Army Educational Outreach Program

2015 Portfolio Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

AEOP_02_05112016

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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–undergraduate programs while exposing 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, providing a management structure that collectively markets the portfolio among members, leveraging available resources, and providing expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM priorities and objectives toward a STEM literate citizenry, STEM savvy educators, and sustainable infrastructure.

AEOP Priorities

Priority 1: STEM Literate Citizenry.

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

Priority 2: STEM Savvy Educators.

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

Priority 3: Sustainable Infrastructure.

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

In FY15, the AEOP central application tool included 45,595 unique program participants, 38,039 were youth program participants and 9,152 were adult participants, which included Army Scientists and Engineers (S&Es) in various roles, such as mentors, judges, and presenters. The AEOP is in the process of transitioning to a centralized application tool and most programs are utilized it for registration in FY15. Of the total participants in 2015, 796 students and 65 teachers from DoDEA schools from the Pacific, Europe and the U.S. The number of unique youth program participants in 2015 (38,039) was slightly lower than in 2014 (41,802).

2015 AEOP Participation Numbers			
		Youth	Adults
CII	Camp Invention Initiative	465	90
CQL	College Qualified Leaders	394	369
eCM	eCYBERMISSION	27,955	4,530
GEMS	Gains in the Education of Mathematics & Science	2,270	464
HSAP	High School Apprenticeship Program	49	35
JSHS	Junior Science & Humanities Symposium	5,829	3,203
JSS	Junior Solar Sprint	636	168
REAP	Research & Engineering Apprenticeship Program	101	68
SEAP	Science & Engineering Apprentice Program	92	73

Unite	Unite	200	112
URAP	Undergraduate Research Apprenticeship Program	48	40
	Total 2015 AEOP Participants	**38,039**	**9,152**

In 2015 the AEOP portfolio experienced increased participation from various collaborating schools, laboratories, Army/DoD S&E's and other collaborating organizations. The AEOP involved participants from 3,854 K-12 schools (compared to 2,918 in FY14), including more than 1,276 Title I schools (compared to 798 in FY14). The portfolio of programs also involved 462 colleges/universities (compared to 412 in FY14), including at least 116 HBCUs/MSIs (compared to 54 in FY14). The AEOP programs self-reported 146 Army and DoD research and development laboratories or Army organizations involved in the work of the programs. The AEOP worked with 64 Army-funded laboratories at colleges/universities (compared to 34 in FY14). There were 1,487 Army and DoD S&Es who participated in 2015 programming (compared to 1,216 in FY14).

In regards to participation of the DoDEA and Army/DoD laboratories, there was a slight decrease as 796 students and 65 teachers from DoDEA schools in the Pacific, Europe and the U.S. that participated in the AEOP through the GEMS, eCM and JSHS programs (compared to 982 students and 71 teachers in FY14). Additionally, through the AEOP competition programs (eCYBERMISSION, JSHS, JSS) and Unite, the AEOP engaged and collaborated with 200 organizations external to schools and the Army and DoD laboratories (e.g., professional STEM organizations, businesses, Technology Student Association state delegations, etc.).

Number of 2015 Collaborating Schools, Laboratories, Army/DoD S&Es, and Other Organizations

	K-12 Schools		Colleges/Universities (represented by participants or serving as host sites)		Army and DoD Research Laboratories/ Army Agencies	Army-Funded University Laboratories	Army and DoD Scientists & Engineers (S&Es)	Other Collaborating Organizations
AEOP Program	Total	Title I	Total	HBCU/MIs				
Camp Invention (CII)*	15	14	NA†	NA†	3	NA†	NA†	NA†
College Qualified Leaders (CQ)	NA†	NA†	120	12	11	NA†	288	NA†
eCybermission (eCM)	1,351	709	71	___§	38	NA†	549	53
Gains in the Education of Mathematics and Science (GEMS)	894	184	40	4	11	NA†	272	NA†
High School Apprenticeship Program (HSAP)	42	20	28	7	NA†	28	NA††	NA†
Junior Science and Humanities Symposium (JSHS)	1,020	148	120	___§	65	NA†	300	134
Junior Solar Sprint (JSS)	266	94	NA†	NA†	3	NA†	26	3
Research and	88	60	37	21	NA†	NA†	NA†	NA†

Engineering Apprenticeship Program (REAP)								
Science and Engineering Apprentice Program (SEAP)	63	11	NA†	NA†	9	NA†	43	NA†
Unite	129	36	10	7	6	NA†	9	10
University Research Apprenticeship Program (URAP)	NA†	NA†	36	7	NA†	36	NA††	NA††
Total Sites	**3,854**	**1,276** ‡	**462**	**116**	**146**	**64**	**1,487**	**200**

§ *Data not available.*
† *Does not apply.*
** Camp Invention Initiative (CII) was not part of program evaluations in 2015.*

The costs for the individual 2015 AEOP elements as well as the average cost per student for each program element are detailed in the table below. The cost of the AEOP summer apprenticeship programs range between $3,525 (SEAP) to $3,700 (URAP). CQL is the most expensive of the apprenticeship programs at an average cost of $10,691 per student participant. The cost of CQL reflects the longer duration of the program, which may take place in the summer or through portions of the academic year (sometimes lasting the entire year), as well as the advanced level of the student participant (college undergraduate or graduate student). The cost of 2015 AEOP competitions ranged from $109.24 (eCM) to $323.28 (JSHS) per participant. GEMS, which is primarily a 1-week summer STEM enrichment activity that takes place at Army laboratories, has an average cost of $358 per student. Unite, a 4-6 week summer STEM enrichment activity for students from historically underserved and under-represented groups that takes place in an existing University pre-collegiate program, has an average cost of $1,618 per student.

2015 AEOP Costs		
	Program Cost	**Cost Per Student Participant**
CII	$193,500	$225
CQL	$4,212,439	$10,691
eCM	$3,053,788	$109.24
GEMS	$812,395	$358
HSAP	$148,687	$3,304
JSHS	$1,884,434	$323.28
JSS	$123,372	$194
REAP	$349,690	$3,462
SEAP	$325,224	$3,535
Unite	$323,632	$1,618
URAP	$173,909	$3,700

The 2015 AEOP portfolio evaluation data were collected by Virginia Tech. The data analysis and reports for the FY15 evaluation were conducted by Purdue University, the new evaluation team for the new Lead Organization (LO) of the AEOP CA Battelle Memorial Institute. With the support of the AEOP CA Consortium Members, Individual Program Administrators (IPAs), and Government POCs, evaluation studies for the CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP programs were completed by the Purdue University team (with Virginia Tech). The only exception was the eCM program evaluation which was completed in FY15 by David Heil & Associates who conducted the evaluation study. This is the final year in which Virginia Tech and David Heil & Associates will be evaluating the AEOP portfolio. Purdue University (under the direction of Carla C. Johnson, Evaluation Director) will lead this work across the next several years of the new contract.

The FY15 AEOP program evaluation utilized participant questionnaires, as well as focus groups and/or interviews with participants and adults who led educational activities or supervised research projects (herein called mentors). This report summarizes the 2015 evaluation of the AEOP portfolio. Ten individual program evaluation reports are available under separate cover. The executive summaries for these ten reports are attached as appendices of this document. This report includes a program overview, evaluation and assessment strategy, study sample, and evaluation findings. The final section offers evidence-based recommendations intended to inform decisions for future program development.

Summary of Findings

The FY15 AEOP evaluation study collected data about participants, their perceptions of program processes, resources, and activities. Data were also collected regarding indicators of student impacts that relate to outcomes aligned with AEOP objectives, program objectives, and Federal guidance for evaluation of Federal STEM investments. A summary of findings is provided in the Summary of Findings table on the next page.

Summary of Findings	
Priority 1: STEM Literate Citizenry *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base.*	• Finding #1: In FY15 the AEOP provided outreach to 38,039 student participants through its comprehensive portfolio of programs. This number represents an overall decrease in number of participants compared to FY14 (41,802) that can be attributed to decline in participation for a few of the AEOP competition programs (i.e., eCM, JSHS, JSS). There were 34,420 students enrolled in FY15 AEOP competitions, which represents 3,562 fewer participants than FY14. However, the AEOP apprenticeship portfolio experienced overall growth in participation with 684 apprentices in 2015 (compared to 585 in FY14). Specifically, CQL increased both number of participants as well as placement rate (394 apprentices representing a 78% placement rate). Similarly, HSAP (49 apprentices, 18% placement rate) experienced growth and SEAP remained steady with the same number of participants as in FY14 (92). REAP and URAP had slight declines in participation in FY 15 (REAP - 101 compared to 117 in FY14; URAP - 48 compared to 59 in FY14). Student STEM enrichment activities (i.e., CII, GEMS, and Unite) also declined in participation overall, as CII enrollment alone was 44% lower than in FY14 (465 compared to 860). Unite experienced a 29% decrease in participation (200 in FY15 versus 280 in FY14). On a positive note, GEMS increased participation in FY15 with 2,270 students enrolled compared to 2,095 in FY14. There were a total of 2,935 students enrolled in STEM enrichment activities in FY15 (compared to 3,235 in FY 14). Despite efforts to include more participants in AEOP activities, FY15 enrollment data reiterated previous years' findings that there is unmet need for youth and adults in the United States and beyond, with 6,418 applicants who were not accepted into the programs. • Finding #2: While the AEOP continued to emphasize participation of underserved and under-represented groups in associated apprenticeship, competition, and enrichment programs, achieving this goal continued to be a challenge in FY15. Participation of females and racial and/or ethnic minorities increased or remained constant in eCybermission, GEMS JSHS-N, and SEAP. However, other programs in the AEOP portfolio experienced declines in participation of one or both of these groups. The participation rate of females in CQL increased from FY14 to FY15 (25% to 40%) and JSS enrolled more racial and/or ethnic minorities (13% to 28%). REAP and Unite, AEOP programs designed to specifically target underserved and under-represented groups maintained their enrollment of 60% or more of racial and/or ethnic minorities. One concerning finding is the over 20% decrease in female participation in Unite, as compared to FY14 (66% and 45% respectively). Further, competitions and programs hosted at Army/DoD laboratories that do local recruiting should examine their recruitment practices to insure that participants from all backgrounds are represented in the applicant pool and are competitive for AEOP enrollment slots. • Finding #3: In FY15, as in FY14, the AEOP provided participants with more frequent exposure to real world, hands-on, and collaborative STEM activities than they are exposed to in regular schooling. • Finding #4: As in FY14, students participating in the AEOP programs in FY15 reported that the experience improved their STEM-specific and 21st Century STEM skills competencies. They also reported gains in their abilities to use the science and

	engineering practices described in the Next Generation Science Standards (NGSS), as well as increases in their STEM confidence and identity. • Finding #5: The AEOP's efforts to engage students in and/or expose them to DoD research continues to be a challenge. While students reported positive attitudes toward DoD STEM research and researchers, there were mixed findings related to mentors discussing DoD STEM research, with some programs experiencing declines from FY14 in this area and mentors discussing STEM opportunities in the DoD with apprentices and students. • Finding #6: The AEOP exposed students to Army and DoD STEM careers and increased their interest in pursuing a DoD STEM career, although some programs were more effective (e.g., JSHS-N, SEAP, UNITE, GEMS, CQL) at doing so than others (e.g., HSAP, JSHS-R, JSS, REAP, URAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities is the most promising practice for informing participants about specific jobs/careers. Most mentors did not find AEOP electronic resources to be useful for exposing apprentices and students to STEM DoD careers, and continue to call for new resources for improving students' awareness of Army and DoD STEM research and careers. • Finding #7: The AEOP programs served to sustain existing STEM educational and career aspirations of participants and to inspire new achievement, including intentions to pursue higher education and STEM careers. In addition, participants reported gains in interest in pursuing DoD STEM careers as a result of participation in AEOP (e.g., GEMS, CQL, and JSHS-N).
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	• Finding #1: AEOP mentors' reported use of effective mentoring strategies overall declined overall in FY15. These strategies include establishing the relevance of learning activities, supporting the diverse needs of students as learners, supporting student development of interpersonal and collaboration skills, supporting student engagement in authentic STEM activities, and supporting student STEM educational and career pathways. • Finding #2: Across the AEOPs, most apprentices and students report being satisfied with their mentors and the quality of instruction they received.
Priority 3: Sustainable Infrastructure *Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.*	• Finding #1: As in FY14, the AEOP evaluation, with the exception of eCM, was standardized across program elements to help ensure a focus on program-wide priorities, improvement efforts, and utilization of best practices in the evaluation of informal STEM education programs. In FY16 eCM will become aligned with the rest of the AEOP portfolio and will be evaluated by Purdue University in the umbrella evaluation. Though there was some focus in FY15 on improving participation in evaluation activities (i.e., AEOP participant and mentor surveys) at regional and national levels, continued focus in this area will improve the representativeness of the evaluation data and provide a clearer picture of AEOP impacts. CII was not included in the AEOP evaluation in FY15. • Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in FY14, the FY15 evaluation indicates that the most effective marketing of AEOP elements occurred at the local

	level and was facilitated by site coordinators, regional directors, and/or local mentors. Centralized efforts to market the AEOP through the AEOP Consortium or program administrators were notably less effective than site-specific work. Many students expressed interest in continued participation in the AEOPs, most frequently expressing interest in repeating the program in which they were currently enrolled. Participants who reported learning about other AEOPs indicated doing so primarily from program activities or their mentors although many mentors reported a lack of knowledge about other AEOPs.

