

IT STARTS HERE. ★

Army Educational Outreach Program

Research and Engineering Apprenticeship Program (REAP)



2017 Annual Program Evaluation Report

PART 1: Executive Summary

February 2018



1 | AEOP Consortium Contacts

U.S. Army Contacts

Matthew Willis, Ph.D.

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

Andrea Simmons

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

AEOP Cooperative Agreement Manager

Louie Lopez

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

Battelle Memorial Institute – Lead Organization

David Burns

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

REAP Program Administrators

Pamela Hampton

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

Irene O'Mara

REAP Program Administrator
Academy of Applied Science
renie@aas-world.org

Evaluation Team Contacts – Purdue University

Carla C. Johnson, Ed.D.

Evaluation Director, AEOP CA
carlacjohnson@purdue.edu

Toni A. Sondergeld, Ph.D.

Assistant Director, AEOP CA
tonisondergeld@metriks.com

Janet B. Walton, Ph.D.

Assistant Director, AEOP CA
walton25@purdue.edu

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

2 | Executive Summary

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

This report documents the evaluation of the Research & Engineering Apprenticeship Program (REAP), one of the AEOP initiatives. REAP is administered by the Academy of Applied Science (AAS). Purdue University, the evaluation lead, prepared the 2017 evaluation report, which addressed questions related to program strengths and challenges, benefits to participants, and REAP's overall effectiveness in meeting AEOP and program objectives.

REAP is a summer research apprenticeship program focused on the development of high school students' STEM competencies, with particular emphasis on groups underserved in STEM¹. 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, experience valuable mentorship, and learn about education and career opportunities in STEM through a challenging STEM experience that is not readily available in high schools.

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

In FY17, 118 REAP apprentices were placed at 41 colleges and universities. The 2017 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 FY17 annual program data compiled by the Academy of Applied Science (AAS).

Summary of Findings

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

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

<p>through personal contacts and interactions.</p>	<p>Apprentices were most likely to have learned about AEOP through someone who works at the school or university they attend (43%); a school or university newsletter, email, or website (35%); someone who works with the program (28%); or a past participant (22%). Few apprentices reported learning about REAP through AEOP social media (4%) or the AEOP website (11%).</p>
	<p>Mentors were most likely to learn about AEOP from a supervisor or superior (39%), a colleague (26%), and the REAP site host or director (23%). Fewer reported learning about REAP through organizational websites such as AAS (10%) or AEOP (19%) and none had learned about AEOP through social media.</p>
<p>REAP apprentices are motivated to participate by a variety of factors although most apprentices cited internal motivations for participation.</p>	<p>The most frequently reported motivators for participating in REAP were apprentices' interest in STEM (94%), desire to learn something new or interesting (86%), desire to expand research or laboratory skills (81%), and the opportunity to learn in new ways that are not possible in school (78%). Over half of apprentices also cited as motivators the opportunity to use advanced laboratory technology (69%), have fun (65%), build college applications or résumés (64%), see how school learning applies to real life (61%), and network (53%).</p>
<p>Apprentices learned about STEM jobs and careers and, to a lesser extent, DoD STEM jobs and careers through various resources during REAP.</p>	<p>Nearly all apprentices (96%) reported learning about at least one STEM job/career during REAP, and almost half of apprentices (48%) reported learning about four or more STEM jobs/careers.</p>
	<p>Fewer apprentices had learned about DoD STEM jobs and careers than about STEM careers more generally, although over two-thirds (69%) reported that they had learned about at least one STEM job/career in the Army or DoD, and about 30% of students reported learning about 4 or more of these careers.</p>
	<p>Over three-quarters of apprentices (77%) reported being more aware of Army and DoD STEM careers as a result of REAP.</p>
	<p>More than half of apprentices reported that their awareness of DoD STEM jobs and careers was somewhat or very much impacted by participating in REAP (61%), the AEOP website (58%), and their mentors (54%). Many apprentices reported not experiencing resources such as AEOP social media (55%) and the ARO website (47%) as resources to learn about DoD STEM jobs and careers.</p>
<p>REAP apprentices engage in STEM practices with more frequency than they typically engage in these practices in school.</p>	<p>Half or more (49%-95%) of apprentices engaged in all STEM practices about which they were asked weekly or every day with the exception of building or making a computer model (54% had not done this during their apprenticeships). Apprentices reported greatest engagement (engaged in weekly or every day) in practices such as interacting with STEM researchers (95%), analyzing data or information and drawing conclusions (91%), working with a STEM researcher or company on a real-world STEM research project (89%), and working collaboratively as part of a team (89%).</p>
	<p>Apprentices engaged in STEM practices significantly more frequently in REAP than they did in school (large effect size with $d = 1.77$).</p>
	<p>More than two-thirds of mentors (70%-94%) reported using all strategies to increase the relevance of learning activities.</p>

