discussing the economic, political, ethical, and/or social context of a STEM career	51.6%	48.4%	
	16	15	31
Recommending student and professional organizations in STEM to my student(s)	62.5%	37.5%	
	20	12	32
Helping students build a professional network in a STEM field	59.4%	40.6%	
	19	13	32
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	43.8%	56.3%	
	14	18	32

Mentors were asked which of the AEOP programs mentors explicitly discussed with their students during REAP. Not surprisingly, the most frequently discussed program was REAP (75%), as can be seen in Table 30. Other programs discussed with students by roughly a quarter of responding mentors were UNITE (28%), URAP (25%), and SMART (23%). A surprisingly low number of mentors discussed UNITE (17%). 44% of the mentors reported discussing AEOP generally with students, but not discussing any specific programs (33%).

Table 30. Mentors Explicitly Discussing AEOPs with Students (n=32)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	18.8%	81.3%	
	6	26	32
UNITE	28.1%	71.9%	
	9	23	32
Junior Science & Humanities Symposium (JSHS)	18.8%	81.3%	
	6	26	32
Science & Engineering Apprenticeship Program (SEAP)	15.6%	84.4%	
	5	27	32
Research & Engineering Apprenticeship Program (REAP)	75.0%	25.0%	
	24	8	32
High School Apprenticeship Program (HSAP)	18.8%	81.3%	
	6	26	32
College Qualified Leaders (CQL)	12.5%	87.5%	
	4	28	32
GEMS Near Peer Mentor Program	12.5%	87.5%	
	4	28	32
Undergraduate Research Apprenticeship Program (URAP)	25.0%	75.0%	
	8	24	32
Science Mathematics, and Research for Transformation (SMART) College Scholarship	21.9%	78.1%	
	7	25	32
National Defense Science & Engineering Graduate (NDSEG) Fellowship	15.6%	84.4%	
	5	27	32
I discussed AEOP with my student(s) but did not discuss any specific program	43.8%	56.3%	
	14	18	32

Mentors' perception of usefulness of AEOP resources was also examined. As can be seen in Chart 31, participation in REAP (72%), REAP Program administrator or site coordinator (59%), and the AEOP website (41%) were most often rated as "very much" useful. Invited speakers, It Starts Here! Magazine, or "career" events and AEOP social media tended not to be seen as very useful, with large proportions of mentors indicating they did not experience these resources. For example, 72% of responding mentors reported not experiencing invited speakers or "career" events, and only 16% rated them as "very much" useful. Similarly, 71% of responding mentors did not experience AEOP social media and only 10% found it very useful, and 81% of respondents did not experience AEOP programs in It Starts Here! Magazine, while only 7% found it useful for exposing students to AEOP.

Table 31. Useful of Resources for Exposing Students to AEOPs (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	62.5%	0.0%	6.3%	9.4%	21.9%	
	20	0	2	3	7	**32**
Army Educational Outreach Program (AEOP) website	31.3%	0.0%	9.4%	18.8%	40.6%	
	10	0	3	6	13	**32**
AEOP on Facebook, Twitter, Pinterest or other social media	71.0%	0.0%	9.7%	9.7%	9.7%	
	22	0	3	3	3	**31**
AEOP brochure	46.9%	0.0%	6.3%	15.6%	31.3%	
	15	0	2	5	10	**32**
It Starts Here! Magazine	80.6%	0.0%	6.5%	6.5%	6.5%	
	25	0	2	2	2	**31**
REAP Program administrator or site coordinator	34.4%	0.0%	3.1%	3.1%	59.4%	
	11	0	1	1	19	**32**
Invited speakers or "career" events	71.9%	0.0%	3.1%	9.4%	15.6%	
	23	0	1	3	5	**32**
Participation in REAP	18.8%	0.0%	0.0%	9.4%	71.9%	
	6	0	0	3	23	**32**

Phone interviews with mentors provided some additional context for strategies they used for informing students about AEOP opportunities, including brochures from AEOP and AEOP instructional supplies. As stated by one mentor:

REAP is doing really good job on that, even a better job there. They send out all these emails all the time with updates and I go to the students like, "Hey, this is an opportunity," or, "This is what's going on in the STEM fields."

I personally, they tell me to go and make sure the students know about these opportunities so I talk to the students about the opportunities. I talk about other programs. Especially I talk about if you're going to go on to college, these are some of the programs you may want to apply to through the Army. For some of these programs, you have to work with the Army and so forth.

The REAP is doing that, they're sending more emails. I think they're doing it by emails and, of course, they're dependent on the mentors to do a lot of it. They're giving us little fliers and stuff like that to do that. (REAP Mentor)

Mentors reported on how useful AEOP resources were for exposing students to DoD STEM careers (see Chart 32). As with the previous item, mentors were most likely to rate participation in REAP as useful, with 66% selecting "very much." Following that choice, the program managers or site coordinators (47%), and the AEOP brochure and/or presentation (25%) were most often rated as "very much" useful. Again, invited speakers or "career" events, It Starts Here! Magazine, and AEOP social media were less likely to be seen as very useful for this purpose (7-13%), with large proportions of mentors indicating they did not experience these resources (71-81%).

Chart 32. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	59.4%	0.0%	6.3%	15.6%	18.8%	
	19	0	2	5	6	32
Army Educational Outreach Program (AEOP) website	34.4%	0.0%	9.4%	18.8%	37.5%	
	11	0	3	6	12	32
AEOP on Facebook, Twitter, Pinterest or other social media	71.0%	0.0%	3.2%	12.9%	12.9%	
	22	0	1	4	4	31
AEOP brochure	50.0%	0.0%	6.3%	18.8%	25.0%	
	16	0	2	6	8	32
It Starts Here! Magazine	80.6%	0.0%	6.5%	6.5%	6.5%	
	25	0	2	2	2	31
REAP Program administrator or site coordinator	37.5%	0.0%	3.1%	12.5%	46.9%	
	12	0	1	4	15	32
Invited speakers or "career" events	71.9%	0.0%	6.3%	9.4%	12.5%	
	23	0	2	3	4	32
Participation in REAP	25.0%	0.0%	3.1%	6.3%	65.6%	
	8	0	1	2	21	32

Mentors who were interviewed were mostly unfamiliar with DoD STEM careers. As stated by one mentor:

> *To be honest with you, I've been so busy to really explore other things, but we have three programs going on simultaneously, and keep track of all of them this summer. I'm also teaching a couple of graduate courses. I just haven't had time to explore them, although the academy has been sending out emails that show some of these different programs that do exist.* (REAP Mentor)

Satisfaction with REAP

Apprentice and mentor satisfaction with the program was also a focus of the evaluation. As can be seen in Chart 33, the vast majority of responding apprentices were somewhat or very much satisfied with each of the listed program features. For example, 98% of apprentices were satisfied with the physical location of REAP, 95% were satisfied with the stipends,

97% were satisfied with the registration process, 94% were satisfied with communication with REAP organizers and 85% were satisfied by the variety of STEM topics offered in REAP.

Chart 33. Apprentice Satisfaction with REAP Program Features (n=102)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	0.0%	1.0%	2.0%	24.5%	72.5%	
	0	1	2	25	74	**102**
Communicating with your REAP host site organizers	1.0%	0.0%	5.0%	23.8%	70.3%	
	1	0	5	24	71	**101**
The physical location(s) of REAP activities	0.0%	2.0%	2.0%	12.7%	83.3%	
	0	2	2	13	85	**102**
The variety of STEM topics available to you in REAP	0.0%	1.0%	13.7%	17.6%	67.6%	
	0	1	14	18	69	**102**
Teaching or mentoring provided during REAP activities	1.0%	2.0%	6.9%	11.8%	78.4%	
	1	2	7	12	80	**102**
Stipends (payment)	2.0%	0.0%	2.9%	15.7%	79.4%	
	2	0	3	16	81	**102**
Research abstract preparation requirements	1.0%	1.0%	7.9%	28.7%	61.4%	
	1	1	8	29	62	**101**
Development opportunities beyond conducting research (attending seminars, taking courses, pursuing competitions, or scholarships, presenting or publishing research, etc.)	12.7%	0.0%	11.8%	13.7%	61.8%	
	13	0	12	14	63	**102**

Apprentices were also asked about their satisfaction with access to their mentor. As can be seen in Table 34, 55% of responding apprentices indicated their mentor was always available (an increase of 20% from 2015), and 25% that their mentor was available more than half of the time. Few apprentices (4%) indicated that their mentor was available half of the time or less.

Table 34. Apprentice Reports of Availability of Mentors (n=102)

Choice	Response Percent	Response Total
I did not have a mentor	0.98 %	1
The mentor was never available	0.00 %	0
The mentor was available less than half of the time	4.90 %	5
The mentor was available about half of the time of my project	14.71 %	15
The mentor was available more than half of the time	24.51 %	25
The mentor was always available	54.90 %	56

Similarly, apprentices were asked about their satisfaction with their mentors and the research experience (see Chart 35). The majority of apprentices indicated being "very much" satisfied with each of the features, with the vast majority being at least somewhat satisfied with each feature. For example, 80% of apprentices indicated "very much" when asked about their research experience overall, with another 18% indicating "somewhat." Similarly, 75% were very much satisfied with their working relationship with their group or team; 65% reported being very much satisfied with the time spent doing meaningful research, and 67% with the time spent with their mentor.

Chart 35. Apprentice Satisfaction with Their Experience (n=102)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
My working relationship with my mentor	1.0%	1.0%	6.9%	17.6%	73.5%	
	1	1	7	18	75	**102**
My working relationship with the group or team	2.0%	2.0%	6.9%	14.7%	74.5%	
	2	2	7	15	76	**102**
The amount of time I spent doing meaningful research	0.0%	2.0%	10.8%	22.5%	64.7%	
	0	2	11	23	66	**102**
The amount of time I spent with my research mentor	1.0%	1.0%	12.7%	18.6%	66.7%	
	1	1	13	19	68	**102**
The research experience overall	0.0%	1.0%	1.0%	17.6%	80.4%	
	0	1	1	18	82	**102**

Apprentices were provided an opportunity to provide additional feedback on their overall satisfaction with their REAP experience in an open-ended item on the survey. Of the 76 apprentices who answered this question, 74 (97%) commented on only positive aspects of the program. These responses were sometimes as simple as, "It was good, I'm sad to go" and "By far the best educational experience I have had ever." Other times, they provided more detail about what they enjoyed, such as in the following examples:

> *I am very satisfied with my REAP experience. Coming in to the program I had expected to learn something new, refresh my memory, and improve skills, and I did just that. REAP helped me to realize that the career I had wanted to pursue was really not for me. I would still like to work in STEM, but in a field other than Computer Science. If I had not participated in the program, I would not have realized this until later. It would have been nice to go on another trip or two, but the visit to ERDC was a great experience. I would definitely recommend this program to someone else.* (REAP Apprentice)

> *My overall satisfaction with my REAP experience was exciting, amazing, fun, and a great opportunity. I have learn many things retaining to engineering careers, other career options, and tips for getting through college. This experience was worth going from 9:00-4:00 o'clock for 5 days out of a week. The mentors were fun to hang around with, and I felt comfortable around them. Their grad students were very helpful, and nice. When our mentor(s) wouldn't be there the grad students would interact with us, and even talk to us about their college experiences. The REAP is an amazing program for people interested in STEM, and I'm very glad that I got accepted into it.* (REAP Apprentice)

> *I believe that REAP is really trying to help students be success while showing them new things. I think that REAP is a great opportunity and that it should be broadened and made bigger so that more people can experience such a great thing.* (REAP Apprentice)

Other responses included positive comments, but had some caveats. For example, one apprentice indicated that it was overall an educational experience, but they wanted to have less down time. In this apprentice's words:

> *I overall enjoyed the REAP program this year. I loved the experiment, I enjoyed talking to the mentors about their studies, and I very much enjoyed interacting with college students who always give helpful tips when you needed them. However, I did not like the fact that we had a whole lot of down time. To be honest, I really did get lazy and tired a lot easily. You do not have to force the future REAP students to always do stuff, but make sure that they are challenged. I can say out of experience that I always do my best work when I am challenged. Plus, challenging your students will not only have them use their STEM knowledge at REAP or in a classroom, but it will encourage them to bring that kind of thinking home with them.* (REAP Apprentice)

Input into how to improve the REAP program was also sought and 68 apprentices gave at least idea for improvement. The most common theme in the responses to this open-ended item, described by 21 (31%), was that the apprentices

wanted more hands-on or meaningful work in STEM. The second most common response, mentioned by 9 (13%) had to do with broadening REAP to include more students. Five of the apprentices mentioned only the need for better communication between the program and the apprentice, and 6 suggested improving REAP by increasing the stipend. These comments are similar to sentiments expressed about the 2014 and 2015 program.

Mentors reported being very much satisfied with the program components they experienced (see Chart 36). For example, 66% of mentors reported being very much satisfied with support for instruction during program activities, 60% were very much satisfied with communication with REAP organizers and the application process, and 56% were very much satisfied with research abstract preparation requirements.