What AEOP participants are saying…

*"**SEAP** and **CQL** have been the most influential academic experiences of my life. I cannot thank AEOP enough for helping young students like me experience work like this that benefits me in so many ways. I have a much better idea of real careers I could follow to put my capabilities to their best use. I have had a great experience this summer, and I hope to continue working in AEOP programs".* – CQL Apprentice

*"**[CQL]** provides a great opportunity for our over-achieving college students who demonstrate a desire and technical capability to become our next wave of STEM professionals in DoD. "*– CQL Mentor

*"I am extremely grateful for being chosen to participate in this program. Before **GEMS**, my knowledge of the military and its research laboratories was very minimal, but after this camp, I feel satisfied with my attained knowledge…I now feel excited about he research going on here at WSMR. The instructors and modules carried an enthusiasm I hope to carry when I pursue STEM."* – GEMS Student

I thought **[e-CYBERMISSION]** *was a good way to strengthen my scientific knowledge in what I'm interested in. It also helps me learn the fundamental[s] and the process needed to come up with a scientific solution* –eCYBERMISSION Student

*"Every summer I participate as a **GEMS** teacher I am blown away by the abilities of the students that participate. They are fully engaged and have a great learning experience. It also furthers my learning as an educator."* – GEMS Mentor

*"Yesterday was actually my last day in the lab and it was one of the saddest things because I can honestly say that my experience with **HSAP** this summer was one of if not the best summer experience that I had. I think that, specifically, that the opportunity that this program provides in the way that it encourages independence and free thinking for people like me who are basically high school students. Really develops the sort of mindset that you need going forward being in high school or in college whether or not you decided to go into research."*– HSAP Apprentice

*"For us, **[HSAP]** is also wonderful. Most of my colleagues here still kept contact with the high school students and they very often write them letters to support different stages. This kind of experience to me is also wonderful."*– HSAP Mentor

*"Participating in **JSHS** was among the most defining moments of my high school career. I learned so much about different STEM fields from listening to all of the speakers and student presenters. I also learned a lot about the different AEOP programs and am very interested in the **SMART** program especially. Additionally, the feedback I got*

from my judges were really helpful in developing future plans for my project. My **JSHS** *experience will always be one I look back to with the fondest memories. Thank you for making it possible.* – JSHS Student

*"***[JSHS]** *is the best event I've found to introduce students with a passion for STEM to careers in STEM. They come back energized, excited about science and what it looks like beyond a high school curriculum."* – JSHS Mentor

*"***[JSS]** *is AWESOME! I learned a lot about STEM through JSS "* – JSS Student

"Very pleased. **[JSS]** *is an excellent program [with] great details to ensure students understand that both their engineering design process and production are equally important."* – JSS Mentor

"**[REAP]** *has provided me with a one in a lifetime opportunity, especially as a high school student. This program has given me the ability to work within a lab setting. This, overall, gave me the idea of what I want to pursue in the future career wise, whether it's becoming a medical doctor or a genetic researcher. I very much enjoyed working with the other students in this program, and also getting a chance to work with a microbiology professor as my mentor. I would have worked this program, even without the stipend, but it's an added bonus and will go towards gas money so I will be able to go to most of my school events and participate in more afterschool activities. Moreover, this REAP program has given me memories and an experience that I will never forget and hopefully will be able to use the knowledge I have gained from completing the REAP program in the future."* - REAP Apprentice.

"I have had a number of **REAP** *students work in my laboratory over the last 10 years. They have always been outstanding students who have a real thirst for knowledge. By giving them a research experience early in their careers the REAP program strongly encourages them to pursue a career into science. By enabling to work with others at various levels (undergraduates, graduate students and professors) it gives them a view of what it takes to become a professional scientist and the path that they can take to obtain that goal. I'm very happy with the REAP program and consider it to be a very valuable one for encouraging American youth to go into STEM fields.."* – REAP Mentor

"I was extremely satisfied with my **SEAP** *experience. It was a lot different than anything I have ever done before, and also one of the most rewarding things I have ever done. While in the program I was able to learn much more about STEM and many scientific procedures…I am very grateful I had the opportunity to learn so much more in such a friendly environment. One of the things that really stood out to me was how kind everyone was, not just my mentor but all the other adults in the lab. I was taught that it was okay to make a mistake, and that science is founded upon making mistakes and learning from them. like me who want nothing more than to experience work in a STEM field while also serving their country."* – SEAP Apprentice

"I am really happy with the candidates that presented themselves in the **[SEAP]** *application process. The student that came to us was very excited to get started and has worked really hard to learn and gain new experiences and knowledge. I have enjoyed having this student and look forward to additional work with her this coming school years."* – SEAP Mentor

"I am very appreciative for the opportunity to go into the **Unite** *program. It taught me skills I will take with me all throughout life. I hope to continue on to the* **REAP** *program and continue learning with these amazing programs.."* – Unite Student

*"**[Unite]** was a wonderful opportunity to expose students from under-represented groups to important STEM topics and to encourage their involvement and excitement in high performance computing. I look forward to participating in the program again in the future"* – Unite Mentor

*"This **[URAP]** experience was great. Communication with my mentor was awesome leading up to and during the program. My mentor was able to answer all my questions and teach me everything I needed to be successful in the program. I gained a lot of knowledge in chemistry that will help me become more well-rounded as genetic engineer. The research I participated in is not in the curriculum for my degree program so I feel that I obtained a lot of extra knowledge that will give me a professional edge in the future. I gained a lot of experience working in the lab with other scientists and got a feel for how working full time in a lab will be once I graduate. My mentor also shared his experience in choosing a path for his education that helped me in thinking about my direction after obtaining my bachelor's degree. ."* – URAP Apprentice

*It was great to have a **[URAP]** student join my group and participate in our projects. [The apprentice] worked hard, and learned quite a lot over the summer. Unfortunately, we had some equipment issues that prevented him from seeing the project to completion, but this is very common in our area and he got to learn just how difficult cutting edge research can be. This experience will benefit him as he attends UCLA as a Physics major in the Fall, and will also help as he becomes involved with research in graduate school."* – URAP Mentor

Recommendations

1. **Increase and broaden participation in selected AEOP programs.** Overall enrollment in AEOP programs decreased by 3,763 participants in FY15 despite concerted efforts to grow enrollment, increase placement rates, and broaden diversity within and across the AEOP. An exception to this finding was the increased overall enrollment in AEOP apprenticeship programs, led by CQL and HSAP growth, though SEAP enrollment remained constant at FY14 levels and REAP and URAP enrollment declined slightly.

   Three of the programs that have no enrollment caps but are contingent upon funding limitations ((AEOP competition programs eCM, JSHS, JSS) experienced declines in enrollment in FY15. This finding reveals the need for broader recruitment and marketing of AEOP competition programs. JSHS-Regional sites tend to have disproportionate participation from the local area around the lead institution, so strategies to reach out and support students to travel longer distances to compete may be one strategy to employ. JSS is currently only open to TSA chapter members and JSS is only one of over 60 potential STEM competitions TSA hosts. It is recommended that TSA consider means to include students whose teachers or schools may not be TSA chapter members. eCM's success with marketing and growing enrollment in recent years contributed to this program having largest group of participants in the AEOP portfolio. Additional investments in growing and maintaining enrollment for eCM should be considered.

   Enrollment in the AEOP STEM enrichment programs varied by program. While enrollment in the GEMS program increased in FY15, Unite experienced a relatively large decrease in enrollment (280 versus 200 in FY14). Like JSS,

Unite is administered by TSA and additional strategies should be considered to grow enrollment and increase the diversity of students participating in the program.

An examination of the AEOP portfolio overall reveals that despite investments in marketing and outreach to underserved and under-represented groups, there has been little progress toward growing the diversity of the AEOP portfolio across programs in FY15 with the exception of some programs (i.e. CQL, JSS) that exhibited slight growth. Other programs' enrollment remained steady at FY14 levels or showed slight increases in participation of one more underrepresented groups (REAP, GEMS, SEAP, JSHS-N). One concerning finding was the 20% decrease in participation of females in Unite (66% in FY14 and 45% in FY15), a program that specifically targets under represented populations. Moreover, findings of this evaluation affirm the need to continue to invest in recruitment and marketing efforts/strategies to grow the participation of students from underrepresented groups.

A final area of need that was revealed through the FY15 evaluation is the focus on connections with Army/DoD laboratories as the primary means for recruiting apprentices for CQL/SEAP programs. It is strongly recommended that site leads utilize the Cvent system for selecting participants for these programs to protect the competitiveness of securing coveted spots in highly popular apprentice programs with low placement rates.

2. **Improve marketing and grow awareness of AEOP.** As was the case in FY14 a substantial proportion of AEOP participants expressed interest in future participation in AEOPs but at the same time reported having little knowledge of individual programs within the AEOP portfolio outside of the program in which they were currently enrolled. It is clear from the FY15 evaluation that current efforts (e.g. distributing the AEOP brochure, AEOP program websites, AEOP website) to expose participants to the various programs within the portfolio are not adequate. It is recommended that the new LO (Battelle Memorial Institute) work in concert with the new marketing firm (Widmeyer) and individual programs in the consortium to develop program materials (i.e. AEOP slide deck, activities to be used within programs as part of content of program) that will purposefully and collectively provide participants with a clear understanding of the AEOP program opportunities. Further, AEOP should consider expanding its strategic outreach initiative effort in increasing awareness of, and participation in AEOP through partnerships with like-minded organizations, especially those with connection to underserved and underrepresented populations. The focus of the AEOP consortium should be on providing participants with an awareness of the pipeline of AEOP programs and should explicitly focus on providing details of each program, application procedures, timelines, and benefits of participation so that participants can make informed decisions about future participation. Furthermore, mentors reported little knowledge of the AEOP portfolio. Similar efforts should be made to prepare mentors and program staff with a variety of easily accessible materials and information that can be readily shared with students and other adults.

3. **Raise awareness of Army/DoD STEM careers and research.** As was the case in FY14, some AEOP program participants did not gain a firm understanding of Army/DoD STEM careers (e.g. HSAP, JSHS-R, JSS, REAP, URAP). This is especially concerning since three of the programs (HSAP, REAP, and URAP) are apprenticeship programs,

although they are not situated at an Army/DoD laboratory. Participants in programs that were housed at Army/DoD sites (e.g. SEAP, GEMS, CQL) reported better rates of awareness of Army/DoD STEM careers. The same was true of JSHS-N, an event that explicitly includes interaction with Army/DoD professionals. It is recommended that all programs examine their instructional/programmatic content and make an effort to build in more experiences for participants to interact with Army/DoD professionals in a variety of settings. Additionally, it is recommended that overarching materials be developed by the LO/consortium that can be used within programs to expose participants to Army/DoD STEM careers (i.e. slide decks, videos profiling Army/DoD STEM personnel/careers, webinars, etc.).

4. **Increase the use of effective mentoring strategies across the AEOP portfolio.** Participants in the FY15 reported decreased use of effective mentoring strategies across the portfolio compared to FY14. This is cause for concern as there is a strong research base that clearly links the use of these mentoring strategies with improved outcomes of the mentor/apprentice relationship in formal settings (i.e. CQL, SEAP, URAP, HSAP, REAP) and in less formal settings (other AEOP programs). It is strongly recommended that the AEOP portfolio generate orientation and training resources for mentors in the various AEOP settings (apprenticeships, competitions, enrichment programs). Further, the AEOP should identify existing effective mentors as potential leadership for development and implementation of a mentor-training program. These resources should be used in FY16 and beyond to better prepare mentors with the expectations for mentoring in the AEOP programs and support mentors in increasing their effectiveness.

5. **Improve the response rates for evaluation questionnaires and participation in site visit activities.** Overall participation in the AEOP evaluation continues to be at a lower than desired. The standardization and rigor of the evaluation continued to improve in 2015, however response rates for the apprentice/student and mentor questionnaires were poor in most AEOP programs, with just over 5,000 out of 60,000 youth and adult participants responding to questionnaires. It is recommended that the Army emphasize the importance of AEOP program evaluations in a multi-faceted manner. While the IPAs for AEOP program and the lab coordinators have exerted efforts to emphasize its importance, it is recommended that a top down approach should also be employed. Perhaps evaluation emphasis can also be applied from Army leadership (funding and policy office) to the respective leaders at each of the participating labs, research, development and engineering centers, and university partners.

   It is recommended that all AEOP programs provide on-site (as applicable) time during the program for both participants and mentors to complete the program questionnaires. Furthermore, since the questionnaire is the primary means of information regarding the progress of AEOP each year, we recommend making participation mandatory for all participants in AEOP programs. Site visit data collection has also been very challenging. Despite program efforts to recruit students and mentors for interviews and focus groups, participation has been less than desired. Programs should work with the evaluation team to determine what supports and incentives will make site visit data collection processes more successful.

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-undergraduate 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, providing a management structure that collectively markets the portfolio among members, leveraging available resources, and providing expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM priorities and objectives toward a STEM literate citizenry, STEM savvy educators, and sustainable infrastructure.

AEOP Priorities

Priority 1: STEM Literate Citizenry.

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

Priority 2: STEM Savvy Educators.

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

Priority 3: Sustainable Infrastructure.

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

2015 Portfolio Overview

This report includes a detailed evaluation of the AEOP activities for FY2015. A summary of individual program level data is outlined in Table 1 below which includes applicant and participant data, numbers of Army and DoD S&Es, participating K-12 schools and colleges/universities, and collaborating organizations including Army and DoD laboratories. Overall participant data summarized for youth and adults by program is presented in Table 2. Partner participation is outlined in Table 3 including the numbers collaborating schools, both K-12 and college/universities, as well as Army and DoD laboratories and S&Es. Program costs are detailed in Table 4.

There were 38,039 youth participants captured in 2015 AEOP programs, a decrease from FY14 (41,802). Overall participation in FY15 AEOP activities included 9,152 adults comprised of 1,507 Army S&Es in varying roles including mentors for research apprenticeships (CQL, REAP, SEAP, and URAP), judges for competitions (eCM, JSS, and JSHS), and presenters in STEM enrichment activities (GEMS and Unite) as well as Army/DoD STEM showcases at competitions (eCM and JSHS). There was a slight decrease in adult participants for the AEOP in FY15 (9,970 in FY14).