REAP mentors use a variety of mentoring strategies with apprentices.	More than half (60%-97%) of mentors used all strategies to support the diverse needs of students as learners.
	More than three-quarters (79%-93%) of mentors reported using all strategies to support student development of collaboration and interpersonal skills.
	Over 90% (91%-96%) of mentors reported using all strategies to support student engagement in authentic STEM activities.
	Over half of mentors reported using all strategies to support students' STEM educational and career pathways, although there was wide variation in the use of specific strategies (53%-96%). For example, just over half of mentors (53%) reported helping students with their resume, application, personal statement, and/or interview preparations while 96% asked students about their educational and/or career goals.
Most mentors did not discuss specific AEOPs other than REAP with their apprentices, and relied on site coordinators and the AEOP website as resources for apprentices.	Some mentors (39%) reported discussing AEOP in general with apprentices, but without reference to any specific programs. Around a quarter of mentors discussed Unite (27%) and URAP (23%) with their apprentices.
	Participation in REAP (80%), the REAP Program administrator or site coordinator (69%), and the AEOP website (54%) were most often rated somewhat or very much useful for exposing students to AEOPs. On the other hand, a majority of mentors reported not experiencing AEOP on social media (70%), and invited speakers or "career" events (63%).
Many apprentices had not heard of many other AEOPs, although they were interested in participating in AEOPs in the future.	Relatively large proportions of apprentices had not heard of other AEOPs including CQL (50%), eCM (46%), and JSHS (39%), however a large majority of apprentices (84%) reported that REAP impacted their awareness of AEOPs.
	A large majority (82%) of apprentices reported increased interest in participating in other AEOPs in the future, with, for example, interest in participating in SMART (63% somewhat/very much interested), URAP (62% somewhat/very much interested), JSHS (42% somewhat/very much interested), and CQL (41% somewhat/very much interested).
	Resources impacting apprentice awareness of AEOP somewhat or very much included participating in REAP (84%), their mentors (64%), and the AEOP website (64%).
Apprentices and mentors reported high levels of satisfaction with REAP.	Apprentices were highly satisfied with REAP program features they had experienced with 75% or more indicating they were somewhat or very much satisfied with each feature listed. For example, large majorities of apprentices were at least somewhat satisfied with the physical location of activities (92%), the application process (91%), the teaching or mentoring they experienced (87%), and communication with host site organizers (85%).
	More than 80% of apprentices reported being somewhat or very much satisfied with all aspects of their research experience including the overall research experience (95%), the mentor relationship (92%), and the group/team relationship (93%).

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

	average, an approaching Demonstrates Mastery level (approximately 2.50). While apprentices improved in all 21 st Century Skills over time, skills associated with creativity, communication, and critical thinking/problem solving saw the largest increases from pre- to post- observations.
REAP impacted apprentices' STEM identities and the likelihood that they will engage in STEM activities in the future.	Apprentices reported that REAP had a substantial impact on their STEM identities, with 80-90% reporting some to large gains on all items in this section. For example, 90% reported some to large gains in their feelings of being prepared for more challenging STEM activities and in their desire to build relationships with mentors who work in STEM.
	Minority apprentices reported significantly greater impacts on their STEM identities compared to non-minority apprentices (effect size is considered small with $d = .481$)
	Although apprentices generally indicated that they would be more likely to engage in STEM activities after REAP, the impacts varied across activities. For example, most apprentices reported that they were more likely or much more likely to engage in working on a STEM project or experiment in a university or professional setting (88%) and talk with friends or family about STEM (85%), however half of apprentices reported that there was little change in the likelihood that they would watch or read non-fiction STEM, and over a third (34%) reported that the likelihood that they would use a computer to design or program something was about the same before and after REAP.
Apprentices had positive opinions of DoD Research and Researchers and had an increased interest in STEM careers in the Army or DoD after participating in REAP.	More than 85% of apprentices agreed or strongly agreed with statements such as "DoD research is valuable to society (89% agreed or strongly agreed) and "DoD researchers advance science and engineering fields" (87% agreed or strongly agreed). Over three-quarters of students (78%) reported that REAP had contributed to their greater appreciation of Army or DoD STEM research.
	Two-thirds (66%) of apprentices reported that they are more interested in pursuing STEM careers with the Army or DoD after participating in REAP and over three-quarters (78%) reported that they are more interested in pursuing a career in STEM after their REAP apprenticeships.
Apprentices reported that REAP had a variety of positive impacts on them.	Two-thirds or more of the apprentices reported that REAP contributed or was the primary reason for various overall impacts. For example, large majorities of apprentices indicated that REAP contributed to their confidence in their STEM knowledge, skills, and abilities (93%); interest in participating in STEM activities outside of school requirements (85%); and interest in earning a STEM degree (78%).

Responsiveness to FY17 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP

priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

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

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

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

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

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

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

REAP FY17 Efforts and Outcomes: AAS worked with the CAM's office to develop a DoD STEM Career webinar where Army scientists and engineers talked about DoD Careers. REAP continues to work with universities and students in creating awareness of DoD opportunities. To facilitate this, directors and mentors received AEOP materials including, flyers, brochures, and information about DoD careers and were encouraged to have open discussion with their apprentices about these opportunities.

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

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

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

Recommendations for FY18 Program Improvement/Growth

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

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

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

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

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

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

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