Chart 36. Mentor Satisfaction with REAP Program Features (n=32)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	34.4%	0.0%	0.0%	6.3%	59.4%	
	11	0	0	2	19	32
Other administrative tasks (in-processing, network access, etc.)	34.4%	0.0%	3.1%	9.4%	53.1%	
	11	0	1	3	17	32
Communicating with Academy of Applied Science (AAS)	54.8%	0.0%	3.2%	9.7%	32.3%	
	17	0	1	3	10	31
Communicating with REAP organizers	28.1%	0.0%	6.3%	6.3%	59.4%	
	9	0	2	2	19	32
Support for instruction or mentorship during program activities	12.5%	3.1%	6.3%	12.5%	65.6%	
	4	1	2	4	21	32
Stipends (payment)	34.4%	0.0%	9.4%	15.6%	40.6%	
	11	0	3	5	13	32
Research abstract preparation requirements	12.5%	6.3%	12.5%	12.5%	56.3%	
	4	2	4	4	18	32

The mentor questionnaire also included open-ended items asking for their opinions about the program. Mentors were asked to identify the three most important strengths of REAP; 27 out of 34 mentors (79%) responded to this question. Although several important aspects of the program were listed, the most frequently described was providing apprentices with hands-on research experiences (22 mentors, or 81%). Mentors wrote things like "gives students an

introduction to STEM" and "exposes high school students to real research programs." This sentiment was echoed in the mentor phone interviews. As two mentors said:

> *They open their eyes to what the possibilities are with respect to engineering, science, and mathematics. Most of these youngsters that we serve in REAP come from high need schools or schools that have a large percentage of low or free lunch students. Many of these schools don't have the kind of activities that being in a real research lab would offer. They really don't have an understanding. In fact, most kids, if their parents are in science or engineering, don't even have the slightest idea what their parents are doing. You can't expect kids just reading out of a textbook to figure out what science is all about and how exciting it can be to discover something on your own, or be in a lab where people are really focused on solving a particular problem. It's just an opportunity that kids just don't have available to them unless there's some kind of special program that provides them that opportunity.*
> *I think it's just an exceptional program with respect to that and to target these youngsters, I think, is very critical as well, although I think that there are kids that are in very well to do districts and schools and private schools that should also have this kind of experience.* (REAP Mentor)

> *The value to the REAP program is introducing the young high school students who are passionate know about engineering, science, and math, to expose them to some of the research that happens. For instance, how do you get a person, we'll say high school, interested in math, science, physics, engineering, and so forth? We lose a lot of them because it's the, "Hey, I'm just doing math, just sitting here doing math and taking these classes. I don't see the applied side." What this allows the high school students to do is to get exposure to some of the research side of things early and get them excited about the research. What that leads to is, maybe getting more involved going into engineering and math and then we can get more people in the program. We've got to keep our competitive edge. As America, we really need to have those careers. We can all have our people excited about them.* (REAP Mentor)

Other responses to the open-ended questionnaire item focused on the benefit to the students because of REAP's opportunity for teamwork/collaboration among apprentices and scientists (21%), and that the experience allowed more support for students from groups underrepresented in STEM fields (19%).

Mentors were also asked to provide three ways in which REAP should be improved for future participants. Of the 24 individuals who responded to this question, three mentors indicated the need for education about other DoD STEM careers and AEOP opportunities, two suggested an increased stipend, two suggested modifying deadlines so that there was more time to interview and make decisions. Also two mentors suggested an informal meeting of all REAP students so they could share their experiences.

Mentors shared their overall satisfaction with their REAP experience in the final open-response item. Of the 25 individuals who responded to this question, 96% described having a positive experience. Nearly all of these responses

included a positive comment about the program, along with listing one or more ways in which the program was beneficial to apprentices. For example:

> *REAP clarifies to the student that STEM is not too difficult and can be interesting. Furthermore, the hands on activities conducted through the REAP program enables the students to:*
> *1. See application of STEM*
> *2. Prepare of college in STEM*
> *3. Be creative*
> *4. Learn state-of-the-art applications* (REAP Mentor)

> *I have been a REAP mentor for a number of years. I am always impressed by the quality of the students in this program and by their desire to continue into STEM fields in college. This is extremely important if the USA is to continue as the scientific leader in the world. Giving students a research experience early in their academic career is the best way to recruit them into STEM.* (REAP Mentor)

> *Excellent opportunity to hone teaching and mentoring skills by providing an environment where challenging topics will be explored with a broad and multi background audience.* (REAP Mentor)

> *I am very happy with the REAP experience. The students were highly motivated and excited. It was helpful to have funds to purchase supplies for them because we were able to modify experiments more efficiently. This is a wonderful program that will continue to strongly impact future students.* (REAP Mentor)

> *The student I had was hard working and never hesitated to ask questions whenever she had any. I think she gained a good amount of knowledge working in the lab. Also she started reading and understanding the chemistry much more than I expected it to be. It' a good experience for me to work with a REAP student and I hope to work with another student again.* (REAP Mentor)

The one mentor who expressed some concern for the program stated:

> *Overall, I am very glad that a program like this exists to give students incentive to venture out and get hands-on experience in a STEM field. Yet, the program seems very underdeveloped. The program only connects the students to their research opportunities and keeps very little contact with the students throughout the research experience. No expectations are set for the student and mentor, therefore, many times, even though research is slow, the student has very little to do and is forced to come into the lab anyway and just sit and wait until they can leave for the day. It would be preferable for REAP to assign periodic assignments for students to do, such as an annotated bibliography, literature review, end-of-research presentation, etc...* (REAP Mentor)

In summary, findings from the Actionable Program Evaluation demonstrate success for REAP in providing a program that actively engages students from underrepresented backgrounds in authentic STEM experiences, including opportunities

to learn important STEM practices. In FY16, REAP continued to build on previous years' progress of providing apprentices with opportunities to learn about DoD or STEM job/careers. Apprentices and mentors continue to be very satisfied with the program and their overall experiences.

Outcomes Evaluation

The FY16 evaluation of REAP continued to include measures of several outcomes relating to AEOP and program objectives, including impacts on apprentices' STEM competencies (e.g., knowledge and skills), STEM identity and confidence, interest in and intent for future STEM engagement (e.g., further education, careers), attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[10] STEM competencies are necessary for a STEM-literate citizenry. STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of REAP measured apprentices' self-reported gains in STEM competencies and engagement in opportunities intended to develop what is considered to be a critical STEM skill in the 21st century—collaboration and teamwork.

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

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

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

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

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

STEM Knowledge and Skills

Nearly all responding apprentices reported gains in their STEM knowledge as a result of the REAP program, with large majorities indicating large or extreme gains in each area (see Chart 37). Large or extreme gains were reported by 84% of apprentices on their knowledge of research conducted in a STEM topic/field, and 73% on their knowledge of a STEM topic/field in depth. Similar impacts were reported on knowledge of how professionals work on real problems in STEM (86%), knowledge of what everyday research work is like in STEM (89%), and knowledge of research processes, ethics, and rules for conduct in STEM (76%). Mentors reported similar impacts on their apprentices' STEM knowledge.

Chart 37. Apprentice Report of Impacts on STEM Knowledge (n=102)

	No gain	A little gain	Some gain	Large gain	Extreme gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	2.9%	24.5%	31.4%	41.2%	
	0	3	25	32	42	**102**
Knowledge of research conducted in a STEM topic or field	0.0%	1.0%	14.9%	37.6%	46.5%	
	0	1	15	38	47	**101**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	1.0%	22.8%	32.7%	43.6%	
	0	1	23	33	44	**101**
Knowledge of how scientists and engineers work on real problems in STEM	1.0%	2.0%	10.8%	34.3%	52.0%	
	1	2	11	35	53	**102**
Knowledge of what everyday research work is like in STEM	0.0%	0.0%	10.8%	32.4%	56.9%	
	0	0	11	33	58	**102**

For further analysis, these apprentice questionnaire items were combined into a composite variable[11] to test for differential impacts across subgroups of apprentices (based on gender, race/ethnicity). There were no significant differences between any of the subgroups; in other words, the subgroups of apprentices reported similar impacts of the program on their STEM knowledge.

Perceived impacts on STEM skills—i.e., apprentices' abilities to use STEM practices, were also examined in the survey. Apprentices reported large and extreme gains on all of the STEM competencies on the survey. Table 38 displays the percentage of responding apprentices reporting large or extreme gains in science-related practice. Apprentices reported large or extreme gains on their ability to support an explanation for an observation with data from experiments (74%),

[11] The Cronbach's alpha reliability for these 5 items was 0.871.

supporting an explanation with STEM knowledge (74%), integrating information from technical or scientific texts (66%), and using knowledge and creativity to suggest a testable explanation for an observation (66%).

Table 38. Apprentices Reporting Gains in STEM Competencies (n=102)

	No gain	A little gain	Some gain	Large gain	Extreme gain	Response Total
Asking a question that can be answered with one or more scientific experiments	1.0%	8.9%	27.7%	29.7%	32.7%	
	1	9	28	30	33	**101**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	2.0%	2.9%	29.4%	31.4%	34.3%	
	2	3	30	32	35	**102**
Considering different interpretations of data when deciding how the data answer a question	2.0%	4.9%	26.5%	37.3%	29.4%	
	2	5	27	38	30	**102**
Supporting an explanation for an observation with data from experiments	1.0%	2.9%	22.5%	39.2%	34.3%	
	1	3	23	40	35	**102**
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	1.0%	2.9%	22.5%	37.3%	36.3%	
	1	3	23	38	37	**102**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	2.0%	7.8%	30.4%	29.4%	30.4%	
	2	8	31	30	31	**102**
Defending an argument that conveys how an explanation best describes an observation	2.0%	14.7%	30.4%	22.5%	30.4%	
	2	15	31	23	31	**102**
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	2.0%	13.7%	27.5%	26.5%	30.4%	
	2	14	28	27	31	**102**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	2.9%	2.9%	28.4%	33.3%	32.4%	
	3	3	29	34	33	**102**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	2.9%	3.9%	21.6%	36.3%	35.3%	
	3	4	22	37	36	**102**

For further analysis, these apprentice questionnaire items were combined into a composite variable[12] to test for differential impacts across subgroups of apprentices (based on gender, race/ethnicity). There were no significant differences between any of the subgroups; in other words, the subgroups of apprentices reported similar impacts of the program on their STEM knowledge. The impact of REAP on "21st Century Skills"[13] that are necessary across a wide variety of fields were also examined in the survey. As can be seen in Chart 39, about three quarters of responding apprentices reported large or extreme gains on each of these skills, including working well with people from all backgrounds (81%), making changes with things do not go as planned (86%), communicating effectively with others (80%), learning to work independently (72%), and viewing failure as an opportunity to learn (80%). Apprentices reported similar gains regardless of race/ethnicity and gender. In addition, mentor reports of apprentice gains in this area are generally similar to those of the apprentices, although the mentors often reported greater apprentice gains.

Chart 39. Apprentice Report of Impacts on 21st Century Skills (n=101)

	No gain	A little gain	Some gain	Large gain	Extreme gain	Response Total
Learning to work independently	5.0%	3.0%	19.8%	37.6%	34.7%	
	5	3	20	38	35	**101**
Setting goals and reflecting on performance	2.0%	3.0%	16.8%	38.6%	39.6%	
	2	3	17	39	40	**101**
Sticking with a task until it is finished	1.0%	4.0%	11.9%	38.6%	44.6%	
	1	4	12	39	45	**101**
Making changes when things do not go as planned	0.0%	4.0%	9.9%	35.6%	50.5%	
	0	4	10	36	51	**101**
Working well with people from all backgrounds	1.0%	4.0%	13.9%	34.7%	46.5%	
	1	4	14	35	47	**101**
Including others' perspectives when making decisions	4.0%	5.0%	14.0%	36.0%	41.0%	
	4	5	14	36	41	**100**
Communicating effectively with others	1.0%	5.9%	12.9%	34.7%	45.5%	
	1	6	13	35	46	**101**
Viewing failure as an opportunity	2.0%	4.0%	13.9%	37.6%	42.6%	

[12] The Cronbach's alpha reliability for these 10 items was 0.944.
[13] The Cronbach's alpha reliability for these 8 items was 0.869.

to learn	2	4	14	38	43	**101**

STEM Identity and Confidence

Increasing REAP participants' STEM knowledge and skills are important for increasing the likelihood that they will pursue STEM further in their education and/or careers. However, they are unlikely to do so if they do not see themselves as capable of succeeding in STEM.[14] Consequently, the apprentice questionnaire included a series of items intended to measure the impact of REAP on apprentices' STEM identity.[15] These data are shown in Chart 40 and strongly suggest that the program has had a positive impact in this area. For example, 81% of responding apprentices reported a large or extreme gain in sense of accomplishing something in STEM. Similarly, substantial proportions of apprentices reported large or greater gain in their desire to build relationships with their mentors (83%), connecting a STEM topic to a personal interest (76%), and feeling prepared for more challenging STEM activities (79%). In addition, 82% reported an increase in their confidence to try out new ideas or procedures, and 65% reported that REAP was influential in deciding on a path to pursue a STEM career. There were no differences in impact based on gender and race/ethnicity.

Chart 40. Apprentice Report of Impacts on STEM Identity (n=99)

	No gain	A little gain	Some gain	Large gain	Extreme gain	Response Total
Interest in a new STEM topic	3.0%	7.1%	25.3%	27.3%	37.4%	
	3	7	25	27	37	**99**
Deciding on a path to pursue a STEM career	2.0%	8.1%	25.3%	27.3%	37.4%	
	2	8	25	27	37	**99**
Sense of accomplishing something in STEM	3.0%	3.0%	13.1%	27.3%	53.5%	
	3	3	13	27	53	**99**
Feeling prepared for more challenging STEM activities	0.0%	2.0%	19.2%	28.3%	50.5%	
	0	2	19	28	50	**99**
Confidence to try out new ideas or procedures on my own in a STEM project	1.0%	2.0%	15.2%	32.3%	49.5%	
	1	2	15	32	49	**99**
Patience for the slow pace of STEM research	2.0%	5.1%	15.2%	28.3%	49.5%	
	2	5	15	28	49	**99**

[14] 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.