Table 1. 2015 AEOP Initiatives	
Camp Invention Initiative (CII) **Program Administrator: U.S. Army Corps of Engineers – Engineering Research & Development Center (ERDC)**	
Description	STEM Enrichment activity for K-6 students at selected host elementary sites near GEMS sites.
Number of Students	465
Number of Teachers & Leadership Interns	90
Number of Sites	10
Number of Army Research Laboratories	3
Total Cost	$104,625
Cost Per Student Participant	$225
College Qualified Leaders (CQL) **Program Administrator: American Society for Engineering Education (ASEE)**	
Description	STEM Apprenticeship Program – Summer or school year, at Army laboratories with Army S&E mentors
Participant Population	College undergraduate and graduate students
Number of Applicants	507
Number of Students (Apprentices)	394
Placement Rate	78%
Number of Adults (Mentors)	193
Number of Army S&Es	176
Number of Army Research Laboratories	11[†]
Number of Colleges/Universities	120
Number of HBCU/MIs	12
Total Cost	$4,212,439
Stipend Cost (Paid by participating Army laboratories)	$4,159,634
Administrative Cost to ASEE	$52,805
Cost Per Student Participant	$10,691
eCYBERMISSION (eCM) **Program Administrator: National Science Teachers Association (NSTA)**	
Description	STEM Competition - Nationwide (including DoDEA schools), web-based, including one national event
Participant Population	6th-9th grade students
Number of Applicants/Students	27,955 registered and 4,280 completed mission folders of whom 78 students/22 teams were selected for NJEE
Placement Rate	N/A (all students who register are participants)
Submission Completion Rate	63.3%
Number of Adults (Team Advisors and Volunteers – incl. S&Es and Teachers)	4,350

Number of Team Advisors (Predominantly math and science teachers)	1,749
Number Volunteers (Ambassadors, Cyberguides, Virtual Judges)	2,601
Number of Army S&Es	549
Number of Army/DoD Research Laboratories	38
Number of K-12 Teachers (Team Advisors)	2,298
Number of K-12 Schools	1,337
Number of K-12 Schools – Title I	709
Number of Colleges/Universities	71
Number of DoDEA Students	551
Number of DoDEA Teachers	40
Number of Other Collaborating Organizations	53
Total Cost	$3,053,788
Mini-grant Costs	$191,901
Scholarships/Awards Cost	$568,944.85
STEM Research Kits Cost	$135,769.90
Cost of National Event (NJ&EE)	$277,238.14
Administrative Cost to NSTA	$1,879,933.50
Cost Per Student Participant	$109.24
Gains in the Education of Mathematics & Science (GEMS) **Program Administrator: American Society for Engineering Education (ASEE)**	
Description	STEM Enrichment Activity - at Army laboratories, hands-on
Participant Population	5th-12th grade students (secondary audience: college undergraduate near-peer mentors, teachers)
Number of Applicants	4,161
Number of Students	2,270
Placement Rate	55%
Number of Adults	464
Number of Near-Peer Mentors	94
Number of Resource Teachers	51
Number of Army S&Es	272
Number of Army Research Laboratories	11
Number of K-12 Teachers	42
Number of K-12 Schools	894
Number of K-12 Schools – Title I	184
Number of Colleges/Universities	40
Number of Colleges/Universities -	40

HBCU/MSIs	
Number of DoDEA Students	N/A
Number of DoDEA Teachers	9
Total Cost	$812,395
Stipend Cost	$679,461
Supplies & Equipment (GEMS Sites)	$0
Administrative Cost to ASEE	$132,934
Cost Per Student Participant	$358
High School Apprenticeship Program (HSAP) **Program Administrator: Army Research Office (ARO)**	
Description	STEM Apprenticeship Program – Summer, in Army-funded laboratories at colleges/universities nationwide, with college/university S&E mentors
Participant Population	9th-12th grade students
Number of Applicants	267
Number of Students (Apprentices)	49
Placement Rate	18%
Number of Adults (Mentors)	35
Number of College/University S&Es	28
Number of K-12 Schools	42
Number of K-12 Schools – Title I	20
Number of Army-Funded College/University Laboratories	28
Number of College/Universities	28
Number of HBCU/MSIs	7
Total Cost	$148,687
Admin/Overhead Costs (Host Sites)	$20,437
Stipend Cost (Paid by AEOP and ARO)	$128,250
Cost Per Student Participant	$3,304
Junior Science & Humanities Symposium (JSHS) **Program Administrator: Academy of Applied Science (AAS)**	
Description	STEM Competition - Nationwide (incl. DoDEA schools), research symposium that includes 47 regional events and one national event
Participant Population	9th-12th grade students
Number of Applicants	9,347 students and 1,003 teachers
Number of Students	5,829 Regional Participants (of whom 218 were selected to attend the National JSHS Symposium)
Placement Rate	62%
Number of Adults (Mentors, Regional Directors, Volunteers – incl. Teachers and S&Es)	3,203
Number of Army and DoD S&Es	300
Number of Army/DoD Research	65

Laboratories	
Number of K-12 Teachers	1,003
Number of K-12 Schools	1,020
Number of K-12 Schools – Title I	148
Number of DoDEA Teachers	8
Number of DoDEA Students	102
Number College/University Personnel	1,240
Number of Colleges/Universities	120
Number of Other Collaborating Organizations	134
Number of HBCU/MSIs	12
Total Cost	$1,884,434
Cost of Regional Symposia Support	$705,904
Cost of National Symposium	$339,410
Administrative Cost to AAS	$269,339
Cost of Scholarships/Awards	$387,270
Cost per Student Participant	$323.28
Junior Solar Sprint (JSS) **Program Administrator: Technology Student Association (TSA)**	
Description	STEM Competition - Solar car competition regional events at 3 Army laboratories and at 17 TSA state events, 1 national event hosted in conjunction with the TSA national conference
Participant Population	5th-8th grade students
Number of Applicants/Students	636
Placement Rate	N/A (all students who register are participants)
Number of Adults (Mentors and Volunteers – incl. Teachers and Army S&Es)	168
Number of Army S&Es	26
Number of Army/DoD Research Laboratories	3
Number of K-12 Schools	266
Number of K-12 Schools – Title I	94
Number of Other Collaborating Organizations	3
Total Cost	$123,372
Scholarships/Awards Cost	$15,073
Stipend Cost	$500
Administrative Cost to TSA	$107,799
Cost Per Student Participant	$194
Research & Engineering Apprenticeship Program (REAP) **Program Administrator: Academy of Applied Science (AAS)**	

Description	STEM Apprenticeship Program – Summer, at colleges/university laboratories, targeting students from groups historically underserved and under-represented in STEM, college/university S&E mentors
Participant Population	9th-12th grade students from groups historically underserved and under-represented in STEM
Number of Applicants	531
Number of Students (Apprentices)	101
Placement Rate	19%
Number of Adults (Mentors)	68
Number of College/University S&Es	68
Number of K-12 Schools	88
Number of K-12 Schools – Title I	60
Number of College/Universities	37
Number of HBCU/MSIs	21
Total Cost	$349,690
Stipend Cost	$200,699
Administrative Cost to AAS	$148,991
Cost Per Student Participant	$3,462
Science & Engineering Apprentice Program (SEAP) **Program Administrator: American Society for Engineering Education (ASEE)**	
Description	STEM Apprenticeship Program – Summer, at Army laboratories with Army S&E mentors
Participant Population	9th-12th grade students
Number of Applicants	663
Number of Students (Apprentices)	92
Placement Rate	15%
Number of Adults (Mentors)	73
Number of Army S&Es	43
Number of Army Research Laboratories	11
Number of K-12 Schools	63
Number of K-12 Schools – Title I	11
Total Cost	$325,224
Stipend Cost (Paid by participating Labs)	$272,419
Administrative Cost to ASEE	$52,805
Cost Per Student Participant	$3,535
Unite **Program Administrator: Technology Student Association (TSA)**	
Description	STEM Enrichment Activity - Pre-collegiate, engineering summer program at university host sites, targeting students from groups historically underserved and under-represented in STEM
Participant Population	Rising 10th and 11th grade students from groups historically underserved and

	under-represented in STEM
Number of Applicants	491
Number of Students (Apprentices)	200
Placement Rate	41%
Number of Adults	112
Number of Army S&Es	9
Number of Army Agencies	6
Number of K-12 Teachers	51
Number of K-12 Schools	129
Number of K-12 Schools – Title I	36
Number of Colleges/Universities	10
Number of HBCU/MSIs	7
Total Cost	$323,632
Stipend Cost	$86,300
Administrative Cost to TSA	$67,600
Cost Per Student Participant	$1,619
Undergraduate Research Apprenticeship Program (URAP) **Program Administrator: Army Research Office**	
Description	STEM Apprenticeship Program – Summer, in Army-funded labs at colleges/universities nationwide, with college/university S&E mentors
Participant Population	College undergraduate students
Number of Applicants	104
Number of Students (Apprentices)	48
Placement Rate	46%
Number of Adults (Mentors)	40
Number of College/University S&Es	36
Number of Army-Funded College/University Laboratories	36
Number of College/Universities	36
Number of HBCU/MSIs	7
Total Cost	$173,909
Admin/Overhead Costs (Host Sites)	$27,373
Stipend Cost (Paid by AEOP and ARO)	$146,536
Cost Per Student Participant	$3,700

† *College/universities or Army/DoD Research Laboratories served as host sites for the AEOP element.*
‡ *Data from Unite reflects the number of participants from Title I schools rather than the number of Title I schools.*

The AEOP participation numbers by individual program are presented in Table 2. There were 38,039 youth and 6,371 adult participants captured in 2015 AEOP activities, of which, 834 students and 81 teachers were from DoDEA schools. The majority of adults, including Army S&Es and K-12 teachers, volunteered with the eCM and JSHS STEM competitions as mentors, advisors, and judges. Three programs increased their participation of youth and/or mentors (CQL, GEMS, and HSAP) while other program participation remained steady or experienced slight declines.

Table 2. 2015 AEOP Participation Numbers			
		Youth	**Adults**
CII	Camp Invention Initiative	465	90
CQL	College Qualified Leaders	394	369
eCM	eCYBERMISSION	27,955	4,350
GEMS	Gains in the Education of Mathematics & Science	2,270	464
HSAP	High School Apprenticeship Program	49	35
JSHS	Junior Science & Humanities Symposium	5,829	3,203
JSS	Junior Solar Sprint	636	168
REAP	Research & Engineering Apprenticeship Program	101	68
SEAP	Science & Engineering Apprentice Program	92	73
Unite	Unite	200	112
URAP	Undergraduate Research Apprenticeship Program	48	40
	Total 2015 AEOP Participants	**38,039**	**9,152**

Partnerships are key to the success of the AEOP portfolio. In FY15, there was strong involvement of adult mentors, judges, and presenters within AEOP apprenticeship, competitions, and STEM program across the country coming from DoD/Army laboratories, K-12 schools, and college/universities. In 2015, 1,507 of the 6,371 adults who participated in AEOP were Army and DoD S&Es who served in the important role of mentor (236 S&Es) to student apprentices through the SEAP and CQL programs; served as judges for the eCM, JSHS, and JSS competitions (875 S&Es); and served as presenters at the GEMS and Unite programs (1,156 S&Es). As in FY14, four of the 11 AEOP initiatives (GEMS, JSS, SEAP, and CQL) took place at Army laboratories. There were 64 college/university S&E's that mentored HSAP/URAP apprentices in 36 Army-funded laboratories at colleges/universities. A longstanding pillar of the AEOP portfolio is the leveraging of Army and DoD S&Es and Army and DoD laboratories, which makes the AEOP in a class of its' own compared to other STEM outreach initiatives.

In FY15 AEOP K-12 engagement was strong and represented a broad array of participants from around the globe. Youth and teachers representing 3,850 K-12 schools, of which at least 1,262 have Title I recognition, comprised the diverse registrant of FY15 AEOP participants. K-12 teachers are critical to the success of both the eCM and JSHS competitions, often engaging entire classrooms of their students in the programs and serving as team advisors or mentors. In 2015, 2,298 K-12 teachers participated in eCM and 1,003 K-12 teachers participated in JSHS.

College/university S&Es, students, and other staff comprised the third group of collaborators for the 2015 AEOP programming. Colleges/universities across the U.S. are host sites for JSHS regional symposia (46), the Unite summer program (10), and both HSAP (28) and URAP (36) apprenticeship programs. The AEOP engaged with 462 colleges/universities in 2015, including 68 HBCU/MSIs. In FY15, a little over 50% of the adult participants in JSHS (1,240) were college/university personnel.

Table 3. Number of 2015 Collaborating Schools, Laboratories, Army/DoD S&Es, and Other Organizations								
AEOP Program	K-12 Schools		Colleges/Universities (represented by participants or serving as host sites)		Army and DoD Research Laboratories/ Army Agencies	Army-Funded University Laboratories	Army and DoD Scientists & Engineers (S&Es)	Other Collaborating Organizations
	Total	Title I	Total	HBCU/MIs				
CII*	15	14	NA†	NA†	3	NA†	NA†	NA†
CQL	NA†	NA†	120	12	11	NA†	288	NA†
eCM	1,337	709	71	___§	38	NA†	549	53
GEMS	894	184	40	4	11	NA†	272	NA†
HSAP	42	20	28	7	NA†	28	NA††	NA†
JSHS	1,020	148	120	___§	65	NA†	300	134
JSS	266	94	NA†	NA†	3	NA†	26	3
REAP	88	60	37	21	NA†	NA†	NA†	NA†
SEAP	63	11	NA†	NA†	9	NA†	43	NA†
Unite	129	36	10	7	6	NA†	9	10
URAP	NA†	NA†	36	7	NA†	36	NA††	NA††
Total Sites	**3,854**	**1,276‡**	**462**	**116**	**146**	**64**	**1,487**	**200**

§ *Data not available.*
† *Does not apply.*
** Camp Invention Initiative (CII) was not part of program evaluations in 2015.*

Associated costs for the implementation of the FY15 AEOP portfolio of programs are detailed in Table 4. The portfolio is broken into three categories of programming: competitions, programs, and apprenticeships. The FY15 AEOP competitions ranged in cost from $109.24 (eCM) to $323.28 (JSHS) per participant. The cost of STEM programs ranged from $35 per student for GEMS, which is primarily a 1-week summer STEM experience in the Army labs, to $1,619 for Unite, a 4-6 week summer STEM experience for students from historically underserved and under-represented groups. The AEOP summer apprenticeship programs range between $3,462 for REAP, a summer program to $11,933 for CQL, a longer program, per student participant. The cost of CQL reflects the longer duration of the program, which may take place in the summer or through portions of the academic year (sometimes lasting the entire year), as well is the level of the advanced level of the student participant (college undergraduate or graduate student).

Similar to FY14 findings, the apprenticeship programs were the most costly and the competitions were the least costly of the AEOP elements on a per student basis for FY15. The cost difference is due in large part to the cost of participant stipends, which are dependent upon the educational level of the student and duration of the program. Interestingly, three AEOP programs were more efficient in FY15 in respects to cost per student participant (CQL, GEMS, HSAP) and experienced a slight decrease in cost per student participant. Other programs experienced slight cost per student participant increases ranging from 4% to 20%.