[15] The Cronbach's alpha reliability for these 8 items was 0.909.

Desire to build relationships with mentors who work in STEM	1.0%	5.1%	11.1%	25.3%	57.6%	
	1	5	11	25	57	**99**
Connecting a STEM topic or field to my personal values	3.0%	1.0%	20.2%	32.3%	43.4%	
	3	1	20	32	43	**99**

Interest and Future Engagement in STEM

The REAP evaluation included a focus on the AEOP key goal to develop a STEM-literate citizenry. In order to examine the impact of REAP on apprentices' interest in future engagement in STEM, participants were asked to reflect on their intentions to engage in STEM activities outside of school, as well as their interest level in participating in future AEOP programs. As can be seen in Chart 41, apprentices indicated they were more likely to engage in many of these activities as a result of REAP. For example, 90% reported being more likely to work on a STEM project or experiment in a university or professional setting; 84% to take an elective STEM class; 85% to participate in a STEM camp, club, or competition; and 76% to mentor or teach other students about STEM. A composite score was created from these items,[16] and composite scores were compared across subgroups of apprentices. There were no statistically significant differences by race/ethnicity or gender.

Chart 41. Change in Likelihood Apprentice will Engage in STEM Activities Outside of School (n=100)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	0.0%	3.0%	36.0%	43.0%	18.0%	
	0	3	36	43	18	**100**
Tinker (play) with a mechanical or electrical device	1.0%	3.0%	34.0%	34.0%	28.0%	
	1	3	34	34	28	**100**
Work on solving mathematical or scientific puzzles	0.0%	3.0%	23.0%	50.0%	24.0%	
	0	3	23	50	24	**100**
Use a computer to design or program something	1.0%	8.0%	33.0%	30.0%	28.0%	
	1	8	33	30	28	**100**
Talk with friends or family about STEM	0.0%	3.0%	19.0%	39.0%	39.0%	
	0	3	19	39	39	**100**

[16] These 10 items had a Cronbach's alpha reliability of 0.844.

Mentor or teach other students about STEM	0.0%	4.0%	20.0%	41.0%	35.0%	
	0	4	20	41	35	**100**
Help with a community service project related to STEM	0.0%	3.0%	17.0%	39.0%	41.0%	
	0	3	17	39	41	**100**
Participate in a STEM camp, club, or competition	0.0%	2.0%	13.0%	36.0%	49.0%	
	0	2	13	36	49	**100**
Take an elective (not required) STEM class	0.0%	1.0%	15.2%	32.3%	51.5%	
	0	1	15	32	51	**99**
Work on a STEM project or experiment in a university or professional setting	0.0%	2.0%	8.0%	35.0%	55.0%	
	0	2	8	35	55	**100**

A large majority (79%) of participants indicated being interested in participating in REAP again; 63% in SEAP, 61% in URAP, and 61% in SMART (see Chart 42). These results are encouraging these programs were among the programs mentors most frequently discussed with their apprentices. Roughly equal proportions of apprentices (~10-25%) expressed having no interest or a little interest in JSHS, GEMS Near Peers, and UNITE. The large percentages (28-44%) of REAP apprentices that have not heard of the other programs is notable.

Chart 42. Apprentice Interest in Future AEOP Programs (n=101)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
Gains in the Education of Mathematics and Science (GEMS)	36.7%	9.2%	11.2%	22.4%	20.4%	
	36	9	11	22	20	**98**
UNITE	36.4%	10.1%	15.2%	13.1%	25.3%	
	36	10	15	13	25	**99**
Junior Science & Humanities Symposium (JSHS)	34.7%	19.4%	9.2%	14.3%	22.4%	
	34	19	9	14	22	**98**
Science & Engineering Apprenticeship Program (SEAP)	17.8%	6.9%	11.9%	16.8%	46.5%	
	18	7	12	17	47	**101**
Research & Engineering Apprenticeship Program (REAP)	3.0%	6.1%	12.1%	18.2%	60.6%	
	3	6	12	18	60	**99**

High School Apprenticeship Program (HSAP)	24.2%	9.1%	10.1%	21.2%	35.4%	
	24	9	10	21	35	**99**
College Qualified Leaders (CQL)	32.3%	4.0%	12.1%	15.2%	36.4%	
	32	4	12	15	36	**99**
GEMS Near Peer Mentor Program	43.4%	9.1%	10.1%	14.1%	23.2%	
	43	9	10	14	23	**99**
Undergraduate Research Apprenticeship Program (URAP)	28.0%	2.0%	9.0%	18.0%	43.0%	
	28	2	9	18	43	**100**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	23.0%	1.0%	15.0%	19.0%	42.0%	
	23	1	15	19	42	**100**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	38.4%	5.1%	11.1%	12.1%	33.3%	
	38	5	11	12	33	**99**

As can be seen in Chart 43, participating in REAP was most likely to be rated as impacting their awareness of AEOP "somewhat" or "very much" (82%). Their mentor (66%) was also rated by a majority of apprentices as having at least somewhat of an impact on their awareness of AEOP programs, as well as the AEOP website (70%). This is a change from 2015, when the majority of apprentices did not report that the AEOP website impacted their awareness of AEOPs.

Chart 43. Impact of Resources on Apprentice Awareness of AEOPs (n=102)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	47.1%	2.9%	22.5%	14.7%	12.7%	
	48	3	23	15	13	**102**
Army Educational Outreach Program (AEOP) website	14.7%	1.0%	14.7%	18.6%	51.0%	
	15	1	15	19	52	**102**
AEOP on Facebook, Twitter, Pinterest or other social media	53.9%	5.9%	18.6%	9.8%	11.8%	
	55	6	19	10	12	**102**
AEOP brochure	20.6%	2.9%	13.7%	30.4%	32.4%	
	21	3	14	31	33	**102**
It Starts Here! Magazine	65.7%	8.8%	14.7%	5.9%	4.9%	

	67	9	15	6	5	**102**
My REAP mentor(s)	11.9%	6.9%	14.9%	17.8%	48.5%	
	12	7	15	18	49	**101**
Invited speakers or "career" events during REAP	41.6%	10.9%	13.9%	12.9%	20.8%	
	42	11	14	13	21	**101**
Participation in REAP	7.8%	2.0%	7.8%	11.8%	70.6%	
	8	2	8	12	72	**102**

Attitudes toward Research

A focus of the AEOP apprenticeship programs is to raise awareness of and improve attitudes and interest in the DoD research. In order to gauge apprentices' attitudes in this area, the questionnaire also asked about their opinions of what DoD researchers do and the value of DoD research more broadly. The data indicate that most responding apprentices have favorable opinions (see Chart 44). For example, 79% agreed or strongly agreed that DoD research develops cutting-edge technologies, 80% agree that DoD research is valuable to society, 80% that DoD researchers solve real-world problems, and 79% that DoD researchers advance science and engineering fields.

Chart 44. Apprentice Opinions about DoD Researchers and Research (n=101)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.0%	3.0%	17.8%	36.6%	42.6%	
	0	3	18	37	43	**101**
DoD researchers develop new, cutting edge technologies	0.0%	2.0%	18.8%	33.7%	45.5%	
	0	2	19	34	46	**101**
DoD researchers solve real-world problems	0.0%	2.0%	18.0%	35.0%	45.0%	
	0	2	18	35	45	**100**
DoD research is valuable to society	0.0%	3.0%	17.0%	32.0%	48.0%	
	0	3	17	32	48	**100**

Education and Career Aspirations

The REAP program, like the other AEOP programs, is focused on positively impacting apprentices' future education and career aspirations. The participant questionnaire asked apprentices to share how far they wanted to go in school before

and after participating in REAP. As can be seen in Table 45, even before their experience with REAP, most students were interested in obtaining a Bachelor's degree or higher. Overall the percentages shifted to the apprentices (see Table 46) wanting to pursue terminal degrees, such as getting a Ph.D. (from 18% before REAP to 32% after REAP) and a combined M.D./Ph.D. (from 8% to 16%).

Table 45. Apprentice Education Aspirations Before REAP (n=101)

Choice	Response Percent	Response Total
Graduate from high school	0.99 %	1
Go to a trade or vocational school	0.00 %	0
Go to college for a little while	0.99 %	1
Finish college (get a Bachelor's degree)	21.78 %	22
Get more education after college	8.91 %	9
Get a master's degree	19.80 %	20
Get a Ph.D.	17.82 %	18
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	20.79 %	21
Get a combined M.D. / Ph.D.	7.92 %	8
Get another professional degree (law, business, etc.)	0.99 %	1

Table 46. Apprentice Education Aspirations After REAP (n=101)

Choice	Response Percent	Response Total
Graduate from high school	0.00 %	0
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)	5.94 %	6
Get more education after college	6.93 %	7
Get a master's degree	18.81 %	19
Get a Ph.D.	31.68 %	32
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	16.83 %	17
Get a combined M.D. / Ph.D.	15.84 %	16
Get another professional degree (law, business, etc.)	3.96 %	4

REAP apprentices were asked what kind of work they expect to be doing at age 30, both reflecting on what their aspiration was before participating in REAP and after REAP (see Table 47 and 48). Some apprentices expressed interest in STEM-related careers both before and after participating in REAP. For example, 24% indicated aspiring to a career in engineering before REAP, with another 23% interested in medicine. After REAP, 31% of apprentices expressed interest in engineering, and 22% in medicine.

Table 47. Apprentice Career Aspirations Before REAP (n=101)

Choice	Response Percent	Response Total
Undecided	8.91 %	9
Science (no specific subject)	3.96 %	4
Physical science (physics, chemistry, astronomy, materials science)	6.93 %	7
Biological science	1.98 %	2
Earth, atmospheric or oceanic science	0.00 %	0
Environmental science	1.98 %	2
Computer science	4.95 %	5
Technology	1.98 %	2
Engineering	23.76 %	24
Mathematics or statistics	1.98 %	2
Medicine (doctor, dentist, veterinarian, etc.)	22.77 %	23
Health (nursing, pharmacy, technician, etc.)	6.93 %	7
Social science (psychologist, sociologist, etc.)	3.96 %	4
Teaching, STEM	0.99 %	1
Teaching, non-STEM	0.00 %	0
Business	1.98 %	2
Law	1.98 %	2
Military, police, or security	1.98 %	2
Art (writing, dancing, painting, etc.)	0.00 %	0
Skilled trade (carpenter	0.00 %	0
Other, (specify):	2.97 %	3

Table 48. Apprentice Career Aspirations After REAP (n=101)

Choice	Response Percent	Response Total
Undecided	3.00 %	3
Science (no specific subject)	3.00 %	3
Physical science (physics, chemistry, astronomy, materials science)	4.00 %	4
Biological science	7.00 %	7
Earth, atmospheric or oceanic science	0.00 %	0
Environmental science	5.00 %	5
Computer science	3.00 %	3
Technology	1.00 %	1
Engineering	31.00 %	31
Mathematics or statistics	1.00 %	1
Medicine (doctor, dentist, veterinarian, etc.)	22.00 %	22
Health (nursing, pharmacy, technician, etc.)	7.00 %	7
Social science (psychologist, sociologist, etc.)	2.00 %	2
Teaching, STEM	1.00 %	1
Teaching, non-STEM	0.00 %	0
Business	1.00 %	1
Law	1.00 %	1
Military, police, or security	2.00 %	2
Art (writing, dancing, painting, etc.)	1.00 %	1
Skilled trade (carpenter, electrician, plumber, etc.)	0.00 %	0
Other, (specify):	5.00 %	5

"When you're in school you don't exactly get to do research. It's kind of hard to apply all the things you learn in the classroom to an actual task or activity. The resources are often quite limited. You're not going to have the time in school, nor are you going to have the equipment." – REAP Apprentice

Apprentices were also asked how they expected to use their STEM knowledge, skills, and/or abilities in their work when they are age 30. As can be seen in Table 49, all apprentices expect to use STEM somewhat in their career. A large majority (91%) expects to use STEM 75-100% of the time in their work, 4% expect to use STEM 51-75% of the time, and 5% expect to use STEM 26-50% of the time. None of the apprentices expected never to use STEM in their work at age 30.

Table 49. Apprentices Expecting to Use STEM in Their Work at Age 30 (n=100)

Choice	Response Percent	Response Total
not at all	0.00 %	0
up to 25% of the time	5.00 %	5
up to 50% of the time	4.00 %	4
up to 75% of the time	42.00 %	42
up to 100% of the time	49.00 %	49

Overall Impact

Apprentices were asked about the overall impacts of participating in REAP on them personally. From these data, it is clear that apprentices thought the program had a substantial impact on them (see Table 50). For example, a large majority of responding apprentices indicated being more confident in their STEM knowledge, skills, and abilities after participation, with 62% reporting that REAP contributed to this impact and another 32% reporting that REAP was the primary reason for this impact. Similarly, apprentices indicated increased interest in participating in STEM activities outside of school assignments (54% reporting that REAP contributed, 33% reporting that REAP was the primary reason) and more awareness of other AEOPs (35% and 50%). Apprentices also reported interest in participating in other AEOPs (45% and 47%), interest in taking STEM classes (57% and 19%), interest in earning a STEM degree (55% and 23%), and pursuing a STEM career (51% and 23%). These items were combined into a composite variable[17] to test for differences among subgroups of apprentices; there were no significant differences found related to gender and race/ethnicity.