Table 4. 2015 AEOP Costs				
		Program Cost	Cost Per Student Participant	Average Stipend Per Student Participant
CII	STEM Enrichment Program (grades K-6)	$104,625	$225	NA
CQL	STEM Apprenticeship Program (undergraduate/graduate)	$4,212,439	$10,691	$10,557
eCM	STEM Competition (grades 6-9)	$3,053,788	$109.24	NA†
GEMS	STEM Enrichment Program (grades 5-12)	$812,395	$358	$100
HSAP	STEM Apprenticeship Program (grades 9-12)	$148,687	$3,304	$3,000
JSHS	STEM Competition (grades 9-12)	$1,884,434	$323.28	NA†
JSS	STEM Competition (grades 5-8)	$123,372	$194	NA†
REAP	STEM Apprenticeship Program (grades 9-12)	$349,690	$3,462	$1,500
SEAP	STEM Apprenticeship Program (grades 9-12)	$325,224	$3,535	$2,961
Unite	STEM Enrichment Program (grades 9-12)	$323,632	$1,619	$431.50
URAP	STEM Apprenticeship Program (undergraduate)	$173,909	$3,700	$3,000

† *Participants in AEOP competitions are not eligible for stipends.*

Evaluation Strategy

The 2015 AEOP portfolio evaluation was a combined effort of Purdue University (the new lead for AEOP evaluation 2015-2025) and Virginia Tech, former Lead Organization (LO) and evaluation lead. The evaluation team at Virginia Tech conducted all data collection for FY15 including survey data for all programs; site visits for selected programs, and focus group/individual interviews with selected program participants. Purdue University was transitioned into the lead for this work beginning October 1, 2015 and conducted all data analysis and prepared all AEOP FY15 evaluation reports. There were two exceptions to this work: eCM and the Camp Invention Initiative. eCM's FY15 evaluation was conducted by David Heil and Associates and a report was provided to the AEOP CAM. The Camp Invention Initiative,
was not independently assessed through the AEOP evaluation. Purdue University and Virginia Tech assessed and evaluated nine of the AEOP elements in collaboration with AEOP CA consortium members,[1] individual program

[1] The 2015 AEOP CA consortium members included the Academy of Applied Science (AAS; JSHS, REAP), the American Society for Engineering Education (ASEE; GEMS, SEAP, CQL), the Technology Student Association (TSA; JSS, Unite), the National Science Teachers Association (NSTA: eCM), the University of New Hampshire (Science Teacher Program Initiative), and Virginia Tech (Lead Organization). HSAP and URAP are managed by the Army Research Office (ARO). The West Point Bridge Design Competition (WPBDC) was removed from the 2015 AEOP as the result of a mutual agreement between the PI of WPBDC and AEOP leadership. WPBDC has evolved in a way that its goals and objectives no longer aligned with those of the AEOP.

administrators (IPAs), the Army Cooperative Agreement Managers (CAMs), and personnel responsible for implementing programs at specific sites (Command Level Coordinators, Lab Coordinators, Regional Directors, etc.). These nine programs were: CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP. The 2015 AEOP evaluation was standardized across these programs to allow for the reporting of consistent information about program quality and impacts. Elements of the data available through the eCM report and Camp Invention that were aligned with the overall AEOP portfolio evaluation were included for reference in this report.

Table 5. AEOP Priorities and Objectives (2015)
PRIORITY ONE: STEM Literate Citizenry
Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base.
Objectives
• Encourage and reward student participation in STEM opportunities.
• Inspire students to excel in science and mathematics.
• Increase participation of underserved populations in the AEOP.
• Expand the involvement of students in ongoing DoD research.
• Increase awareness of DoD STEM career opportunities.
PRIORITY TWO: STEM "Savvy" Educators
Support and empower educators with unique Army research and technology resources.
Objectives
• Partner with schools and teachers at local and state educational agencies for shared standards in science and mathematics.
• Use incentives to promote teacher participation in the AEOP.
• Provide online resources for educators to share best practices.
• Provide and expand mentor capacity of the Army's highly qualified scientists and engineers.
PRIORITY THREE: Sustainable Infrastructure
Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.
Objectives
• Develop and implement cohesive program metrics for each individual program and across all of the AEOP.
• Provide STEM educational opportunities for students at all stages of their K-12 education.
• Integrate programs in a central branding scheme, inclusive of a centralized website, for a strategic and comprehensive marketing strategy.
• Establish a competitive process for funding new STEM investments that align to the overall program strategy.

The 2015 evaluation was informed by AEOP objectives[2] (established in 2012) and by the objectives of individual AEOP elements. The evaluation studies were carried out using a logic model that proposes a pathway of influence for the AEOP; ultimately linking AEOP inputs and activities to intended outcomes that align with AEOP priorities and objectives as well as federal requirements for reporting on federal STEM investments. The logic model provides a framework for

[2] The AEOP priorities and objectives have been updated for 2015 to include the addition of 1-f: Increase participants' awareness of AEOP's pipeline of opportunities; and 2-g: Increase educators' awareness of AEOP pipeline of opportunities.

the near- and long-term AEOP evaluation plan, ensuring that evaluation questions yield information that is valuable to the AEOP and that evaluation assessments include appropriate measures of intended outputs and outcomes that align with the AEOP's priorities and objectives and federal requirements.

In 2015, the AEOP evaluation studies focused predominantly on assessing the quality of AEOP programs as well as near- and mid-term impacts. Thus, data collection included questions about the benefits of participation to participants, program strengths and challenges, and overall effectiveness in meeting AEOP and program objectives. In addition, each program evaluation noted which recommendations from previous evaluations had been implemented (evidence-based change). Figure 1 below provides a simple graphical depiction of the AEOP Evaluation logic model.

The AEOP element evaluations generally sought to answer these fundamental questions:

Key Evaluation Questions

- What aspects of an AEOP motivate participation?
- What aspects of an AEOP's structures, processes, and resources are working well?
- What aspects of an AEOP could be improved?
- Did participation in an AEOP:
  - Increase participants' STEM competencies?
  - Increase participants' interest in or intent for future STEM engagement?
  - Increase participants' awareness of and interest in other AEOP opportunities?
  - Increase participants' awareness of and interest in Army/DoD STEM careers?

Inputs	Activities	Outputs	Outcomes (Near-term)	Impact (Mid- and Long-Term)
• US Army sponsorship • Broad roster of AEOP initiatives available for student engagement • IPAs providing coordination and oversight of programs • Operations conducted at Army/DoD research facilities, universities, schools, and local/regional and national competitions • Army/DoD and university S&Es, local and DoDEA/DoDDS educators, and other volunteers serving as STEM "mentors" • Online and on-site curricular resources • Stipends and awards for students and educator participants • Centralized branding and comprehensive marketing • Centralized evaluation and annual reporting	• Engagement in "authentic" STEM experiences through: • Curriculum-driven summer programs at Army research institutions and universities • Summer and academic year apprenticeship programs at Army research institutions and universities • Local/regional and national STEM competitions	• Increasing numbers and diversity of student participants • Increasing numbers and diversity of "mentor" participants • Increasing numbers and diversity of Army/DoD scientists and engineers engaged in programs • Increasing numbers of K-college schools served through participant engagement • Increasing number of curricular resources distributed through websites and program participation • Students, "mentors," site coordinators, and IPAs contributing to evaluation	• Increased student interest and engagement in STEM (formal and informal) • Increased participant STEM skills, knowledge, abilities, and confidence • Increased participant knowledge of other AEOP opportunities • Increased participant knowledge of Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve programs	• Increased student participation in other AEOP opportunities and DoD scholarship/ fellowship programs • Increased student interest in and pursuit of STEM coursework in secondary and post-secondary schooling • Increased student interest in and pursuit of STEM degrees • Increased student interest in and pursuit of STEM careers • Increased student interest in and pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of the AEOP

Figure 1. AEOP Evaluation Logic Model

The 2015 AEOP evaluation plan is summarized by program in Table 6. In short, most evaluations utilized participant questionnaires, as well as focus groups or interviews with the youth population (herein called students and apprentices) and adult participants who led educational activities or supervised research (herein called mentors).

Table 6. 2015 AEOP Evaluation Strategy

AEOP Element	Assessment Tools	Program-Level Objectives
CQL	Program Evaluation: • Apprentice questionnaire • Apprentice interviews	• To nurture interest and provide research experience in STEM for college students and recent graduates contemplating further studies. • To provide opportunities for continued association with the DoD laboratories and STEM enrichment of previous SEAP, GEMS, and other AEOP program participants, as well as allow new college students the opportunity to engage with DoD laboratories. • To outreach to participants inclusive of youth from groups historically under-represented and underserved in STEM. • To increase participant knowledge in targeted STEM areas and develops research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research (poster, paper, oral presentation, etc.). • To educate participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories. • To acquaint participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community. • To provide information to participants about opportunities for STEM enrichment and ways they can mentor younger STEM students through GEMS, eCYBERMISSION, and other AEOP opportunities.
eCM	Program Evaluation:[3] • Student pre- and post-questionnaires • NJ&EE student questionnaire • Team advisor questionnaire • Student focus groups • Team advisor focus group • NJ&EE observation	• To provide a positive STEM learning experience for students, team advisors, and Cyberguides. • To support and empower educators through incentives and online resources to promote participation in eCYBERMISSION. • To increase students' interest and engagement in STEM learning as well as their pursuit of future STEM coursework and STEM related careers. • To broaden, deepen, and diversify the pool of STEM talent to support the US Defense Industry Base.

[3] Conducted by David Heil & Associates

GEMS	Program Evaluation: • Student questionnaire • Mentor questionnaire • Student focus groups • Mentor focus groups	• To nurture interest and excitement in STEM for middle and high school participants. • To nurture interest and excitement in STEM for mentor participants. • To implement STEM enrichment experiences that are hands-on, inquiry-based educational modules that enhance in-school learning. • To increase participant knowledge in targeted STEM areas and laboratory skills. • To increase the number of outreach participants inclusive of youth from groups historically under-represented and underserved in STEM. • To encourage participants to pursue secondary and post-secondary education in STEM. • To educate participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories. • To provide information to participants about opportunities for STEM enrichment through advancing levels of GEMS as well as other AEOP initiatives.
HSAP	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Mentor interviews • Apprentice interviews	• To provide hands-on science and engineering research experiences to high school students. • To educate students about the Army's interest and investment in science and engineering research and the associated educational opportunities available to students through the AEOP. • To provide students with experience in developing and presenting scientific research. • To benefit students from the expertise of a scientists or engineer as a mentor. • To develop students' skills and background to prepare them for competitive entry to science and engineering undergraduate programs.
JSHS	Regional Symposia Evaluation: • Student questionnaire • Mentor questionnaire National Symposium Evaluation: • Student questionnaire • Student focus groups • Rapid student interviews • Rapid mentor interviews	• To promote research and experimentation in STEM at the high school level. • To recognize the significance of research in human affairs and the importance of humane and ethical principles in the application of research results. • To search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering. • To recognize innovative and independent research projects

	• Mentor focus group • Mentor questionnaire[4]	of youth in regional and national symposia. • To expose students to academic and career opportunities in STEM and to the skills required for successful pursuit of STEM. • To expose students to STEM careers in Army and/or DoD laboratories. • To increase the future pool of talent capable of contributing to the nation's scientific and technological workforce.
JSS	Program Evaluation: • Student questionnaire • Mentor questionnaire • Student focus groups • Mentor focus group • Rapid student interviews • Rapid mentor interviews	• To create a national infrastructure to manage local, regional, and national JSS events and increase participation. • To enhance training opportunities and resources for teachers/mentors. • To coordinate tracking and evaluation opportunities for student and teacher participation in JSS. • To leverage AEOP through cross-program marketing efforts.
REAP	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Mentor interviews • Apprentice interviews	• To provide high school students from groups historically under-represented and underserved in STEM, including alumni of the AEOP's Unite program, with an authentic science and engineering research experience. • To introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP. • To provide participants with mentorship from a scientists or engineer for professional and academic development purposes. • To develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.
SEAP	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews	• To acquaint qualified high school students with activities of DoD laboratories through summer research and engineering experiences. • To provide students with opportunities and exposure to scientific and engineering practices and personnel not available in there school environment. • To expose those students to DoD research and engineering activities and goals in a way that encourages a positive image and supportive attitude toward our defense community. • To establish a pool of students preparing for careers in science and engineering with a view toward potential government service. • To prepare these students to serve as positive role models for their peers thereby encouraging other high school

[4] A single mentor questionnaire was administered to all mentors, regardless of whether their student was selected for the National Symposium.

		students to take more science and math courses. • To involve a larger percentage of students from previously under-represented segments of our population, such as women, African-Americans and Hispanics, in pursuing science and engineering careers.
Unite	Program Evaluation: • Student questionnaire • Mentor questionnaire • Student interviews • Mentor interviews	• To effectively show participants the real word applications of math and science. • To raise participant confidence in the ability to participate in engineering activities. • To inspire participants to consider engineering majors in college. • To remove social barriers and negative attitudes about engineering. • To promote collaboration and problem solving in a team environment. • To expose participants to STEM careers in the Army and DoD. • To increase the number of STEM graduates to fill the projected shortfall of scientists and engineers in national and DoD careers.
URAP	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Apprentice interviews • Mentor interviews	• To provide hands-on science and engineering research experience to undergraduates in science or engineering majors. • To educate students about the Army's interest and investment in science and engineering research and the associated educational and career opportunities available to students through the Army and the DoD. • To provide participants with experience in developing and presenting scientific research. • To provide participants with experience to develop an independent research program in preparation for research fellowships. • To develop students' research skills with the intent of preparing them for graduate school and careers in science and engineering research. • To benefit students from the expertise of a scientist or engineer as a mentor.

Evaluation instruments were iteratively reviewed and revised by individual program administrators (IPAs), the Army Cooperative Agreement Managers (CAMs), and evaluators. All instruments were approved by Virginia Tech's Internal Review Board (IRB) for the protection of human research subjects. Additional details about Virginia Tech's measures and sampling, data collection and analyses, and reporting and dissemination are provided in Appendix A.

Study Sample

The FY15 AEOP evaluation included an analysis of participation in questionnaires, the primary data collection method. The response rate and associated margin of error at the 95% confidence level for each sample were computed (see Table 7). As was the case in FY14, most of the margins of error for individual programs do not fall within the acceptable range (2-5%). This can be partially attributed to the fact that random sampling is not used for participation in the surveys. The large margin of error can indicate is potential for response bias (that those who chose to respond to the questionnaire are not representative of the entire population). Consequently, results from the questionnaire data should be viewed as preliminary indicators of program quality and impact and not viewed as conclusive.

Table 7. 2015 AEOP Questionnaire Participation

Program	2014 Questionnaire	Sample	Population	Participation Rate	Margin of Error @ 95% Confidence[5]
CQL	Apprentice	125	394	32%	±7.3%
	Mentor	38	369	10%	±15.1%
eCM	Student (pre-questionnaire)	2,492	27,955	8%	
	Student (post-questionnaire)	809	27,955	3%	
	NJ&EE Student	77	77	100%	
	Team Advisor	209	1,828	12%	
GEMS	Student	2,118	2,270	93%	±0.55%
	Mentor (incl. NPM, RT, S&Es)	30	464	6%	±17.3%
HSAP	Apprentice	35	49	72%	±8.7%
	Mentor	25	41	61%	±9.2%
JSHS	Regional Symposia Student	356	5,829	6%	±5.03%
	National Symposium Student	61	218	28%	±10.80%
	Mentor	239	1,003	24%	±5.54%
JSS	Student	92	636	14%	±9.46%
	Mentor	22	281	8%	±20.0%
REAP	Apprentice	88	101	87%	±3.77%
	Mentor	55	68	81%	±10.9%
SEAP	Apprentice	48	97	50%	±10.1%
	Mentor	24	116	21%	±17.9%
Unite	Student	156	280	56%	±5.5%
	Mentor	34	160	21%	±17.6%
URAP	Apprentice	27	48	56%	±10.9%
	Mentor	16	40	40%	±10.1%
Total AEOP Questionnaire Participation		**5,437**	**61,351**	9%	

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

Focus groups and/or interviews were conducted with participants and mentors from each of the programs. Purposive sampling was used for assembling diverse focus groups when larger populations were available at a site. Convenience sampling was employed when small numbers of participants were available at a site. In total, 123 students, apprentices, and mentors participated in focus groups in 2015. Interviews were conducted with 76 AEOP program individuals, including 43 participants and 33 mentors. Evaluators purposively sampled from programs' enrollment data to identify phone interview candidates exhibiting geographic, demographics, and STEM interest diversity. Table 6 summarizes focus group and interview participation.

Table 8. 2015 AEOP Focus Group and Interview Participation

Program	2015 Focus Group and Interview	Focus Group Sample	Interview Sample
CQL	Apprentice		8
	Mentor		
eCM	NJ&EE Student	22	
	NJ&EE Team Advisor	22	
GEMS	Student	25	
	Mentor	13	
HSAP	Apprentice		8
	Mentor		8
JSHS	Regional Symposium Participant	24	
	Competition Advisor/Mentor	11	
JSS	Student	5	8
	Mentor	2	9
REAP	Apprentice		7
	Mentor		5
SEAP	Apprentice		2
	Mentor		
Unite	Student		7
	Mentor		7
URAP	Apprentice		3
	Mentor		4
Total AEOP Focus Group/Interview Participation		**123**	**76**

Evaluation Findings

The FY15 AEOP evaluation findings are organized within the three AEOP priorities and associated objectives to provide insight into portfolio progress toward achieving the desired outcomes of the AEOP. These priorities include:

- **Priority One: STEM Literate Citizenry** - ***Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base***
- **Priority Two: STEM Savvy Educators** - ***Support and empower educators with unique Army research and technology resources***
- **Priority Three: Sustainable Infrastructure** - ***Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army***

Priority One: STEM Literate Citizenry

Findings from the FY15 AEOP evaluation reveal progress toward achieving a STEM Literate Citizenry with some continued challenges from FY14. Major trends that support the achievement of this AEOP priority along with evidence from assessment data that inform the findings are presented below.

Finding #1: In FY15 the AEOP provided outreach to 38,039 participants through its comprehensive portfolio of programs. This number represents an overall decrease in number of participants compared to FY14 (41,802) that can be attributed to decline in participation for a few of the AEOP competition programs (i.e., eCM, JSHS, JSS). There were 34,420 students enrolled in FY15 AEOP competitions, which represents 3,562 fewer participants than FY14. However, the AEOP apprenticeship portfolio experienced overall growth in participation with 684 apprentices in 2015 (compared to 585 in FY14). Specifically, CQL increased both number of participants as well as placement rate (394 apprentices representing a 78% placement rate). Similarly, HSAP (49 apprentices, 18% placement rate) experienced growth and SEAP remained steady with the same number of participants as in FY14 (92). REAP and URAP had slight declines in participation in FY 15 (REAP 101 compared to 117 in FY14; URAP 48 compared to 59 in FY14). Student STEM enrichment activities (i.e., CII, GEMS, and Unite) also declined in participation overall, as CII enrollment alone was 44% lower than in FY14 (465 compared to 860). Unite experienced a 29% decrease in participation (200 compare to 280 in FY14). On a positive note, GEMS increased participation in FY15 with 2,270 students enrolled compared to 2,095 in FY14. There were a total of 2,935 students enrolled in STEM enrichment activities in FY15 (compared to 3,235 in FY 14). Despite efforts to include more participants in AEOP activities, FY15 reiterated the continued unmet need for youth and adults in the United States and beyond, with 6,418 applicants who were not accepted into the programs.

As in FY14, the FY15 AEOP portfolio consisted of STEM programs designed to nurture students' STEM interests and aspirations throughout their educational career. AEOP includes STEM competitions (eCM, JSHS, and JSS), STEM enrichment activities (CII, GEMS and Unite), and STEM apprenticeship programs (CQL, HSAP, REAP, SEAP, and URAP). The GEMS Near-Peer Mentors (NPM) program also provided professional development to undergraduate student scientists and engineers (S&Es)-in-training, who lead educational activities for youth in the GEMS program.

More than 3,403 K-12 teachers and 1,487 Army and DoD S&Es engaged in AEOP programs as participants, led educational activities, supervised research, or served as competition advisors, judges, event hosts or other volunteers. These data do not reflect others who may have been impacted within the organizations of those served or serving in the AEOP. These data also do not reflect the potentially broader and undetermined impact of AEOP's online educational resources made freely available through eCM and JSS, or those resources available to GEMS NPMs and GEMS resource teachers.

In FY15 the AEOP received over 40,000 appliations to individual programs – indicating continued strong interest in AEOP opportunities. However, in FY15 10% fewer applications were received (44,632 FY15; 49,686 FY14). There continues to be considerable unmet need across the AEOP programs as well as only 37,574 participants were selected for inclusion programs. This represents a decrease in number of participants from FY14 (41,802). Registration data indicate that many AEOP programs were filled to capacity while others had capacity for more participants but were unable to fill slots

due to interest, funding, or lack of enough programmatic support (e.g., mentors, volunteers). 2015 AEOP application numbers and placement rates are detailed in Table 9. As in FY14, eCybermission contunes to be the largest program (enrolling more than 50% of the total number of AEOP participants) in the AEOP portfolio in regards to number of participants (27,955). eCybermission is a web-based STEM competition for 6th-9th grade youth that is open to all who meet registration qualifications – with no enrollment cap at this time. JSS, another STEM competition, was similarly open to all those who registered in 2015 and included 636 participants – a decline from 891 in FY14.

In FY15 there continued to be a variation in the number of applicants versus number of participants occurred within the AEOP apprenticeship programs, enrichment activities, and the JSHS competition. The 2015 apprenticeships (CQL, HSAP, REAP, SEAP, and URAP) were competitive with a placement rate ranging from 15% (SEAP) to 78% (CQL). Overall, there were 2,042 applicants (an increase from FY14) and 684 students selected for apprenticeships (an increase from FY14), resulting in a 2015 AEOP apprenticeship placement rate of 33%, up from 31% in FY14. High school apprenticeships (HSAP, REAP, and SEAP) were most competitive with a combined placement rate of only 17% (same as FY14) as compared to an undergraduate/graduate apprenticeship (CQL and URAP) placement rate of 72% (an increase from 57% in FY14).

Acceptance into the 2015 AEOP STEM enrichment activities (Unite and GEMS) was competitive and rates decreased from FY14, as only 55% of GEMS applicants and 41% of Unite applicants were selected to participate. As in the case with apprenticeships, the AEOP is limited in the number of students it can accept to GEMS and Unite by availability of resources that include funding, space, and staff. The JSHS competition is similarly restricted in the number of students that it can accept to participate in regional symposia. In 2015 62% (an increase from 55% in FY14) of JSHS regional applicants were selected to compete – over 3,000 youth were turned away.

Table 9. 2015 AEOP Number of Applications and Placement Rates

		Youth Applicants	Youth Participants	Placement Rate
CQL	STEM Apprenticeship Program (undergrad/grad)	507	394	78%
eCM	STEM Competition	27,955	27,955	NA†
GEMS	STEM Enrichment Activity	4,161	2,270	55%
HSAP	STEM Apprenticeship Program (high school)	267	49	18%
JSHS	STEM Competition	9,347	5,829	62%
JSS	STEM Competition	636	636	NA†
REAP	STEM Apprenticeship Program (high school)	531	101	19%
SEAP	STEM Apprenticeship Program (high school)	633	92	15%
Unite	STEM Enrichment Activity	491	200	41%
URAP	STEM Apprenticeship Program (undergrad)	104	48	46%
	Total	**44,632**	**37,574**	-

† *In 2015, all youth who meet registration requirements for eCM and JSS were able to participate.*

As in 2014, students and mentors from across the AEOP consistently recommended program expansion as a priority for future programming. Expansion was defined in a variety of ways, including the following:

- Expanding programs' geographic reach, including increasing the number of sites, especially in communities with higher proportions of historically underserved and under-represented populations in STEM, and/or providing support to participants from schools or districts at a distance from existing sites;
- Expanding programs' staffing capacity at existing sites to offer more positions for students;
- Expanding the number of apprenticeships and/or laboratories funded at university sites and formal opportunities for building participant "learning communities" at and across sites;
- Expanding the length of time of the programs and apprenticeships; and
- Expanding programs' repertoires of offerings to include a broader range of relevant and interesting STEM subject matter, as well as seminars and/or field trips to broaden the experience beyond the laboratory

Finding #2: The AEOP continued to emphasize participation of underserved and under-represented groups in associated apprenticeship, competition, and enrichment programs and in FY15 achieving this goal continued to be a challenge. eCM, GEMS JSHS-N, and SEAP increased or remained constant with their participation of females and racial and/or ethnic minorities. However, other programs in the AEOP portfolio experienced declines in participation with one or both of these groups. CQL increased participation of females (25% to 40%) and JSS included more racial and/or ethnic minorities (13% to 28%). REAP and Unite, AEOP programs designed to specifically target underserved and under-represented groups maintained their enrollment of 60% or more of racial and/or ethnic minorities. One concerning finding related to enrollment of females is that Unite decreased over 20% (66% to 45%) in FY15. Further, competitions and programs hosted at Army/DoD laboratories that do local recruiting should examine their recruitment practices to insure potential participants from all backgrounds are represented and competitive for AEOP enrollment slots.

Table 10 summarizes participant demographics collected through registration records and questionnaires in 2014 and 2015. These data indicate that 2015 AEOP programs served participants identifying with groups that are historically underserved and under-represented in STEM. Notably, eCM, GEMS, and SEAP have increased participation for both females and underrepresented minorities in FY15. However, the data indicate mixed progress in expanding the participation of historically underserved and under-represented groups for other programs in the AEOP portfolio. For example, eCM, GEMS, JSHS, JSS and SEAP appear to have increased the proportion of racial/ethnic minorities participating. However, the proportions of minority students participating decreased in CQL, HSAP, REAP, Unite, and URAP. Similarly, CQL, eCM, GEMS, JSHS-N, and SEAP appear to have increased the proportion of female participants, but the proportion appears to have decreased in HSAP, JSHS-R, JSS, REAP, Unite, and URAP.

The ability of individual AEOPs to recruit participants from groups that are historically underserved and under-represented in STEM may be influenced by each program's objectives. For example, some programs within the AEOP portfolio (REAP and Unite) are designed to specifically target underserved and under-represented groups; other programs (e.g., SEAP and CQL) base their student selection on competitive criteria. Therefore, while progress in achieving this goal should be celebrated given the potential challenges of diversifying the portfolio within current guidelines. However, all AEOP programs have been given the goal of diversifying participation and are working toward achieving this through various strategies and partnerships.

Table 10. Student Demographics for 2014 and 2015						
	Females		Racial & Ethnic Minorities		Free or Reduced-Price Lunch Eligible	
	2014	2015	2014	2015	2014	2015
CQL	25%	40%	18%	13%	NA[††]	NA[††]
eCM	49%	49%	15%[††††]	20%[††††]	---[§†]	16%[††††]
GEMS	44%	45%	45%	45%	12%	11%
HSAP	50%[†]	40%	50%[†]	29%	38%[†]	---[§†]
JSHS-R	69%	61%	23%	23%	19%	16%
JSHS-N	58%	70%	6%	22%	7%	3%
JSS	29%[†]	27%	13%[†]	28%	14%[†]	20%
REAP	73%	61%[†††]	65%	60%[†††]	48%	42%[†††]
SEAP	40%	45%	21%	35%	5%	5%
Unite	66%	45%	96%	94%	34%	51%
URAP	50%[†]	33%	50%[†]	22%	NA[††]	NA[††]

[†] *Data were not provided/collected from the specified program.*

[††] *Not applicable – college program.*

[†††] *REAP participant demographic data was not available. Reported percentages are from the 88 survey respondents.*

[††††] *Data only collected from state winners through the Cvent pilot.*

All of the programs in the 2015 AEOP portfolio continued to implement program- and site-level mechanisms intended to attract participants from populations historically underserved and under-represented in STEM. Across the AEOP, efforts included targeted marketing via electronic, print, phone, and in-person communications and/or partnerships with agencies and organizations serving underserved and under-represented groups.

- Tribal, rural, and urban K-12 districts, schools, and teachers;
- Minority serving institutions (MSIs) and historically black colleges and universities (HBCUs);
- Professional organizations (e.g., Society of Women Engineers, National Society of Black Engineers, and Society of Hispanic Engineers);
- Mentoring programs (e.g., Louis Stokes Alliance for Minority Participation Bridge to the Doctorate and UConn Mentor Connection); and
- Regional and national societies promoting STEM educational opportunities for minority groups (e.g., Southeastern Consortium for Minorities in Engineering and Hispanic Association for Colleges and Universities).

These efforts were met with varying success. Discussion of the general impact of AEOP communication efforts is included in priority 3, finding 2. Most AEOP participants report learning about the AEOPs through site-level communication instead of through centralized efforts.