[17] The Cronbach's alpha reliability for these 10 items was 0.860.

Table 50: Apprentice Opinions of REAP Impacts (n=101)

	Disagree - This did not happen	Disagree - This happened but not because of REAP	Agree - REAP contributed	Agree - REAP was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	1.0%	5.0%	62.4%	31.7%	
	1	5	63	32	101
I am more interested in participating in STEM activities outside of school requirements	1.0%	12.9%	53.5%	32.7%	
	1	13	54	33	101
I am more aware of other AEOPs	9.9%	5.9%	34.7%	49.5%	
	10	6	35	50	101
I am more interested in participating in other AEOPs	5.0%	4.0%	44.6%	46.5%	
	5	4	45	47	101
I am more interested in taking STEM classes in school	2.0%	21.8%	57.4%	18.8%	
	2	22	58	19	101
I am more interested in earning a STEM degree	3.0%	19.8%	54.5%	22.8%	
	3	20	55	23	101
I am more interested in pursuing a career in STEM	5.0%	21.8%	50.5%	22.8%	
	5	22	51	23	101
I am more aware of Army or DoD STEM research and careers	16.8%	5.9%	34.7%	42.6%	
	17	6	35	43	101
I have a greater appreciation of Army or DoD STEM research	12.0%	5.0%	33.0%	50.0%	
	12	5	33	50	100
I am more interested in pursuing a STEM career with the Army or DoD	26.7%	9.9%	33.7%	29.7%	
	27	10	34	30	101

Apprentices were asked to list the three most important ways they benefited from the REAP program. The 72 open-ended responses fell into four categories: learning more about STEM research (50%), gaining stronger 21st Century skills such as confidence, patience and time management (19%), gaining more awareness of STEM careers (18%), and learning stronger communication skills and networking (13%).

Apprentice comments from the interviews expand on some of these impacts. As four apprentices said:

Being able to work in a lab, work with professors, and work with students sort of made me realize what research really was. It's helped me gain experience using all of the equipment I've learned about in my books and my studies. It's helped me really just apply the knowledge I've gained, but also learned something else in being able to study things that pertain to a subject of interest just for me. (REAP Apprentice)

We've been given hands-on opportunity, and, actually, had to go to a real labs where they have projects, different batch of real projects. I feel like I'm an actual engineer. I get to talk to them, and they help me learn about everything that they do. It made me want to pursue it more, because now, I know, exactly, what I'm getting myself into. In terms of school, I have an idea. (REAP Apprentice)

I think the biggest benefit was me learning that I do want to pursue an engineering career in life, and learning what engineering is actually all about. It's really important. A lot of people go to college and they want to be engineers because they're good in math and science, but they never actually realized how much work it takes and dedication and time. I learned that I really do love doing engineering. It's not just like a dream now. I can actually think about it because it's coming up in the next couple years. (REAP Apprentice)

I would say the biggest advantage or skill that I've gained from it is just being in this environment, being in an environment where you're doing something for the greater good, you're making an impact or trying to help society. And the little, tiny skills that you'll gain is stuff that will help you not only in school or college but in life in general, people skills, the actual technique skills, extra education, and those type of skills. (REAP Apprentice)

Summary of Findings

The FY16 evaluation of REAP collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to AEOP's and REAP's objectives and intended outcomes. A summary of findings is provided in Table 51.

Table 51. 2016 REAP Evaluation Findings	
Participant Profiles	
REAP continues to have success in serving historically underrepresented and underserved populations.	REAP experienced continued success in recruiting female students at a high rate. In fact, 73% of participants in FY16 were female, a population that is historically underrepresented in STEM fields. There was an increase in female apprentices (from 61% in 2015) for REAP.
	REAP was very successful in meeting the program requirement of providing outreach to students from historically underrepresented and underserved groups as defined in admission requirements using the AEOP definition (students must self-identify as meeting at least two of the following requirements: qualifies for free or reduced-price lunch; is a minority historically underrepresented in STEM (Alaskan Native, Native American, Black or African American, Hispanic, Native Hawaiian, or other Pacific Islander); is a female pursuing research in physical science, computer science, mathematics, or engineering; receives special education services; has a disability; speaks English as a second language; or is a potential first-generation college student). There were a total of 120 apprentices involved in REAP and 73% of the apprentices were female. 46% of apprentices reported their race/ethnicity as African American, 16% Asian/Pacific Islander, 14% Hispanic, 3% Native American, 18% Caucasian, and 3% did not report race/ethnicity.
	REAP continued to implement the bridge with UNITE, another AEOP program that serves students from underrepresented and underserved groups. The percentage of REAP apprentices who have participated in UNITE continues to increase from 2013 to 2016.
REAP mentors are gradually becoming more diverse from year to year.	FY16 mentors were remained predominantly male (68%) and White (41%). However, this did represent a decrease in the percentage of White mentors overall from 2015 and from 2014.
	A comparison of apprentice and mentor demographics suggested that many apprentices of underserved or underrepresented populations are not likely to have mentors sharing the same gender or race/ethnicity. Having a mentor who shares an apprentice's gender or race/ethnicity is a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.

REAP apprentices tend to want to pursue higher education degrees after attending REAP.	Before their experience with REAP, most students were interested in obtaining a Bachelor's degree or higher. Overall the percentages shifted to the apprentices (see Table 25b) wanting to pursue terminal degrees, such as getting a Ph.D. (from 18% before REAP to 32% after REAP) and a combined M.D./Ph.D. (from 8% to 16%).
Actionable Program Evaluation	
REAP apprentices were recruited from a more diverse variety of sources, rather than only at the local level. REAP mentors continue to learn about the program through personal contacts.	Mentors used a variety of methods to recruit apprentices. Many mentors indicated recruiting their apprentice(s) through applications from AAS or AEOP (38%), K-12 teachers at the local schools (34%), and informational materials sent to a K-12 setting (31%). About a quarter indicated colleagues from the workplace (22%). Communications from both a K-12 school (16%) and a university (16%) helped with recruitment. About the same amount of students were recruited from organizations that serve underserved or underrepresented populations (16%), and STEM or STEM education conferences (16%).
	The most frequently mentioned source of information about the local REAP program was someone who works at the school or university (19%) followed by school or university newsletter, email, or website (17%) and someone who works with the program (17%). Other sources mentioned relatively frequently were the AEOP website (13%), and past participant (12%).
	The sources that the responding mentors most frequently identified were a supervisor or superior (41%), a colleague (38%), the AEOP website (22%) and a past REAP participant (16%). In 2015 33% of responding mentors stated AAS as a source for learning about REAP as compared to 9% in 2016.
REAP is strongly marketed to students from historically underrepresented and underserved groups.	The RFP specified to university directors/mentors that the targeted participants were underrepresented and underserved high school students. In addition, the REAP administrator worked with all of the directors and mentors to ensure that the students being considered for the apprenticeships identified as coming from an underrepresented and underserved groups.
Participation in REAP helps students identify knowledge and skills for STEM careers.	Some apprentices expressed interest in STEM-related careers both before and after participating in REAP. For example, 24% indicated aspiring to a career in engineering before REAP, with another 23% interested in medicine. After REAP, 31% of apprentices expressed interest in engineering, and 22% in medicine.
	All apprentices expect to use STEM somewhat in their career. A large majority (91%) expects to use STEM 75-100% of the time in their work, 4% expect to use STEM 51-75% of the time, and 5% expect to use STEM 26-50% of the time. None of the apprentices expected never to use STEM in their work at age 30
REAP apprentices engage in meaningful STEM learning through analyzing or interpreting data and carrying out investigations.	86% of responding apprentices indicated analyzing or interpreting data on most days or every day; 76% reported carrying out investigations; and 79% reported posing questions to investigate. In addition, apprentices indicated being integrally involved the work of STEM on most days or every day, including drawing conclusions from an investigation (75%), using laboratory procedures and tools (85%), and carrying out an investigation (76%). However, 61% of apprentices did not build or create a computer model.

REAP mentors are improving efforts to promote AEOP opportunities and DoD STEM careers and some resources to promote other AEOP opportunities are useful.	Participating in REAP was most likely to be rated as impacting their awareness of AEOP "somewhat" or "very much" (82%). Their mentor (66%) was also rated by a majority of apprentices as having at least somewhat of an impact on their awareness of AEOP programs, as well as the AEOP website (70%). This is a change from 2015, when the majority of apprentices did not report that the AEOP website impacted their awareness of AEOPs.
	Participation in REAP (72%), REAP Program administrator or site coordinator (59%), and the AEOP website (41%) were most often rated as "very much" useful. Invited speakers, It Starts Here! Magazine, or "career" events and AEOP social media tended not to be seen as very useful, with large proportions of mentors indicating they did not experience these resources.
Connections between REAP and UNITE continue to grow stronger.	The percentage (20%) of REAP apprentices who have participated in UNITE continues to increase from 2013 to 2016. This represents a continued increased attendance in UNITE by REAP apprentices since 2013.
The REAP program is highly valued by apprentices and mentors.	98% of apprentices were satisfied with the physical location of REAP, 95% were satisfied with the stipends, 97% were satisfied with the registration process, 94% were satisfied with communication with REAP organizers and 85% were satisfied by the variety of STEM topics offered in REAP.
	66% of mentors reported being very much satisfied with support for instruction during program activities, 60% were very much satisfied with communication with REAP organizers and the application process, and 56% were very much satisfied with research abstract preparation requirements.
Outcomes Evaluation	
REAP apprentices reported large or extreme gains in STEM knowledge and competencies.	Nearly all responding apprentices reported gains in their STEM knowledge as a result of the REAP program, with large majorities indicating large or extreme gains in each area. Large or extreme gains were reported by 84% of apprentices on their knowledge of research conducted in a STEM topic/field, and 73% on their knowledge of a STEM topic/field in depth. Similar impacts were reported on knowledge of how professionals work on real problems in STEM (86%), knowledge of what everyday research work is like in STEM (89%), and knowledge of research processes, ethics, and rules for conduct in STEM (76%).
	Apprentices reported large or extreme gains on their ability to support an explanation for an observation with data from experiments (74%), supporting an explanation with STEM knowledge (74%), integrating information from technical or scientific texts (66%), and using knowledge and creativity to suggest a testable explanation for an observation (66%).
	Additionally, 97% of mentors reported supervising students while they were doing STEM research, and 97% provided students with constructive feedback on STEM competencies. The strategies of having students search for and review technical research, demonstrating laboratory techniques, and learning collaboratively was reported by at least 84% of the mentors.

REAP apprentices' reported gains in 21st Century Skills.	81% of responding apprentices reported a large or extreme gain in sense of accomplishing something in STEM. Similarly, substantial proportions of apprentices reported large or greater gain in their desire to build relationships with their mentors (83%), connecting a STEM topic to a personal interest (76%), and feeling prepared for more challenging STEM activities (79%). In addition, 82% reported an increase in their confidence to try out new ideas or procedures, and 65% reported that REAP was influential in deciding on a path to pursue a STEM career.
REAP mentors engaged in best practices and supported students engaged in STEM learning.	Mentors reported finding out about students' backgrounds and interests at the beginning of the program (84%), and most gave students real-life problems to investigate or solve (97%). Over 70% of the mentors reported asking students to relate outside events or activities to topics covered in the program and selecting readings or activities that relate to students' backgrounds. The majority of mentors also reported helping students understand how STEM can help them improve their communities (72%), and encouraging students to suggest new readings, activities, or projects (94%). Mentors also suggested other ways that they establish relevance, such as demonstrating how skills learned in the laboratory are pertinent to other fields.
	Mentors indicated having students listen to the ideas of other with an open mind (91%) and had them work on collaborative activities (91%). The vast majority had students explain difficult ideas to other (88%), and tell others about their backgrounds and interests (66%).
	Apprentices were asked to indicate what kind of work they expected to be doing at age 30, and the data were coded as STEM-related or non-STEM-related. The majority of the apprentices were interested in STEM-related careers before participating in REAP, and almost all were interested in STEM-related careers after participating in REAP.
REAP outcomes include apprentice learning about STEM topics that were new to them and applying STEM learning to real-life situations	Apprentices reported that they learned about STEM topics that were new to them (91%), and applied STEM learning to real-life situations (81%). Mentors were asked similar questions about the nature of the apprentices' experiences. Overall, their responses paint a similar picture of the REAP experience.
	Apprentices indicated they were more likely to engage in many of these activities as a result of REAP. For example, 90% reported being more likely to work on a STEM project or experiment in a university or professional setting; 84% to take an elective STEM class; 85% to participate in a STEM camp, club, or competition; and 76% to mentor or teach other students about STEM.
REAP gives apprentices opportunities to participate in STEM that they cannot get in school.	There is a statistically significant difference in student perceptions of STEM Learning and STEM Engagement when comparing these activities in School and REAP. Apprentices report significantly higher STEM Learning and STEM Engagement in REAP over school (Learning effect size is large with d = 2.14; Engagement effect size is large with d = 1.68).

Responsiveness to FY15 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY15 to programs and summarize efforts and outcomes reflected in the FY16 APR toward these areas.