2015 AEOP outreach to engage underserved and under-represented populations did, however, reveal three promising practices: the issuance of program-specific mini-grants to incentivize and enable participation of a target group, the issuance of Strategic Outreach Initiatives to incentivize and enable participation of a larger target group in the AEOP portfolio of programs, the further implementation of the Unite-REAP pipeline.

The eCM mini-grant program continues to provide a model for how AEOP might shift from a vision of equal support to one that deliberately devotes resources to encourage the participation and success of students historically underserved and under-represented in STEM programs. Building off 2013 efforts, 2015 eCM offered the opportunity for mini-grants to teachers, schools, and school districts with award amounts differentiated by number of potential student participants and the proportion of students eligible for free or reduced-price lunch (FRL). The mini-grants were advertised broadly, but also targeted specific urban districts with high populations of underserved and under-represented students. In addition to mini-grants, eCM continued to offer and further developed a suite of teacher supports, including an online teacher advisor resource guide developed by teachers, an online discussion forum that provided access to volunteers and Cyberguides, and program administrator-hosted webinars and professional development. The mini-grants and teacher supports were intended help build a critical mass of resources at a school and increase classroom integration of eCM activities. In 2015, 53 mini-grants were awarded (4 district grants, 5 school grants, 1 grant to SECME, and 37 chapter grants). Replicating the eCM mini-grant program within other AEOP elements could positively impact overall efforts to increase participation rates from targeted underserved and under-represented student populations.

In 2015 the Army, together with the LO, issued a solicitation to seek partnerships with organizations with existing STEM programming for K-college students from historically underserved and under-represented groups as well as their parents and teachers. The intent of this effort was to promote, implement, and integrate the AEOP portfolio of STEM opportunities within the partnering organization's existing framework. 2015 Strategic Outreach Initiatives were established with Harmony Public Schools in Texas (40 K-12 schools, including 24 T-STEM schools and 38 Title I schools) and the California MESA Schools Program (7 universities, 60 Title I schools, and up to 60,000 K-12 students). The End-of-Year Implementation Report provided by Harmony Public Schools (HPS) reflects the establishment of a successful partnership with the AEOP highlighting the following AEOP-specific achievements:

- The Center for STEM Education at HPS conducted meetings and trainings to promote all AEOP endorsed STEM activities, competitions, and instructional programs among teachers, campus project coordinators, science department chairs, counselors, and district academic leaders;
- JSS was implemented at 14 HPS middle schools (7 schools affiliated with local TSA chapters, 7 schools organized school/district competitions);
- 439 HPS students and 132 teams participated in eCM;
- 8 HPS students participated in GEMS-USAISR (17 applicants);
- 3 HPS schools promoted JSHS (with 11 projects submitted to the 2015 Texas A&M University regional symposia);
- 1 HPS participated in REAP at the University of Houston (there were several applicants;
- Several HPS students applied to SEAP at AMRDEC-AED but none were excepted for 2015 – will continue to promote for 2015;
- Information distributed through counselors to students and their families on all AEOP initiatives including the SMART scholarship; and
- HPS followed the AEOP over social media and frequently made their own posts about HPS AEOP participants, tagging the AEOP.

The Unite-REAP pipeline continues to serve as a best practice for recruiting, supporting, and developing youth from underserved and under-represented groups in the AEOP, as part of the mission of these two programs is to have 100% of student participation from underserved and underrepresented populations. Unite and REAP deliberately coordinate across programs to promote the participation of talented students in successive AEOP programs over time. In fact, the 2015 solicitation to select Unite host sites specified that each site would serve the same cohort of students over two consecutive summers to enable provision of continued developmental, academic, and social support to participants. After the two-year Unite term, several alumni from each of the Unite sites will be recruited to participate as research apprentice through REAP. In 2015, 18 alumni of Unite participated in REAP.

As in prior years, inconsistent demographic data collection limits the extent to which the success of mechanisms to increase and retain participation of students from underserved and under-represented populations in the AEOP can be accurately assessed. 2015 AEOP efforts to centralize the registration/application process, including the standardization of the collection of demographic data in this process, should improve evaluators' ability to judge these efforts in the future.

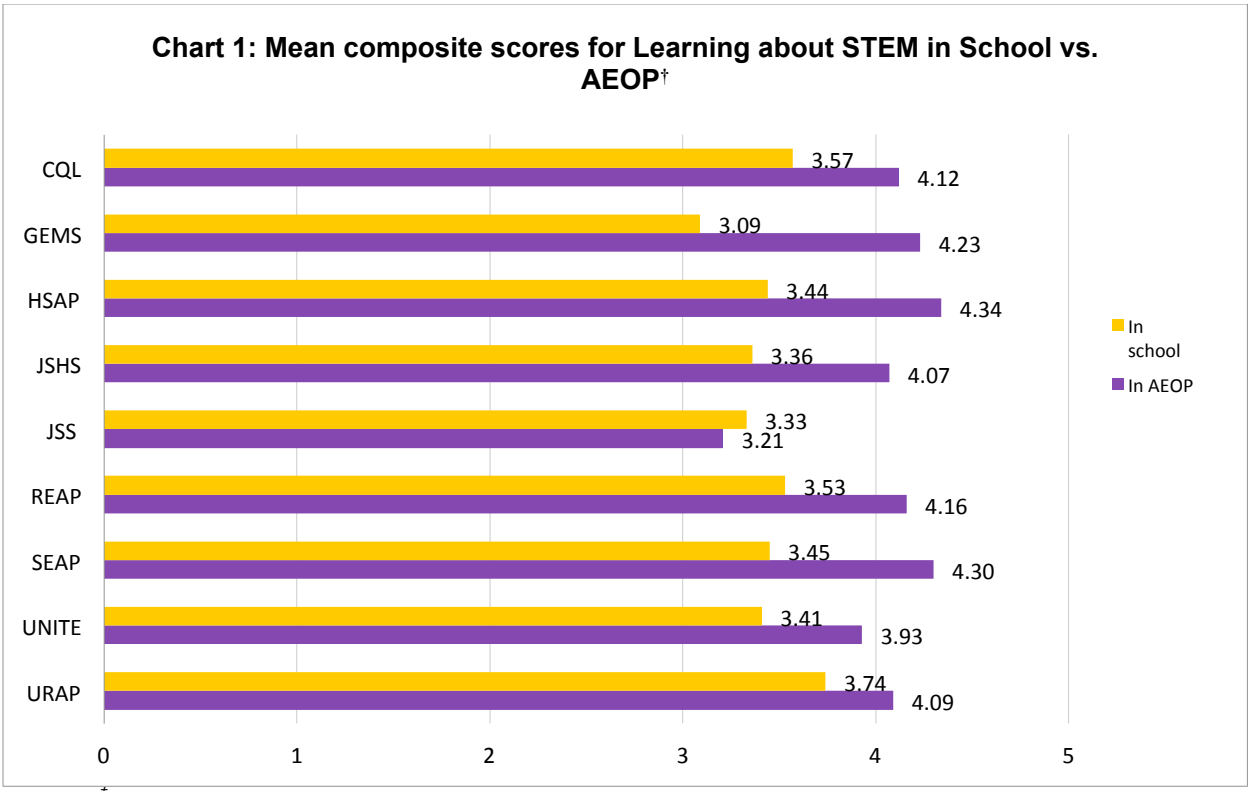
Finding #3: In FY15, as in FY14, the AEOP provided participants with more frequent exposure to real world, hands-on, and collaborative STEM activities than they are exposed to in regular schooling.

A focus of the AEOP is to provide experiences that engage participants in exploring STEM topics, practices, and careers through real world, hands-on, and collaborative STEM activities that extend and enhance traditional school activities. To this end, participants were asked how often they were provided opportunities to learn about STEM in their school and in their AEOP program (individual items are shown in Table 11), using a 5-point responses scale that ranged from "not at all" to "every day." The individual questionnaire items focused in this area were grouped into two composite variables (one for "in AEOP" and one for "in school"), which have the advantage of being more reliable than individual items. The composites have a minimum possible score of 1 and a maximum possible score of 5.

Table 11. Items that Form the Learning about STEM in School and Learning about STEM in AEOP Composites for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. Apply STEM knowledge to real life situations
2. Communicate with other students about STEM
3. Interact with scientists or engineers
4. Learn about new discoveries in STEM
5. Learn about different careers that use STEM
6. Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you

Chart 1 displays the mean composite scores for participants learning about STEM in AEOP and school.[6] For all except one program (JSS), results showed that AEOP students and apprentices reported learning significantly more about STEM in AEOP compared to school. All significant differences had medium to large effect sizes. [7,8]

[6] Due to the small number of participants, composite scores were not computed for HSAP. Additionally, the eCM questionnaire did not include these items, so composite scores could not be calculated.



† *Response options for the items forming this composite were: 1 – Not at all, 2 – At least once, 3 – A few times, 4 – Most days, 5 – Every day.*

Participants were also asked about their perceptions of the frequency of opportunities to engage in STEM practices in their AEOP program as compared to in school, which were also combined into composite variables. These items are shown in Table 12.

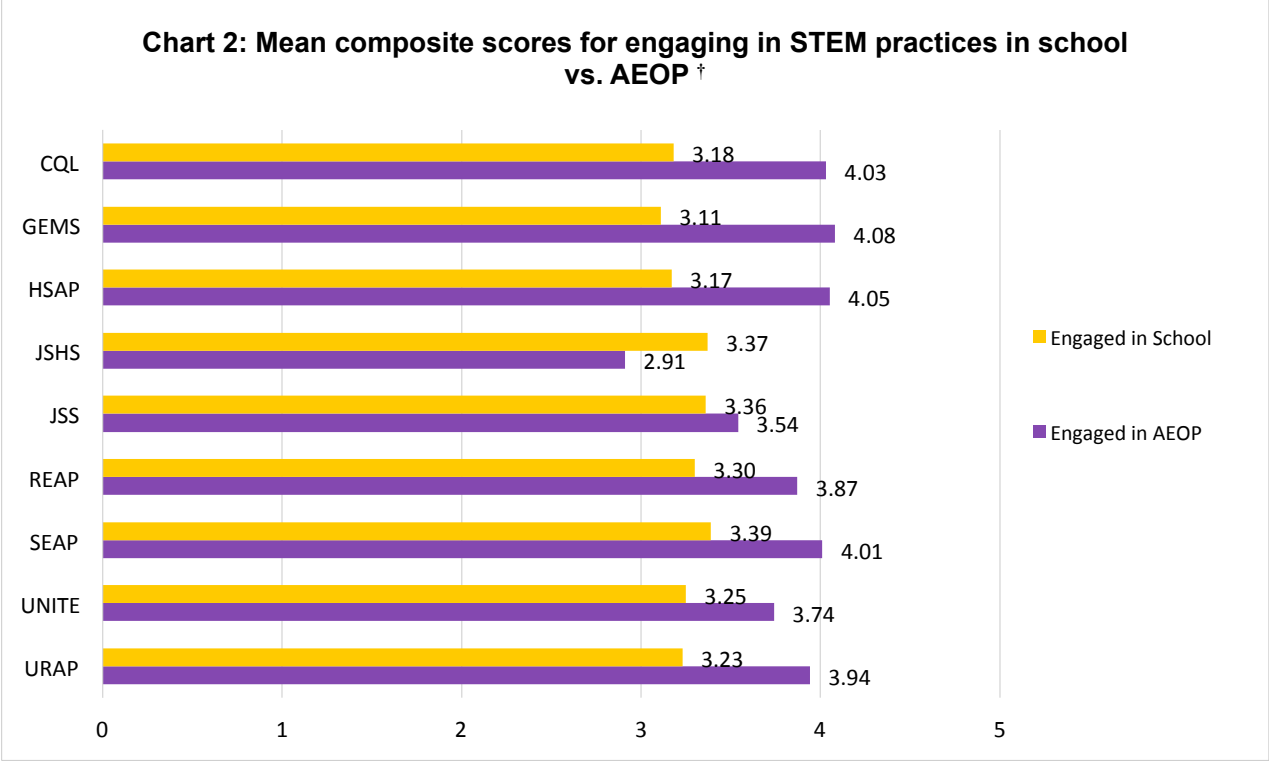
Table 12. Items that Form the Engaging in STEM Practices in School and Engaging in STEM Practices in AEOP Composites for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. Analyze data or information
2. Identify questions or problems to investigate
3. Carry out an investigation
4. Come up with creative explanations or solutions
5. Design an investigation
6. Draw conclusions from an investigation
7. Participate in hands-on STEM activities

[7] When comparing two means, the effect size "d" is calculated as the difference between the two means divided by the pooled standard deviation. Effect sizes of about 0.20 are typically considered small, 0.50 medium, and 0.80 large. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillside, NJ: Lawrence Erlbaum Associates.

[8] Effect sizes: CQL, d = 0.72 standard deviations; GEMS, d = 2.09 standard deviations; HSAP, d = 2.76 standard deviations; JSHS-Regional, d = 1.04 standard deviations; JSHS-National, d = 2.43; REAP, d = 1.44 standard deviations; SEAP, d = 1.10 standard deviations; Unite, d = 0.95 standard deviations; and URAP, d = 1.07 standard deviations.

8. Build or make a computer model
9. Use laboratory procedures and tools
10. Work as part of a team

Chart 2 displays the mean composite scores for all programs. For the composite score of engaging in STEM practices, apprentices and students reported significant STEM engagement differences between AEOP programs and their normal classrooms with more engagement in AEOP programs. This is true in all but two instances – in JSHS students reported significantly greater STEM engagement in the classroom, and JSS had no significant differences between AEOP and classroom STEM engagement found. These findings may be a result of how AEOP competition programs are run with students typically engaging in STEM AEOP project related activities at school before the competitions actually occur.



† *Response options for the items forming this composite were: 1 – Not at all, 2 – At least once, 3 – A few times, 4 – Most days, 5 – Every day.*

In focus groups and interviews as well as in questionnaire responses, apprentices, students, and mentors reported that one of AEOP's greatest benefits is that the programs provide opportunities for participants to engage in authentic STEM activities that are more intensive than or not available in typical school experiences. Participants in all programs reported that, through program activities, students develop or expand their STEM abilities and 21st Century STEM Skills. This is illustrated in the following apprentices' quotes:

I've learned so much from this hands on experience in the labs that I feel confident entering college; participating in this program has definitely given me the upper hand. I was very engaged in the lab experiments, much more than I would have been reading about the procedures in a textbook. (SEAP Apprentice)

[REAP] helped me become better at working on labs/experiments and has exposed me to topics in STEM that I was not aware of before REAP. It is very nice that even though this is my first job I am contributing to meaningful research about a topic that is important to me and my family. (REAP Apprentice)

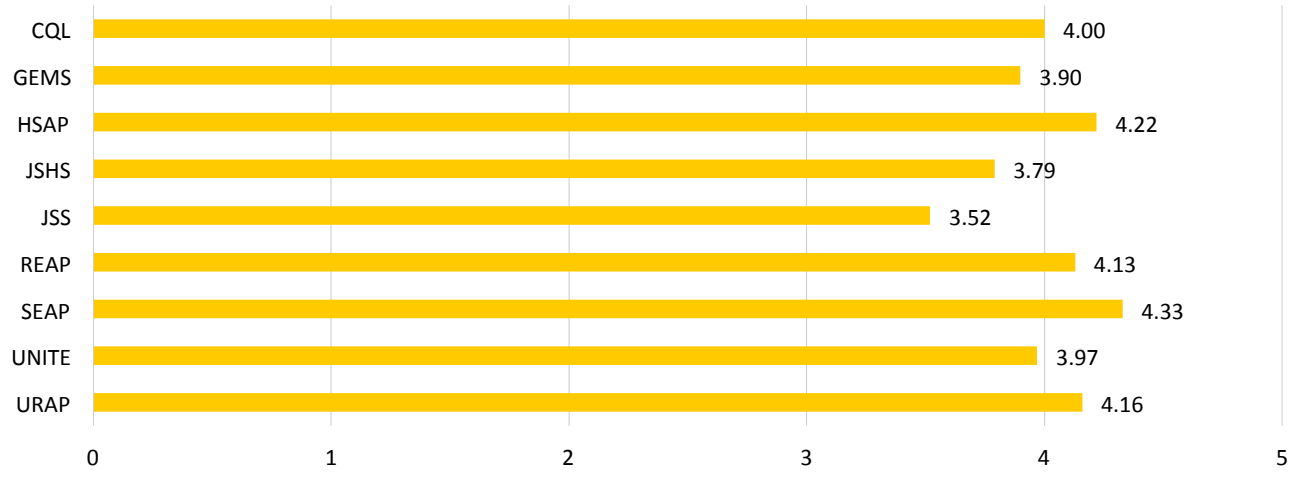
Finding #4: As in 2014, students participating in the AEOP programs in 2015 reported that the experience improved their STEM-specific and 21st Century STEM skills competencies. They also reported gains in their abilities to use the science and engineering practices described in the Next Generation Science Standards (NGSS), as well as increases in their STEM confidence and identity.

A focus of the AEOP programming is to develop students STEM knowledge, skills, and abilities, as well as their 21st Century Skills, and abilities to appropriately apply them. Students' perceptions of gains in their STEM-specific and 21st Century STEM Skills as a result of participating in AEOP, as well as impacts of participation on students' STEM confidence and identy were examined in the FY15 evaluation.

Table 13 is comprised of five items that collectively form the participants' perceptions of gains in STEM knowledge composite. Participants rated their perceived gains using a 5-point scale from "no gain" to "extreme gain." Findings indicate that participants from all programs perceived at least some gain in their STEM knowledge after participating in AEOP (Chart 3).

Table 13. Items that form the Perceived Gains in STEM Knowledge Composite for CQL, HSAP, JSHS, REAP, SEAP, Unite and URAP
1. Knowledge of how scientists and engineers work on real problems in STEM
2. In depth knowledge of a STEM topic(s)
3. Knowledge of research conducted on a STEM topic or field
4. Knowledge of research processes, ethics, and rules for conduct in STEM
5. Knowledge of what everyday research work is like in STEM

Chart 3: Mean composite scores for perceived gains in STEM knowledge†

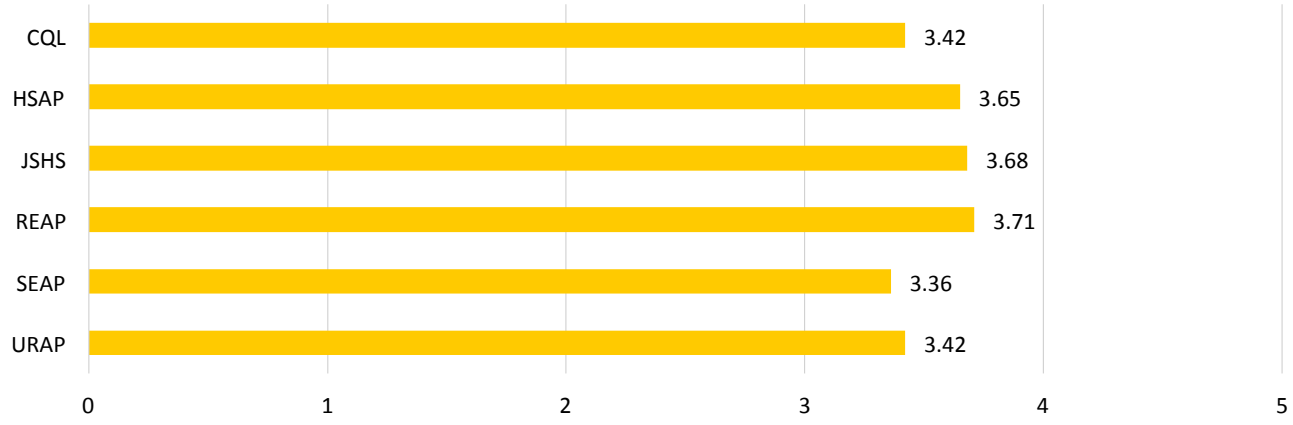


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

The FY15 evaluation investigated the impact of participation on participants' abilities to use the science and engineering practices described in the NGSS. Participants whose projects involved science were asked to describe their gains on items related to science practices; those with projects focusing on engineering were asked about engineering practices.[9] The science-related items (see Table 14) form a composite called Perceived Gains in Science Practices. Findings indicated that participants reported some gain in their abilities to use the science practices as a result of participating in AEOP.

Table 14. Items that form the Perceived Gains in Science Practices Composite for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. Asking a question that can be answered with one or more scientific experiments
2. Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation
3. Making a model of an object or system showing its parts and how they work
4. Designing procedures for an experiment that are appropriate for the question to be answered
5. Identifying the limitations of the methods and tools used for data collection
6. Carrying out procedures for an investigation and recording data accurately
7. Using computer models of objects or systems to test cause and effect relationships
8. Organizing data in charts or graphs to find patterns and relationships
9. Considering different interpretations of data when deciding the data answer a question
10. Supporting an explanation for an observation with data from experiments
11. Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge
12. Identifying the strengths and limitation of explanations in terms of how well they describe or predict observations
13. Defending an argument that conveys how an explanation best decribes an observation
14. Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations
15. Integrating information from technical or scientific texts and other media to support your explanation of an observation
16. Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics

Chart 4: Mean composite scores for perceived gains in science practices†

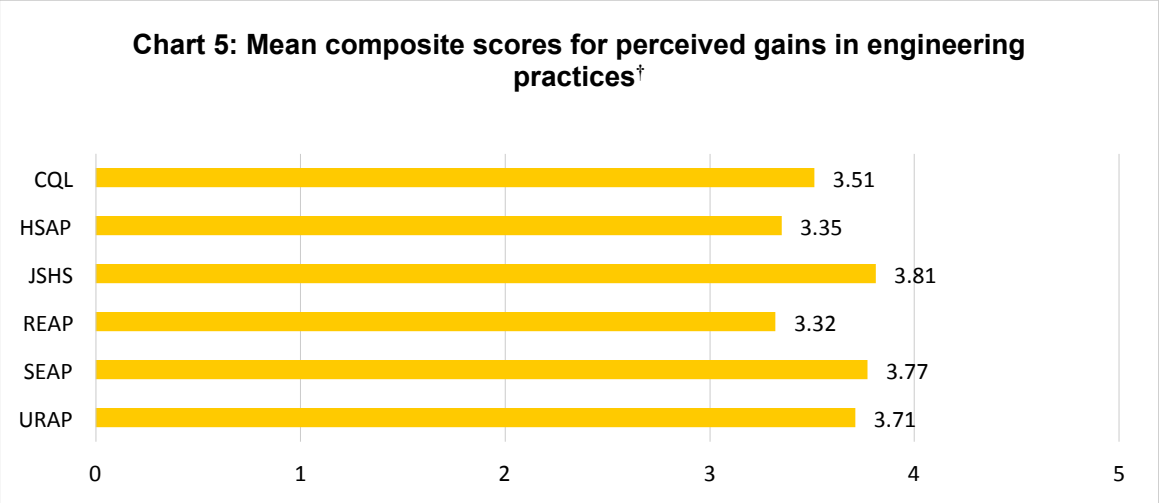


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

†† *Unite is not included in this chart as the survey did not ask all of the items for this composite score (only 11 of 16 items).*

Engineering practice items (see Table 15) form a composite called Perceived Gains in Engineering Practices. As can be seen in Chart 5, mean composite scores indicate that the apprentices and students from across the programs felt they made at least some gains in their engineering practices as a result of participating in the AEOP.

Table 15. Items that form the Perceived Gains in Engineering Practices Composite for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. Defining a problem that can be solved by developing a new or improved object, process, or system
2. Using knowledge and creativity to propose a testable solution for a problem
3. Making a model of an object or system to show its parts and how they work
4. Designing procedures for an experiment that are appropriate for the question to be answered
5. Identifying the limitations of the methods and tools used for data collection
6. Carrying out procedures for an investigation and recording data accurately
7. Using computer models of an object or system to investigate cause and effect relationships
8. Considering different interpretations of the data when deciding if a solution works as intended
9. Organizing data in charts or graphs to find patterns and relationships
10. Supporting a solution for a problem with data from experiments
11. Supporting a solution with relevant scientific, mathematical, and/or engineering knowledge
12. Identifying the strengths and limitations of solutions in terms of how well they meet design criteria
13. Defend an argument that conveys how a solution best meets design criteria
14. Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts
15. Integrating information from technical or scientific texts and other media to support your solution to a problem
16. Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)

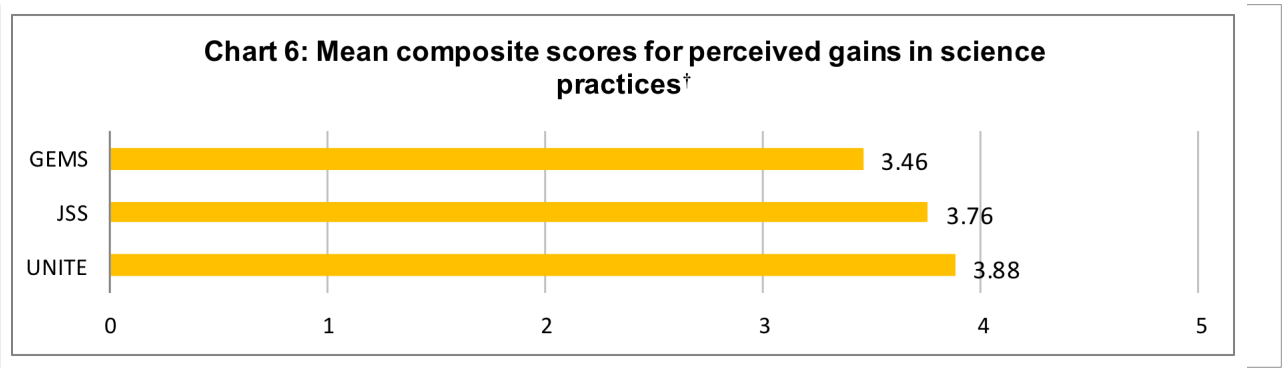


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

As may be expected, the data in Charts 4 and 5 suggest that some programs had a larger impact on students' perceptions of gains in science practices than engineering practices, some had a larger impact on students' perception of gains in engineering practices, and some had similar impacts on both. REAP participants reported the largest gains in science practices, while JSHS reported the greatest gains in engineering practices. Moreover, findings overall indicate gains for all programs in the AEOP portfolio and this is the main takeaway from the data.

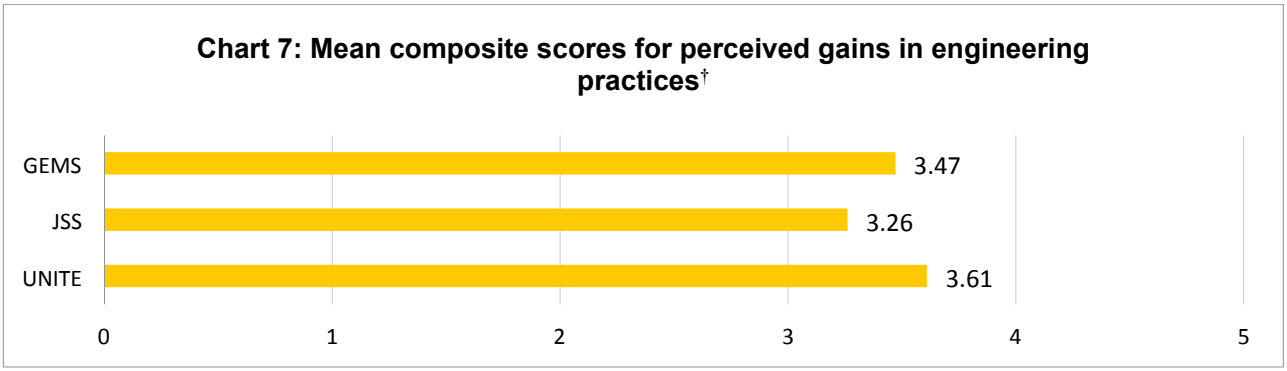
Due to the fact that GEMS, JSS, and Unite questionnaire items were slightly different to be more age-appropriate for their audience, this data and associated findings are presented separately from the other programs for the gains in science practices composite and engineering practices composite. GEMS, JSS, and Unite students were asked about perceived gains on 11 STEM practices, displayed in Table 16. Findings displayed in Chart 6 and 7 indicate that students from these programs reported at least some gains in science and engineering practices as a result of participating in the AEOP.