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

Finding: Although the REAP mentor group was more diverse ethnically, there were fewer female mentors than in 2014. Efforts should be made to focus on increasing the number of female mentors, perhaps by encouraging junior faculty (typically more female professors are in the lower ranks in STEM fields) to partner with senior faculty to submit proposal to be a REAP site.

REAP FY16 Efforts and Outcomes: REAP mentor group continues to hold steady with similar numbers reported in 2015. Only 32% of the REAP mentors were female, a slight increase in Hispanic/Latino mentors, from 2% to 4% and a decrease in Black or African American mentors, from 21% to 17%. Conversely, 73% of REAP participants were female. All AEOP programs should be working to attain a mentor population that mirrors their respective participant groups. More targeted efforts should be executed to achieve this in FY17.

Finding: A number of apprentices suggested that the REAP program could be improved by extending the length of the experience. Similar to responses from FY14, many apprentices in FY 15 noted that 5-8 weeks was not enough time to learn about and get involved with a research project.

REAP FY16 Efforts and Outcomes: REAP program administration has been concerned about the continuum of STEM research education once students leave the lab at the end of the summer. REAP program administrators will determine if there are any mentors who are assisting students once the official apprenticeship ends and develop a plan to introduce to other universities.

Finding: Mentors and apprentices are overall not aware of DoD STEM research and careers. Forty-five percent of apprentices reported not learning about any DoD STEM careers during their REAP experience.

REAP FY16 Efforts and Outcomes: In FY16, student awareness of DoD STEM careers was 73%, an increase of 28% over FY15. The increased awareness of DoD STEM careers was due to weekly communication with apprentices and mentors that included the 2016 Guide to STEM Careers and the AEOP newsletters.

Finding: Mentors and apprentices mentioned that the amount of the stipend was too small. One mentor mentioned that they never paid themselves out of the funding, and rather they made sure the students had an appropriate stipend.

REAP FY16 Efforts and Outcomes: Stipend amounts across all apprenticeships seem to be inconsistent. Perhaps, AAS, Battelle and the CAM will discuss at a future date. In the meantime, AAS will continue to provide certificates of recognition/appreciation to students and mentors. AAS will also work with partners to determine if there are other incentives that are being used within the consortium.

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

Finding: REAP should continue to focus on growing the number of mentors participating in the program to work toward a 1:1 mentor/apprentice ratio. One potential strategy for consideration is to increase the amount of the mentor stipend (currently $1,000).

REAP FY16 Efforts and Outcomes: In FY16, REAP achieved a 1:1 mentor/apprentice ratio due to increased communication with directors. AAS also issued certificates of appreciation to all mentors in FY16. AAS will explore ways to provide more incentives for mentors, especially to more diverse population.

Finding: As was found in 2014, REAP apprentices report having little previous experience with AEOP and limited knowledge of other AEOP programs, even after participating in REAP. Given the goal of having apprentices progress from REAP into other AEOP programs, the program may want to have a systematic method to inform mentors in tangible ways to increase apprentices' exposure to AEOP.

REAP FY16 Efforts and Outcomes: In FY16, REAP student awareness of AEOP opportunities was 81%, well above the FY16 target of 60% and a definite increase from FY15. This increase in awareness was largely due to weekly communication to students and mentors that included all AEOP program information, AEOP newsletter, 2016 Guide to STEM Careers and a new social media campaign.

Finding: Exposure to DoD STEM careers and research are also areas targeted for improvement for REAP.

REAP FY16 Efforts and Outcomes: In FY16, REAP student awareness of DoD STEM careers was 73%. The increase in awareness was largely due to weekly communication to students and mentors that included all AEOP program information, AEOP newsletter, 2016 Guide to STEM Careers and a new social media campaign. In FY17, AAS will have more direct contact with mentors. AAS will also work with directors and mentors to develop best practices. AAS will also develop a web-based orientation for students and mentors. Due to the satisfactory results, AAS will continue weekly communication with students and mentors.

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

Finding: No findings tied to recommendations for REAP in this area in FY15.

FY16 Recommendations

Evaluation findings indicate that FY16 was a successful year overall for the REAP program. The REAP program has the goal of broadening the talent pool in STEM fields, and, overall, the program has been successful at attracting students from groups historically underrepresented and underserved in these fields. A primary area of growth for REAP has been in broadening diversity of participants. In particular, there has been a steady increase in the number of female apprentices. Strategies that have been shown to be effective for encouraging historically underserved and underrepresented students in STEM careers include providing role models for students, exposing them to different education and career possibilities, providing guidance on how to pursue specific education and career paths (e.g., what courses they need to take in school, how to navigate the college application process), and providing coaching on the "soft skills" (e.g., time management, communication skills) needed to be successful in STEM careers. This is an encouraging trend and it is expected that having more role models will continue to encourage students from groups historically underrepresented and underserved in STEM to participate in REAP.

Another area of strength for REAP is reported meaningful STEM learning in the REAP program. Both mentors and apprentices reported increased confidence in pursuing STEM activities. Most of the REAP apprentices intend to continue to pursue STEM activities outside of school, and outreach to these apprentices about other opportunities is essential. One example of a positive trend is the UNITE/REAP partnership, which continues to increase apprentices participating in both programs consistently since 2013.

While these successes for REAP are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY16 and beyond:

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

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

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

1. Although REAP has seen some success with informing both mentors and apprentices about DoD STEM careers, efforts should be made to help mentors and apprentices become more aware of opportunities to pursue DoD STEM careers. The program should continue to provide mentors and apprentices with new materials and

resources (website links, articles, etc.) that describe current DoD STEM research and careers which can be easily passed on to all REAP apprentices. Creating a network for mentors to form a community of practice where mentors can share their research activities with other mentors could be a first step to informing apprentices about other Army/DoD STEM careers. Some apprentices and mentors made suggestions that DoD STEM researchers visit REAP sites or hold a webinar to inform and inspire REAP apprentices to pursue work in this avenue.

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

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

Appendices

Appendix A

FY16 REAP Evaluation Plan

Purpose

Per the FY16 Army Education Outreach Program (AEOP) Annual Program Plan (APP), Purdue University will conduct an evaluation study of the Research and Engineering Apprenticeship Program (REAP) that includes two post-program questionnaires:

1. AEOP Participant Questionnaire to be completed by student participants of the REAP program at all university sites; and
2. AEOP Mentor Questionnaire to be completed by REAP mentors (typically a University Scientist or Engineer), and/or others who support students as they participate in the REAP program.

Questionnaires are the primary method of data collection for AEOP evaluation and collect information about participants' experiences with and perceptions of program resources, structures, and activities; potential benefits to participants; and strengths and areas of improvement for programs.

From FY14 to FY16, questionnaire assessments have been revised and shorted while maintaining alignment with:

- Army's strategic plan and AEOP Priorities 1 (STEM Literate Citizenry), 2 (STEM Savvy Educators) and 3 (Sustainable Infrastructure);
- Federal guidance for evaluation of Federal STEM investments (e.g., implementation and outcomes evaluation, outcomes evaluation of STEM-specific competencies, transferrable competencies, identifying with STEM, intentions to engage in STEM-related activities, and educational/career pathways);
- Best practices and published assessment tools in STEM education, informal STEM education, STEM outreach, and evaluation research communities;
- AEOP's vision to improve the quality of the data collected, focusing on changes in intended student outcomes and contributions of AEOPs like REAP effecting those changes.

Deployment of common questionnaires with items that are appropriate for all AEOP programs allows evaluators to compare findings across AEOPs and, if administered in successive years, to establish longitudinal studies of student outcomes through the pipeline of AEOP programming. Questionnaires incorporate batteries of items from established assessments that have been validated in published research making external comparisons possible.

All AEOPs are expected to administer a Participant and a Mentor questionnaire provided to them by Purdue University. AEOP-wide Participant and Mentor questionnaires have two versions each; an "advanced" version (for JSHS and apprenticeship programs) and a "basic" version (for GEMS, JSS, and REAP). Similar item sets are used in both versions, with slight modifications to item wording or the number of items used to accommodate the needs of participants from each individual program. Additionally, program-specific questionnaires have been customized to gather information about programmatic structures, resources, and activities that are unique to each AEOP.

Participant Questionnaire Administration Details

- Distribute the survey near or after the conclusion of the students' REAP experience;
- Please encourage participant participants to participate in AEOP evaluation efforts. Before, during, and after the REAP program activities please mention that questionnaires are forthcoming. It is also helpful to remind Principal Investigators (PIs) and mentors about questionnaires so they can encourage students to participate as well as a reminder for themselves to participate in the surveys;
- If other, non-AEOP, survey(s) will be administered to REAP students please encourage them to prioritize the completion of AEOP's REAP evaluation survey. These data are critical to maintain funding for REAP. Additionally, evaluators will release de-identified data from these assessments to individual REAP sites to help them focus program improvement efforts;
- The REAP survey will be distributed using the CVENT registration system so please inform students and mentors that their registration with CVENT is crucial for the AEOPs records and to look for further communication from the Academy of Applied Science (AAS) and the AEOP through the CVENT portal:

Participants – Evaluation Questionnaire Invitation

Dear REAP participant,

Evaluators from Purdue University are conducting a study to learn about student experiences in the Research and Engineering Apprenticeship Program (REAP). We are asking you to fill out this survey because you participated in REAP. Your feedback will be used to help us improve REAP for students in the future. The sponsor of REAP, the Army Educational Outreach Program (AEOP), is paying for this study. In 2016, more than 100 apprentices and 90 mentors will participate in REAP and evaluators from Purdue University want to hear from you and your mentor.

Here's how you can help:

1) *Complete the REAP Student Survey using the hyperlink below. Your parent or guardian has already provided permission for us to ask you to participate in the survey. Now, it is up to you to decide whether you want to participate or not. The survey takes 25-30 minutes to complete on average.*
   http://www.cvent.com/d/yfqw8b

2) *Pass this document along to the mentor(s) who supported you as you as you participated in REAP. Ask them to complete the* ***REAP Mentor Survey.*** *The survey will take 25-30 minutes. The link for the mentor survey is:*
   http://www.cvent.com/d/9fqw8l

If you have any questions about these surveys or your participation in the evaluation study ***please contact the Purdue University evaluation team:*** *Dr. Carla C. Johnson, carlacjohnson@purdue.edu or at (765) 494-0019.*

Thank you so much for your participation in the evaluation of REAP!

Mentor Questionnaire Administration Details

- Distribute the survey near or after the conclusion of the mentors' REAP experience;

- Encourage all adults serving as REAP mentors (typically a University Scientist or Engineer), and others who supported students as they participated in REAP, to complete the survey;
- Encourage mentor participation in the evaluation study before, during, and after program activities;
- If other, non-AEOP, survey(s) will be administered to adults please encourage them to prioritize the completion of AEOP's REAP evaluation survey. These data are critical to maintain funding for REAP. Additionally, evaluators will release de-identified data from these assessments to REAP sites to help them focus program improvement efforts;
- The REAP survey will be distributed using the CVENT registration records so please inform students and mentors that their registration is crucial for the AEOPs records and to look for further communication from AAS and the AEOP through the CVENT portal:

Adult Participants – Evaluation Questionnaire Invitation

Dear Colleague:

You are receiving this email because you participated in the 2016 Research and Engineering Apprenticeship Program (REAP) program in support of one or more students' learning experience(s).

Evaluators from Purdue University are conducting program evaluation on behalf of the Technology Student Association (AAS) and U.S. Army. The purpose of evaluation is to determine how well the Army Educational Outreach Program (AEOP) is achieving its primary mission – promoting student interest and engagement in science, technology, engineering, and mathematics (STEM). Purdue University is surveying adults who participated in REAP in support of students as they participated in the REAP program (REAP Mentors – University Scientists or Engineers). More than 100 students and 90 adults participated in the REAP program this year and Purdue University wants to hear from you!

Here's how you can help:

1) *Click on the link below and complete the **REAP Mentor Survey**. The survey will take about 25-30 minutes.*
   http://www.cvent.com/d/9fqw8l

2) *Pass an email along to those students you supported in REAP and ask them to complete the appropriate survey. Their survey also takes about 25-30 minutes to complete.*

*If you have any questions about the evaluation, these surveys, or your participation in the evaluation, **please contact the Purdue University evaluation team:** Dr. Carla C. Johnson, carlacjohnson@purdue.edu or at (765) 494-0019.*

Thank you so much for your participation in the evaluation of REAP.

Regards,

Telephone Interviews

Purpose

Per the FY16 Army Education Outreach Program (AEOP) Annual Program Plan (APP), Purdue University will conduct an evaluation study of REAP that includes telephone interviews with REAP mentors and apprentices.

Interviews provide the evaluation team first-hand opportunities to speak with participant and adult REAP participants. The contextual information gleaned from these interviews help evaluators understand the nuance of the evaluation data collected from questionnaires, adding depth to evaluative findings. PURDUE UNIVERSITY's interview assessment efforts focus on program successes and attempt to inform useful program changes so that REAP can improve in the future.

Evaluation activities during Purdue University's Phone Interview

- 8 – 12 one-on-one phone interviews with REAP apprentices (approx. 15-20 min. each);
- 5 – 8 one-on-one phone interviews with REAP mentors (approx. 15-20 min each);

Selecting Interview Participants

Purdue University will purposefully sample from REAP participants using CVENT enrollment data (site name, apprentice/mentor participant names, gender, & race/ethnicity). The IPA and Purdue University will "invite" selected participants that comprise the desired sample to participate via email through the CVENT portal. Participants will each RSVP prior to the scheduled interview date so that an alternate may be identified if needed.

Purposeful sampling is an attempt to assemble a sample of participants that are likely to provide information about the full range of experiences possible in REAP. The interview sample will be selected using the following information:

- Gender
- Grade level
- Racial/ethnic group
- Socio-economic status indicators (e.g., qualification for free or reduced-price lunches)

Scheduling and Technology:

Purdue University will establish dates and times for each interview that accommodate the program activities for each site. The majority of these dates will occur in mid to late July – the purpose of which is to speak with participants after they have experienced the majority of experiences available in their REAP program. Purdue University will attempt to convene interviews between 10 a.m. and 2 p.m. in each site's time zone to minimize disruption to the program.

A simple telephone will be used to conduct each interview. Evaluators at Purdue University will also use a recording device to record the interview. All recordings are used for note-taking and transcription purposes only. After transcription, audio files will be destroyed.

Obtaining Informed Assent/Consent: Prior to the Interview

Apprentice and mentor participants should be informed of the evaluation interview *before* it is conducted. This ensures that individuals do not feel pressured to participate. It would be ideal if Purdue University, the IPA, and/or site coordinators work together to invite apprentices and mentors to participate and provide them with demographic surveys and consent/assent forms:

- Use the recruitment email text below to invite apprentices and mentors to volunteer for interviews.
- Be sure to include the date and time of the interview as well as the location of the telephone that they can use for the interview call (if needed).
- PURDUE UNIVERSITY evaluators will also provide and review the assent/consent forms with participants just prior to conducting the Interview. Interviews will be audio-recorded for note taking purposes.

Interview Invitation Email:

Dear [participant],

I would like to inform you that evaluators from Purdue University will be carrying out interviews with Research and Engineering Apprenticeship Program (REAP) participants on behalf of the Academy of Applied Science (AAS) and the Army Educational Outreach Program (AEOP). Purdue University is very interested in hearing your opinions about REAP and would like to formally invite you to participate in one of the interviews, on the telephone, at a time listed below.

Purpose of the Interview:

Evaluators from Purdue University are conducting the evaluation study to determine if REAP is achieving its objective(s) as a program, the results of which will be used by one of the primary sponsors of REAP (U.S. Army) to ensure funding for the program in the future. Interviews provide evaluators the opportunity to speak with students and mentors about their experiences in REAP which helps them illustrate and understanding how the REAP program affects participants. In the end, Purdue University's findings will demonstrate REAP's success as a program and to make REAP better for future participants.

Interview Logistics:

We are working with the evaluation team to organize an interview during your REAP experience. Interviews are being conducted across the REAP program with student participants and with mentors (anyone who supervises, guides, or supports REAP students) Please look at the dates, times, and locations of the interviews and decide which one you are available to attend:

1. ***Student Interview #1: Date, Time, Location of telephone or quiet room***
2. ***Student Interview #2: Date, Time, Location of telephone or quiet room***
3. ***Mentor Interview: Date, Time, Location of telephone or quiet room***

Participating in the Interview:

Interviews will be conducted with students across all REAP sites and evaluators will ask all participants the same series of questions. The interview will take 15 – 20 minutes of your time. If you do not volunteer, Purdue University evaluators would still like to hear from you so they will send you an evaluation questionnaire after REAP.

If you volunteer, please fill out the appropriate forms attached to this message – one for minors (17 yrs. or younger) and one for adults.

If you have questions about the REAP interviews, please contact the Purdue University evaluation team:

Dr. Carla C. Johnson, carlacjohnson@purdue.edu or at (765) 494-0019.

Appendix B

FY16 REAP Apprentice Interview Protocol

2016 REAP Evaluation Study
Student Interview or Focus Group Protocol

Facilitator: My name is [evaluator] and I'd like to thank you for meeting with us today! We are really excited to learn more about your experiences in REAP. In case you have not been in an evaluation interview before, I'd like to give you some ground rules that I like to use in interviews. They seem to help the interview move forward and make everyone a little more comfortable:

- What is shared in the interview stays in the room.
- It is important for us to hear the positive and negative sides of all issues.
- Only one person speaks at a time.
- This is voluntary - you may choose not to answer any question, or stop participating at any time.
- We will be audio recording the session for note-taking purposes only. Audio will be destroyed.
- Do you have any questions before we begin?

Key Questions

1. **Why did you choose to participate in REAP this year?**
    - How did you hear about REAP?
    - Who did you hear about it from?

The Army Educational Outreach Program (AEOP) is a primary sponsor of REAP. We do these interviews to help the AEOP create reports and defend funding for the program. They need specific information to defend the money for the program.

2. **We need to understand more about how REAP is teaching students about STEM career opportunities in the Army and Department of Defense.**
    - During REAP, did you learn anything about STEM careers in the Army or Department of Defense?
    - How did you learn about them (e.g., field trips, invited speakers, other activities, etc.)?
    - Are you interested in pursuing a career in STEM with the Army or Department of Defense?
3. **The AEOP sponsors a wide range of national STEM outreach programs other than REAP. You are definitely eligible to participate in some of these programs and we need to know if you learned about them during REAP**
    - During REAP, did you learn about any of the outreach programs that the AEOP sponsors? (SMART, NDSEG, REAP, etc.)
    - How did you learn about them?
    - Do you think that you will try to participate in any of those programs?
4. **Tell us about your experiences in REAP this year.**
    - What, specifically do you think you got out of participating in REAP?
    - How do your experiences in REAP compare to your school experiences in STEM?
    - What would you say was the biggest benefit you gained from participating in REAP?
5. **Do you have any suggestions for improving REAP for other students in the future?**
6. **Last Chance - Have we missed anything? Tell us anything you want us to know that we didn't ask about.**

Appendix C

FY16 REAP Mentor Interview Protocol

2016 REAP Evaluation Study
Mentor Interview or Focus Group Protocol

Facilitator: My name is [evaluator] and I'd like to thank you for meeting with us today! We are really excited to learn more about your experiences in REAP. In case you haven't been in a focus group before, I'd like to give you some ground rules that I like to use in focus groups. They seem to help the group move forward and make everyone a little more comfortable:

- What is shared in the room stays in the room.
- Only one person speaks at a time.
- If you disagree please do so respectfully.
- It is important for us to hear the positive and negative sides of all issues.
- We will be audio recording the session for note-taking purposes only. Audio will be destroyed.
- Do you have any questions about participating in the focus group?

Key Questions:

1. **When you think about REAP, what kind of value does this program add**?
    - How do you think students benefit from participating in REAP?
    - Can you think of a particular student or group of students that benefit the most from REAP?
    - How have you benefited from participating in REAP?

One of the primary sponsors of the REAP program is the Army Educational Outreach Program (AEOP). The AEOP needs specific information to create reports and defend funding for its outreach programs, REAP included.

2. **We need to understand more about how REAP is helping students know more about STEM career opportunities in the Department of Defense, especially civilian positions.**
    - Have you seen any efforts by REAP to educate participants about the Army, DoD, or careers in the DoD?
    - What strategies seem to be the most effective for REAP students?
    - Do you have any suggestions for helping REAP teach students about careers in the DoD?

The AEOP sponsors a wide range of national STEM outreach programs that these students qualify for.

3. **The AEOP needs to know if REAP is teaching students about the other STEM outreach programs that it sponsors.**
    - First, are you aware of the other programs offered by the AEOP? (e.g., REAP, CQL, CQL, SMART, etc)
    - Have you seen any efforts at REAP to educate adults or students about the other AEOP programs?
    - What seems to work the best? The worst?
    - Any suggestions for helping the AEOP educate these students about the other programs?

4. **The AEOP is trying to make sure that its programs become more effective at reaching adult and youth participants from underserved and underrepresented groups (racial/ethnic groups, low SES, etc.).**
    - Have you seen any efforts by REAP to help engage underserved or underrepresented groups of adults and youth?
    - What strategies seem to work the best? The worst?
    - Any suggestions for helping REAP reach new populations of adult and youth participants?

5. **What suggestions do you have for improving REAP?**
6. **Last Chance - Have we missed anything? Tell us anything you want us to know that we didn't ask about.**

Appendix D

FY16 REAP Apprentice Survey Instrument

Contact Information		
Please verify the following information:		
*First Name:		
*Last Name:		
*Email Address:		
All fields with an asterisk (*) are required.		

*1. Do you agree to participate in this survey? (required)(*Required)		
Select one.		
○	Yes, I agree to participate in this survey	(Go to question number 2.)
○	No, I do not wish to participate in this survey	Go to end of chapter

4. What grade will you start in the fall? (select one)	
Select one.	
○	9th
○	10th
○	11th
○	12th
○	College freshman
○	Choose not to report
○	Other, (specify)::

5. What is your gender?	
Select one.	
○	Male
○	Female
○	Choose not to report

6. What is your race or ethnicity?	
Select one.	
○	Hispanic or Latino
○	Asian
○	Black or African American
○	Native American or Alaska Native
○	Native Hawaiian or Other Pacific Islander
○	White
○	Choose not to report
○	Other race or ethnicity, (specify)::

7. Do you get free or reduced lunches at school?	
Select one.	
○	Yes
○	No
○	Choose not to report

8. At which of the following REAP sites did you participate? (Select ONE)

Select one.

○	Alabama State University – Montgomery, AL
○	Ball State University, IN
○	California State University, CA
○	Colorado State University – Fort Collins, CO
○	College of St. Benedict & St. John's University, MN
○	Delaware State University – Dover, DE
○	Georgia State University – Atlanta, GA
○	Iowa State University, IA
○	Jackson State University – Jackson, MS
○	Loyola University – Chicago, IL
○	Michigan Technological University – Houghton, MI
○	Marshall University, WV
○	Miami Dade University, Miama, FL
○	Montana State University – Bozeman, MT
○	New Jersey Institute of Technology – Newark, NJ
○	New Mexico State, NM
○	Oakland University – Rochester, MI
○	Purdue University, IN
○	Savannah State University, Savannah, GA
○	South Dakota School of Mines – Rapid City, SD
○	Tennessee State University, TN
○	Texas Southern University – Houston, TX
○	Texas Tech University – Lubbock, TX
○	University of Alabama – Huntsville, AL
○	University of Arkansas - Pine Bluff, AR
○	University of California, Berkeley – Berkeley, CA
○	University of Central Florida – Orlando, FL
○	University of Colorado Springs, Colorado Springs, CO

○	University of Houston – Houston, TX
○	University of Illinois, Urbana, IL
○	University of Iowa, IA
○	University of Maryland, Baltimore, MD
○	University of Massachusetts, Lowell – Lowell, MA
○	University of Missouri – Columbia, MO
○	University of New Hampshire – Durham, NH
○	University of New Mexico, NM
○	University of North Carolina - Charlotte, NC
○	University of Puerto Rico, PR
○	University of South Florida – Tampa, FL
○	University of Texas, El Paso – El Paso, TX
○	University of Texas - Arlington, TX
○	University of Utah – Salt Lake City, UT
○	Xavier University of Louisiana – New Orleans, LA

9. How often did you do each of the following in STEM classes at school?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	○	○	○	○	○
Apply STEM learning to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○

10. How often did you do each of the following in REAP this year?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	○	○	○	○	○
Apply STEM learning to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○

11. How often did you do each of the following in STEM classes at school?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Use laboratory procedures and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

12. How often did you do each of the following in REAP this year?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Use laboratory procedures and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

13. How much did each of the following resources help you learn about Army Educational Outreach Programs (AEOPs)?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Academy of Applied Science (ASS) website	○	○	○	○	○
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
My REAP mentor(s)	○	○	○	○	○
Invited speakers or “career” events during REAP	○	○	○	○	○
Participation in REAP	○	○	○	○	○

14. How much did each of the following resources help you learn about STEM careers in the Army or Department of Defense (DoD)?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Academy of Applied Science (AAS) website	○	○	○	○	○
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
My REAP mentor(s)	○	○	○	○	○
Invited speakers or “career” events during REAP	○	○	○	○	○
Participation in REAP	○	○	○	○	○

15. How SATISFIED were you with the following REAP features?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Applying or registering for the program	○	○	○	○	○
Communicating with your REAP host site organizers	○	○	○	○	○
The physical location(s) of REAP activities	○	○	○	○	○
The variety of STEM topics available to you in REAP	○	○	○	○	○
Teaching or mentoring provided during REAP activities	○	○	○	○	○
Stipends (payment)	○	○	○	○	○
Research abstract preparation requirements	○	○	○	○	○
Development opportunities beyond conducting research (attending seminars, taking courses, pursuing competitions, or scholarships, presenting or publishing research, etc.)	○	○	○	○	○

16. How much input did you have in selecting your REAP research project?

Select one.

○	I did not have a project
○	I was assigned a project by my mentor
○	I worked with my mentor to design a project
○	I had a choice among various projects suggested by my mentor
○	I worked with my mentor and members of a research team to design a project
○	I designed the entire project on my own

17. How often was your mentor available to you during REAP?

Select one.

○	I did not have a mentor
○	The mentor was never available
○	The mentor was available less than half of the time
○	The mentor was available about half of the time of my project
○	The mentor was available more than half of the time
○	The mentor was always available

18. To what extent did you work as part of a group or team during REAP?

Select one.

○	I worked alone (or alone with my research mentor)
○	I worked with others in a shared laboratory or other space, but we work on different projects
○	I worked alone on my project and I met with others regularly for general reporting or discussion
○	I worked alone on a project that was closely connected with projects of others in my group
○	I work with a group who all worked on the same project

19. How SATISFIED were you with each of the following:

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
My working relationship with my mentor	○	○	○	○	○
My working relationship with the group or team	○	○	○	○	○
The amount of time I spent doing meaningful research	○	○	○	○	○
The amount of time I spent with my research mentor	○	○	○	○	○
The research experience overall	○	○	○	○	○

20. The list below includes effective teaching and mentoring strategies. From the list, please indicate which strategies that your mentor(s) used when working with you in REAP:

Select one per row.

	Yes - my mentor used this strategy with me	*No - my mentor did not use this strategy with me*
Helped me become aware of STEM in my everyday life	○	○
Helped me understand how I can use STEM to improve my community	○	○
Used a variety of strategies to help me learn	○	○
Gave me extra support when I needed it	○	○
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	○	○
Allowed me to work on a team project or activity	○	○
Helped me learn or practice a variety of STEM skills	○	○
Gave me feedback to help me improve in STEM	○	○
Talked to me about the education I need for a STEM career	○	○
Recommended Army Educational Outreach Programs that match my interests	○	○
Discussed STEM careers with the DoD or government	○	○

21. Which of the following statements apply to your research experience in REAP? (Choose ALL that apply)

Select all that apply.

☐	I presented a talk or poster to other students or faculty
☐	I presented a talk or poster at a professional symposium or conference
☐	I attended a symposium or conference
☐	I wrote or co-wrote a paper that was/will be published in a research journal
☐	I wrote or co-wrote a technical paper or patent
☐	I will present a talk or poster to other students or faculty
☐	I will present a talk or poster at a professional symposium or conference
☐	I will attend a symposium or conference
☐	I will write or co-write a paper that was/will be published in a research journal
☐	I will write or co-write a technical paper or patent
☐	I won an award or scholarship based on my research

22. As a result of your REAP experience, how much did you GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
In depth knowledge of a STEM topic(s)	○	○	○	○	○
Knowledge of research conducted in a STEM topic or field	○	○	○	○	○
Knowledge of research processes, ethics, and rules for conduct in STEM	○	○	○	○	○
Knowledge of how scientists and engineers work on real problems in STEM	○	○	○	○	○
Knowledge of what everyday research work is like in STEM	○	○	○	○	○

23. Which category best describes the focus of your student(s) REAP activities?	
Select one.	
○	Science
○	Technology
○	Engineering
○	Mathematics

24. As a result of your REAP experience, how much did you GAIN in your ability to do each of the following?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Asking a question that can be answered with one or more scientific experiments	○	○	○	○	○
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	○	○	○	○	○
Considering different interpretations of data when deciding how the data answer a question	○	○	○	○	○
Supporting an explanation for an observation with data from experiments	○	○	○	○	○
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	○	○	○	○	○
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	○	○	○	○	○
Defending an argument that conveys how an explanation best describes an observation	○	○	○	○	○
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your explanation of an observation	○	○	○	○	○
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	○	○	○	○	○

25. As a result of your REAP experience, how much did you GAIN in your ability to do each of the following?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Defining a problem that can be solved by developing a new or improved object, process, or system	○	○	○	○	○
Using knowledge and creativity to propose a testable solution for a problem	○	○	○	○	○
Making a model of an object or system to show its parts and how they work	○	○	○	○	○
Designing procedures for an experiment that are appropriate for the question to be answered	○	○	○	○	○
Identifying the limitations of the methods and tools used for data collection	○	○	○	○	○
Carrying out procedures for an experiment and recording data accurately	○	○	○	○	○
Using computer models of an object or system to investigate cause and effect relationships	○	○	○	○	○
Considering different interpretations of the data when deciding if a solution works as intended	○	○	○	○	○
Organizing data in charts or graphs to find patterns and relationships	○	○	○	○	○
Supporting a solution for a problem with data from experiments	○	○	○	○	○
Supporting a solution with relevant scientific, mathematical, and/or engineering knowledge	○	○	○	○	○
Identifying the strengths and limitations of solutions in terms of how well they meet design criteria	○	○	○	○	○
Defend an argument that conveys how a solution best meets design criteria	○	○	○	○	○

Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your solution to a problem	○	○	○	○	○
Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)	○	○	○	○	○

26. As a result of your REAP experience, how much did you GAIN in each of the skills/abilities listed below?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Learning to work independently	○	○	○	○	○
Setting goals and reflecting on performance	○	○	○	○	○
Sticking with a task until it is finished	○	○	○	○	○
Making changes when things do not go as planned	○	○	○	○	○
Working well with people from all backgrounds	○	○	○	○	○
Including others' perspectives when making decisions	○	○	○	○	○
Communicating effectively with others	○	○	○	○	○
Viewing failure as an opportunity to learn	○	○	○	○	○

27. As a result of your REAP experience, how much did you GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Interest in a new STEM topic	○	○	○	○	○
Deciding on a path to pursue a STEM career	○	○	○	○	○
Sense of accomplishing something in STEM	○	○	○	○	○
Feeling prepared for more challenging STEM activities	○	○	○	○	○
Confidence to try out new ideas or procedures on my own in a STEM project	○	○	○	○	○
Patience for the slow pace of STEM research	○	○	○	○	○
Desire to build relationships with mentors who work in STEM	○	○	○	○	○
Connecting a STEM topic or field to my personal values	○	○	○	○	○

28. AS A RESULT OF YOUR REAP experience, are you MORE or LESS likely to engage in the following activities in science, technology, engineering, or mathematics (STEM) outside of school requirements or activities?

Select one per row.

	Much less likely	*Less likely*	*About the same before and after*	*More likely*	*Much more likely*
Watch or read non-fiction STEM	○	○	○	○	○
Tinker (play) with a mechanical or electrical device	○	○	○	○	○
Work on solving mathematical or scientific puzzles	○	○	○	○	○
Use a computer to design or program something	○	○	○	○	○
Talk with friends or family about STEM	○	○	○	○	○
Mentor or teach other students about STEM	○	○	○	○	○
Help with a community service project related to STEM	○	○	○	○	○
Participate in a STEM camp, club, or competition	○	○	○	○	○
Take an elective (not required) STEM class	○	○	○	○	○
Work on a STEM project or experiment in a university or professional setting	○	○	○	○	○

29. Before you participated in REAP, how far did you want to go in school?

Select one.

○	Graduate from high school
○	Go to a trade or vocational school
○	Go to college for a little while
○	Finish college (get a Bachelor's degree)
○	Get more education after college
○	Get a master's degree
○	Get a Ph.D.
○	Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)
○	Get a combined M.D. / Ph.D.
○	Get another professional degree (law, business, etc.)

30. After you have participated in REAP, how far do you want to go in school?

Select one.

○	Graduate from high school
○	Go to a trade or vocational school
○	Go to college for a little while
○	Finish college (get a Bachelor's degree)
○	Get more education after college
○	Get a master's degree
○	Get a Ph.D.
○	Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)
○	Get a combined M.D. / Ph.D.
○	Get another professional degree (law, business, etc.)

31. When you are 30, to what extent do you expect to use your STEM knowledge, skills, and/or abilities in your job?

Select one.

○	not at all
○	up to 25% of the time
○	up to 50% of the time
○	up to 75% of the time
○	up to 100% of the time

32. Before you participated in REAP, what kind of work did you want to do when you are 30? (select one)

Select one.

○	Undecided
○	Science (no specific subject)
○	Physical science (physics, chemistry, astronomy, materials science)
○	Biological science
○	Earth, atmospheric or oceanic science
○	Environmental science
○	Computer science
○	Technology
○	Engineering
○	Mathematics or statistics
○	Medicine (doctor, dentist, veterinarian, etc.)
○	Health (nursing, pharmacy, technician, etc.)
○	Social science (psychologist, sociologist, etc.)
○	Teaching, STEM
○	Teaching, non-STEM
○	Business
○	Law
○	Military, police, or security
○	Art (writing, dancing, painting, etc.)
○	Skilled trade (carpenter
○	Other, (specify)::

33. After you participated in REAP, what kind of work do you want to do when you are 30? (select one)

Select one.

○	Undecided
○	Science (no specific subject)
○	Physical science (physics, chemistry, astronomy, materials science)
○	Biological science
○	Earth, atmospheric or oceanic science
○	Environmental science
○	Computer science
○	Technology
○	Engineering
○	Mathematics or statistics
○	Medicine (doctor, dentist, veterinarian, etc.)
○	Health (nursing, pharmacy, technician, etc.)
○	Social science (psychologist, sociologist, etc.)
○	Teaching, STEM
○	Teaching, non-STEM
○	Business
○	Law
○	Military, police, or security
○	Art (writing, dancing, painting, etc.)
○	Skilled trade (carpenter, electrician, plumber, etc.)
○	Other, (specify)::

34. How interested are you in participating in the following programs in the future?

Select one per row.

	I've never heard of this program	*Not at all*	*A little*	*Somewhat*	*Very much*
Gains in the Education of Mathematics and Science (GEMS)	○	○	○	○	○
UNITE	○	○	○	○	○
Junior Science & Humanities Symposium (JSHS)	○	○	○	○	○
Science & Engineering Apprenticeship Program (SEAP)	○	○	○	○	○
Research & Engineering Apprenticeship Program (REAP)	○	○	○	○	○
High School Apprenticeship Program (HSAP)	○	○	○	○	○
College Qualified Leaders (CQL)	○	○	○	○	○
GEMS Near Peer Mentor Program	○	○	○	○	○
Undergraduate Research Apprenticeship Program (URAP)	○	○	○	○	○
Science Mathematics, and Research for Transformation (SMART) College Scholarship	○	○	○	○	○
National Defense Science & Engineering Graduate (NDSEG) Fellowship	○	○	○	○	○

35. How many jobs/careers in STEM did you learn about during REAP?

Select one.

○	None
○	1
○	2
○	3
○	4
○	5 or more

36. How many Army or Department of Defense (DoD) STEM jobs/careers did you learn about during REAP?

Select one.

○	None
○	1
○	2
○	3
○	4
○	5 or more

37. How much do you agree or disagree with the following statements about Department of Defense (DoD) researchers and research:

Select one per row.

	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
DoD researchers advance science and engineering fields	○	○	○	○	○
DoD researchers develop new, cutting edge technologies	○	○	○	○	○
DoD researchers solve real-world problems	○	○	○	○	○
DoD research is valuable to society	○	○	○	○	○

38. Which of the following statements describe you after participating in the REAP program?

Select one per row.

	Disagree - This did not happen	*Disagree - This happened but not because of REAP*	*Agree - REAP contributed*	*Agree - REAP was primary reason*
I am more confident in my STEM knowledge, skills, and abilities	○	○	○	○
I am more interested in participating in STEM activities outside of school requirements	○	○	○	○
I am more aware of other AEOPs	○	○	○	○
I am more interested in participating in other AEOPs	○	○	○	○
I am more interested in taking STEM classes in school	○	○	○	○
I am more interested in earning a STEM degree	○	○	○	○
I am more interested in pursuing a career in STEM	○	○	○	○
I am more aware of Army or DoD STEM research and careers	○	○	○	○
I have a greater appreciation of Army or DoD STEM research	○	○	○	○
I am more interested in pursuing a STEM career with the Army or DoD	○	○	○	○

39. What are the three most important ways that REAP has helped you?

Benefit #1:	
Benefit #2:	
Benefit #3:	

40. What are the three ways that REAP should be improved for future participants?

Improvement #1:	
Improvement #2:	
Improvement #3:	

41. Please tell us about your overall satisfaction with your REAP experience.

Appendix E

FY15 REAP Mentor Survey Instrument

Contact Information		
Please verify the following information:		
*First Name:		
*Last Name:		
*Email Address:		
All fields with an asterisk (*) are required.		

*1. Do you agree to participate in this survey? (required)(*Required)	
Select one.	
○	Yes, I agree to participate in this survey
○	No, I do not wish to participate in this survey

4. What is your gender?	
Select one.	
○	Male
○	Female
○	Choose not to report

5. What is your race or ethnicity?	
Select one.	
○	Hispanic or Latino
○	Asian
○	Black or African American
○	Native American or Alaska Native
○	Native Hawaiian or Other Pacific Islander
○	White
○	Choose not to report
○	Other race or ethnicity, (specify)::

6. Which of the following BEST describes the organization you work for? (select ONE)	
Select one.	
○	No organization
○	School or district (K-12)
○	State educational agency
○	Institution of higher education (vocational school, junior college, college, or university)
○	Private Industry
○	Department of Defense or other government agency
○	Non-profit
○	Other, (specify):

7. Which of the following BEST describes your current occupation (select ONE)		
Select one.		
○	University educator	(Go to question number 13.)
○	Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	(Go to question number 13.)
○	Scientist, Engineer, or Mathematics professional	(Go to question number 13.)
○	Other, (specify)::	(Go to question number 13.)

13. Which of the following best describes your primary area of research?	
Select one.	
○	Physical science (physics, chemistry, astronomy, materials science, etc.)
○	Biological science
○	Earth, atmospheric, or oceanic science
○	Environmental science
○	Computer science
○	Technology
○	Engineering
○	Mathematics or statistics
○	Medical, health, or behavioral science
○	Social Science (psychology, sociology, anthropology)
○	Other, (specify)::

15. Which of the following BEST describes your role during REAP?

Select one.

- ○ Research Mentor
- ○ Research Team Member but not a Principal Investigator (PI)
- ○ Other, (specify)::

16. How many REAP students did you work with this year?

_____ students.

17. How did you learn about REAP? (Check all that apply)

Select all that apply.

☐	Academy of Applied Science (AAS)
☐	Army Educational Outreach Program (AEOP) website
☐	AEOP on Facebook, Twitter, Pinterest, or other social media
☐	A STEM conference or STEM education conference
☐	An email or newsletter from school, university, or a professional organization
☐	Past REAP participant
☐	A student
☐	A colleague
☐	My supervisor or superior
☐	A REAP site host or director
☐	Workplace communications
☐	Someone who works with the Department of Defense (Army, Navy, Air Force)
☐	Other, (specify)::

18. How many times have YOU PARTICIPATED in any of the following Army Educational Outreach Programs (AEOPs) in any capacity? If you have heard of an AEOP but never participated select "Never." If you have not heard of an AEOP select "Never heard of it."

Select one per row.

	Never	*Once*	*Twice*	*Three or more times*	*I've never heard of this program*
Camp Invention	○	○	○	○	○
eCYBERMISSION	○	○	○	○	○
Junior Solar Sprint (JSS)	○	○	○	○	○
West Point Bridge Design Contest (WPBDC)	○	○	○	○	○
Junior Science & Humanities Symposium (JSHS)	○	○	○	○	○
Gains in the Education of Mathematics and Science (GEMS)	○	○	○	○	○
GEMS Near Peers	○	○	○	○	○
UNITE	○	○	○	○	○
Science & Engineering Apprenticeship Program (SEAP)	○	○	○	○	○
Research & Engineering Apprenticeship Program (REAP)	○	○	○	○	○
High School Apprenticeship Program (HSAP)	○	○	○	○	○
College Qualified Leaders (CQL)	○	○	○	○	○
Undergraduate Research Apprenticeship Program (URAP)	○	○	○	○	○
Science Mathematics, and Research for Transformation (SMART) College Scholarship	○	○	○	○	○
National Defense Science & Engineering Graduate (NDSEG) Fellowship	○	○	○	○	○

19. Which of the following were used for the purpose of recruiting your student(s) for apprenticeships? (select ALL that apply)

Select all that apply.

☐	Applications from Academy of Applied Science (AAS) or the AEOP
☐	Personal acquaintance(s) (friend, family, neighbor, etc.)
☐	Colleague(s) in my workplace
☐	K-12 school teacher(s) outside of my workplace
☐	University faculty outside of my workplace
☐	Informational materials sent to K-12 schools or Universities outside of my workplace
☐	Communication(s) generated by a K-12 school or teacher (newsletter, email blast, website)
☐	Communication(s) generated by a university or faculty (newsletter, email blast, website)
☐	STEM or STEM Education conference(s) or event(s)
☐	Organization(s) that serve underserved or underrepresented populations
☐	The student contacted me (the mentor) about the program
☐	I do not know how student(s) were recruited for REAP
☐	Other, (specify)::

20. How SATISFIED were you with the following REAP features?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Application or registration process	○	○	○	○	○
Other administrative tasks (in-processing, network access, etc.)	○	○	○	○	○
Communicating with Academy of Applied Science (AAS)	○	○	○	○	○
Communicating with REAP organizers	○	○	○	○	○
Support for instruction or mentorship during program activities	○	○	○	○	○
Stipends (payment)	○	○	○	○	○
Research abstract preparation requirements	○	○	○	○	○

21. The list below describes mentoring strategies that are effective ways to establish the relevance of learning activities for students. From the list below, please indicate which strategies you used when working with your student(s) in REAP.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Become familiar with my student(s) background and interests at the beginning of the REAP experience	○	○
Giving students real-life problems to investigate or solve	○	○
Selecting readings or activities that relate to students' backgrounds	○	○
Encouraging students to suggest new readings, activities, or projects	○	○
Helping students become aware of the role(s) that STEM plays in their everyday lives	○	○
Helping students understand how STEM can help them improve their own community	○	○
Asking students to relate real-life events or activities to topics covered in REAP	○	○

22. The list below describes mentoring strategies that are effective ways to support the diverse needs of students as learners. From the list below, please indicate which strategies you used when working with your student(s) in REAP.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Identify the different learning styles that my student (s) may have at the beginning of the REAP experience	○	○
Interact with students and other personnel the same way regardless of their background	○	○
Use a variety of teaching and/or mentoring activities to meet the needs of all students	○	○
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	○	○
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	○	○
Directing students to other individuals or programs for additional support as needed	○	○
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	○	○

23. The list below describes mentoring strategies that are effective ways to support students' development of collaboration and interpersonal skills. From the list below, please indicate which strategies you used when working with your student(s) in REAP.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Having my student(s) tell other people about their backgrounds and interests	○	○
Having my student(s) explain difficult ideas to others	○	○
Having my student(s) listen to the ideas of others with an open mind	○	○
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	○	○
Having my student(s) give and receive constructive feedback with others	○	○
Having students work on collaborative activities or projects as a member of a team	○	○
Allowing my student(s) to resolve conflicts and reach agreement within their team	○	○

24. The list below describes mentoring strategies that are effective ways to support students' engagement in "authentic" STEM activities. From the list below, please indicate which strategies you used when working with your student(s) in REAP.

Select one per row.

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

25. This list describes mentoring strategies that are effective ways to support students' STEM educational and career pathways. The list also includes items that reflect AEOP and Army priorities. From this list, please indicate which strategies you used when working with your student(s) in REAP.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Asking my student(s) about their educational and/or career goals	○	○
Recommending extracurricular programs that align with students' goals	○	○
Recommending Army Educational Outreach Programs that align with students' goals	○	○
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	○	○
Discussing STEM career opportunities within the DoD or other government agencies	○	○
Discussing STEM career opportunities in private industry or academia	○	○
Discussing the economic, political, ethical, and/or social context of a STEM career	○	○
Recommending student and professional organizations in STEM to my student(s)	○	○
Helping students build a professional network in a STEM field	○	○
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	○	○

26. How useful were each of the following in your efforts to expose student(s) to Army Educational Outreach Programs (AEOPs) during REAP?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Academy of Applied Science (AAS) website	○	○	○	○	○
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
REAP Program administrator or site coordinator	○	○	○	○	○
Invited speakers or “career” events	○	○	○	○	○
Participation in REAP	○	○	○	○	○

27. How USEFUL were each of the following in your efforts to expose your student(s) to Department of Defense (DoD) STEM careers during REAP?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Academy of Applied Science (AAS) website	○	○	○	○	○
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
REAP Program administrator or site coordinator	○	○	○	○	○
Invited speakers or “career” events	○	○	○	○	○
Participation in REAP	○	○	○	○	○

28. Which of the following AEOPs did YOU EXPLICITLY DISCUSS with your student(s) during REAP? (check ALL that apply)

Select one per row.

	Yes - I discussed this program with my student(s)	*No - I did not discuss this program with my student(s)*
Gains in the Education of Mathematics and Science (GEMS)	○	○
UNITE	○	○
Junior Science & Humanities Symposium (JSHS)	○	○
Science & Engineering Apprenticeship Program (SEAP)	○	○
Research & Engineering Apprenticeship Program (REAP)	○	○
High School Apprenticeship Program (HSAP)	○	○
College Qualified Leaders (CQL)	○	○
GEMS Near Peer Mentor Program	○	○
Undergraduate Research Apprenticeship Program (URAP)	○	○
Science Mathematics, and Research for Transformation (SMART) College Scholarship	○	○
National Defense Science & Engineering Graduate (NDSEG) Fellowship	○	○
I discussed AEOP with my student(s) but did not discuss any specific program	○	○

29. How much do you agree or disagree with the following statements about Department of Defense (DoD) researchers and research:

Select one per row.

	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
DoD researchers advance science and engineering fields	○	○	○	○	○
DoD researchers develop new, cutting edge technologies	○	○	○	○	○
DoD researchers solve real-world problems	○	○	○	○	○
DoD research is valuable to society	○	○	○	○	○

30. How often did YOUR STUDENT(S) have opportunities to do each of the following in REAP?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn new science, technology, engineering, or mathematics (STEM) topics	○	○	○	○	○
Apply STEM knowledge to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○
Use laboratory or field techniques, procedures, and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

31. As a result of their REAP experience, how much did your student(s) GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
In depth knowledge of a STEM topic(s)	○	○	○	○	○
Knowledge of research conducted in a STEM topic or field	○	○	○	○	○
Knowledge of research processes, ethics, and rules for conduct in STEM	○	○	○	○	○
Knowledge of how professionals work on real problems in STEM	○	○	○	○	○
Knowledge of what everyday research work is like in STEM	○	○	○	○	○

32. Which category best describes the focus of your student(s) REAP activities?

Select one.

○	Science	(Go to question number 33.)
○	Technology	(Go to question number 34.)
○	Engineering	(Go to question number 34.)
○	Mathematics	(Go to question number 34.)

33. AS A RESULT OF THEIR REAP EXPERIENCE, how much did your student(s) GAIN in their abilities to do each of the following?

Select one per row.

If answered, go to question number 35.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Asking a question that can be answered with one or more scientific experiments	○	○	○	○	○
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	○	○	○	○	○
Making a model of an object or system showing its parts and how they work	○	○	○	○	○
Designing procedures for an experiment that are appropriate for the question to be answered	○	○	○	○	○
Identifying the limitations of the methods and tools used for data collection	○	○	○	○	○
Carrying out procedures for an experiment and recording data accurately	○	○	○	○	○
Using computer models of objects or systems to test cause and effect relationships	○	○	○	○	○
Organizing data in charts or graphs to find patterns and relationships	○	○	○	○	○
Considering different interpretations of data when deciding how the data answer a question	○	○	○	○	○
Supporting an explanation for an observation with data from experiments	○	○	○	○	○
Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	○	○	○	○	○
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	○	○	○	○	○

Defending an argument that conveys how an explanation best describes an observation	○	○	○	○	○
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your explanation of an observation	○	○	○	○	○
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	○	○	○	○	○

34. **AS A RESULT OF THEIR REAP EXPERIENCE, how much did your student(s) GAIN in their ability to do each of the following?**

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Defining a problem that can be solved by developing a new or improved object, process, or system	○	○	○	○	○
Using knowledge and creativity to propose a testable solution for a problem	○	○	○	○	○
Making a model of an object or system to show its parts and how they work	○	○	○	○	○
Designing procedures for an experiment that are appropriate for the question to be answered	○	○	○	○	○
Identifying the limitations of the methods and tools used for data collection	○	○	○	○	○
Carrying out procedures for an experiment and recording data accurately	○	○	○	○	○
Using computer models of an object or system to investigate cause and effect relationships	○	○	○	○	○
Considering different interpretations of the data when deciding if a solution works as intended	○	○	○	○	○
Organizing data in charts or graphs to find patterns and relationships	○	○	○	○	○
Supporting a solution for a problem with data from experiments	○	○	○	○	○
Supporting a solution with relevant scientific, mathematical, and/or engineering knowledge	○	○	○	○	○
Identifying the strengths and limitations of solutions in terms of how well they meet design criteria	○	○	○	○	○
Defend an argument that conveys how a solution best	○	○	○	○	○

meets design criteria					
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your solution to a problem	○	○	○	○	○
Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)	○	○	○	○	○

35. AS A RESULT OF THE REAP EXPERIENCE, how much did your student(s) GAIN (on average) in the skills/abilities listed below?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Learning to work independently	○	○	○	○	○
Setting goals and reflecting on performance	○	○	○	○	○
Sticking with a task until it is finished	○	○	○	○	○
Making changes when things do not go as planned	○	○	○	○	○
Including others' perspectives when making decisions	○	○	○	○	○
Communicating effectively with others	○	○	○	○	○
Confidence with new ideas or procedures in a STEM project	○	○	○	○	○
Patience for the slow pace of research	○	○	○	○	○
Desire to build relationships with professionals in a field	○	○	○	○	○
Connecting a topic or field with their personal values	○	○	○	○	○

36. Which of the following statements describe YOUR STUDENT(S) after participating in the REAP program?

Select one per row.

	Disagree - This did not happen	*Disagree - This happened but not because of REAP*	*Agree - REAP contributed*	*Agree - REAP was primary reason*
More confident in STEM knowledge, skills, and abilities	○	○	○	○
More interested in participating in STEM activities outside of school requirements	○	○	○	○
More aware of other AEOPs	○	○	○	○
More interested in participating in other AEOPs	○	○	○	○
More interested in taking STEM classes in school	○	○	○	○
More interested in earning a STEM degree	○	○	○	○
More interested in pursuing a career in STEM	○	○	○	○
More aware of DoD STEM research and careers	○	○	○	○
Greater appreciation of DoD STEM research	○	○	○	○
More interested in pursuing a STEM career with the DoD	○	○	○	○

37. What are the three most important strengths of REAP?	
Strength #1:	
Strength #2:	
Strength #3:	

38. What are the three ways REAP should be improved for future participants?	
Improvement #1:	
Improvement #2:	
Improvement #3:	

39. Please tell us about your overall satisfaction with your REAP experience.

Appendix F

Academy of Applied Science (AAS)
FY16 Evaluation Report Response

The Academy of Applied Science did not have a written response to the FY16 REAP evaluation report.