Table 16. Items that form the Perceived Gains in Science Practices Composite for GEMS, JSS, and Unite
1. Asking a question that can be answered with one or more scientific experiments
2. Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation
3. Making a model of an object or system showing its parts and how they work
4. Carrying out procedures for an experiment and recording data accurately
5. Using computer models of objects or systems to test cause and effect relationships
6. Organizing data in charts or graphs to find patterns and relationships
7. Considering different interpretations of data when deciding how the data answer a question
8. Supporting an explanation for an observation with data from experiments
9. Defending an argument that conveys how an explanation best describes an observation
10. Integrating information from technical or scientific texts and other media to support your explanation of an observation
11. Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)



† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

Table 17. Items that form the Perceived Gains in Engineering Practices Composite for GEMS and JSS
1. Defining a problem that can be solved by developing a new or improved object, process, or system
2. Using knowledge and creativity to propose a testable solution for a problem
3. Making a model of an object or system to show its parts and how they work
4. Carrying out procedures for an experiment and recording data accurately
5. Using computer models of an object or system to investigate cause and effect relationships
6. Considering different interpretations of the data when deciding if a solution works as intended
7. Organizing data in charts or graphs to find patterns and relationships
8. Supporting a solution for a problem with data from experiments
9. Defend an argument that conveys how a solution best meets design criteria
10. Integrating information from technical or scientific texts and other media to support your solution to a problem
11. Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)



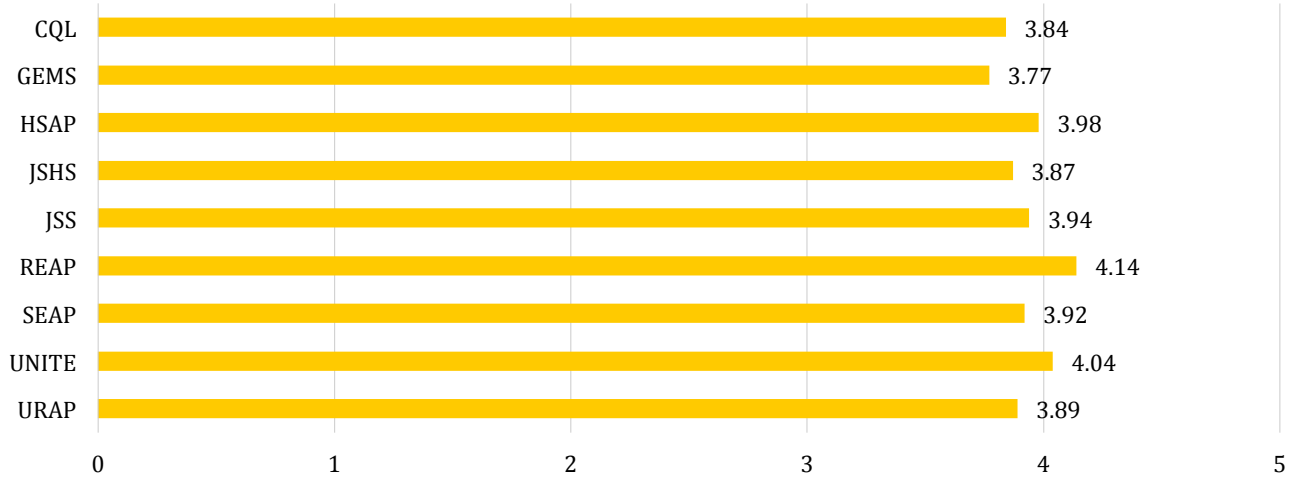
† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

In FY15, participants were also asked about the impact of the AEOP on 21st Century STEM skills that are deemed necessary across a wide variety of fields. The Perceived Gains in 21st Century Skills composite is outlined in Table 18. Findings are outlined in Chart 8 that include the mean composite scores for each program. Unite and REAP participants reported large gains overall. Participants in other programs experienced some gain across the program.

Table 18. Items that form the Perceived Gains in 21st Century STEM Skills Composite for CQL, JSHS, REAP, SEAP, URAP, HSAP, GEMS, JSS, and Unite
1. Sticking with a task until it is finished
2. Making changes when things do not go as planned
3. Working well with students from all backgrounds
4. Including others' perspectives when making decisions
5. Communicating effectively with others
6. Viewing failure as an opportunity to learn

† *These two items were not included on the GEMS, JSS, and Unite versions of the survey.*

Chart 8: Mean composite scores for perceived gains in 21st century STEM skills†

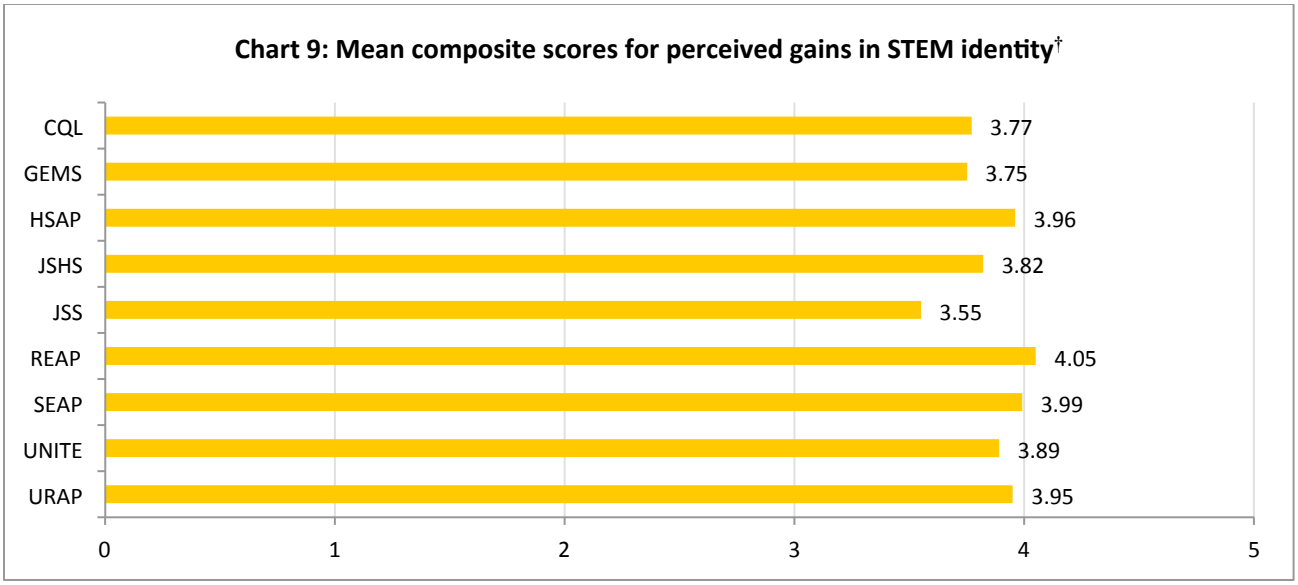


† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

STEM identity development, similar to self-confidence in STEM or self-efficacy in STEM was another domain that was explored in the FY15 evaluation. Participants were asked about the extent to which their program experiences enhanced their STEM identity. A series of nine items comprise the Perceived Gains in STEM Identity composite (Table 19). Findings indicated that REAP participants experienced large gain. Apprentices and students from all of the represented programs perceived that students' made at least some gains in their STEM identity as a result of participating in the AEOP (Chart 9).

Table 19. Items that form the Perceived Gains in STEM Identity Composite for CQL, JSHS, REAP, SEAP, URAP, HSAP, GEMS, JSS, and Unite
1. Interest in a new STEM topic or field
2. Deciding on a path to pursue a STEM career
3. Sense of accomplishing something in STEM
4. Feeling prepared for more challenging STEM activities
5. Thinking creatively about a STEM project or activity[†]
6. Desire to build relationships with mentors who work in STEM
7. Connecting a STEM topic or field to my personal values

[†] *Not included on the CQL, JSHS, REAP, SEAP, URAP, HSAP versions of the survey*
[††] *Not included on the GEMS, JSS, Unite versions of the survey*



[†] *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

In addition to the above items, participants were also asked to rate the extent of their agreement with items describing program impacts related to their STEM confidence and interest. These items also asked about their interest in taking additional STEM classes in school and pursuing STEM activities outside of school, and their confidence in their STEM knowledge, skills, and abilities. Table 20 shows the percentage of students agreeing that the program contributed at to the impact described. Most notably, the vast majority of students in each program (79-97%) agreed that the program had impacted their confidence in their STEM knowledge, skills, and abilities. In the second area, AEOP program participation impact on students' interest in taking STEM classes in school there was also positive responses with 52% to 89% agreement. The final area, AEOP program participation impact on interest in participating in STEM activities outside of school requirements, there were positive response (55-81%) for all programs with the exception of eCM. It is notable to mention that REAP, SEAP, and Unite percentage agreement on the three items increased in agreement from FY14.

Table 20. Students Agreeing that the Program Contributed to their STEM Confidence and Interest.											
	CQL	eCM	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	Unite	URAP
I am more confident in my STEM knowledge, skills, and abilities.	91%	69%	91%	94%	79%	84%	79%	96%	97%	90%	93%
I am more interested in participating in STEM activities outside of school requirements.	75%	46%	82%	80%	72%	80%	66%	89%	81%	85%	82%
I am more interested in taking STEM classes in school.	55%	52%	76%	69%	61%	58%	71%	81%	69%	81%	59%

Data from all programs indicate that participation in AEOPs impacts apprentices' and students' perceived STEM knowledge, ability to engage in STEM practices, 21st Century STEM skills, and STEM identity. In addition to questionnaire data, these impacts were also highlighted in focus groups, interviews, and in responses to open-ended questionnaire items. For example:

> *I think [JSS] is a great program for the kids…it's really been a wonderful experience – they had to learn to work together. And in the end they came up with something that they created together.* (JSS Mentor)

> *"JSHS gave me the opportunity to present my research to experts across all scientific disciplines; JSHS gave me the opportunity learn about other fields of science outside my research expertise, [and] I was able to meet other like-minded young scientists and collaborate on solving real-world problems"* (JSHS student)

> *[SEAP] just gave me an overall experience of what their career field would be about. What they would have to do on a daily basis and it also gave me a presentation spot where I could actually go up and give a presentation. (SEAP Apprentice)*

> *Students in my chemistry class were able to study about seven important concepts that they will cover during the first half of chemistry. They were also able to master several basic math skills and calculator usage that will make them more confident and willing to tackle the math of chemistry*. (Unite Mentor)

<u>Finding #5</u>: The AEOP's efforts to engage students in and/or expose them to DoD research continues to be a challenge. Students reported positive attitudes toward DoD STEM research and researchers. However, there were mixed findings related to mentors discussing DoD STEM research (some programs declined from FY14) and STEM opportunities in the DoD with apprentices and students.

The AEOP contributes to and highlights the DoD STEM research interests through program activities that engage participants in or provide meaningful exposure to DoD research. Table 21 summarizes some of these efforts in 2015.

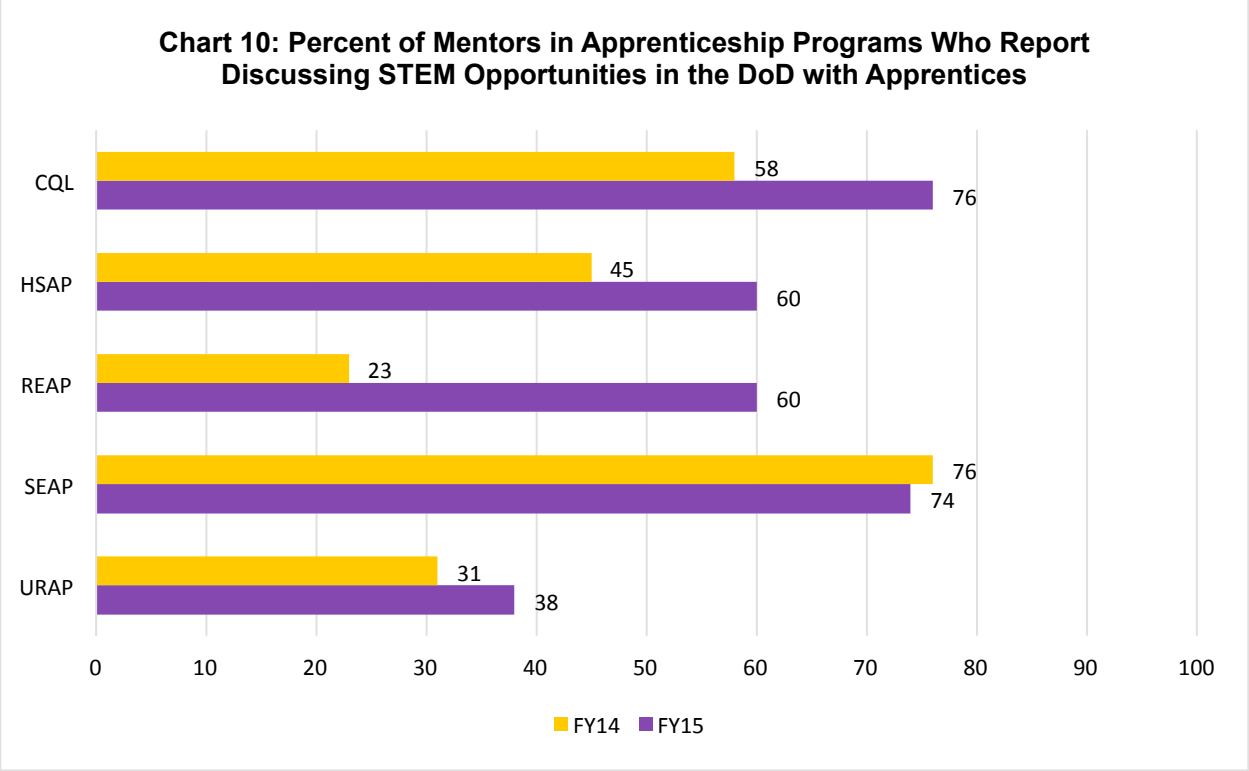
Table 21. 2015 Participant Engagement in and Exposure to DoD Research	
AEOP	**Engagement in DoD Research**
CQL, SEAP	**486** high school and undergraduate or graduate participants serving as apprentices on DoD research projects at Army or DoD research laboratories.
HSAP, URAP	**97 (49 for HSAP, 48 for URAP)** high school and undergraduate participants serving as apprentices on Army research projects at college/university research laboratories.
GEMS	**2,270** elementary, middle and high school participants, **94** undergraduate NPMs, and **42** K-12 teachers were engaged in DoD research through GEMS activities hosted by Army research laboratories.
AEOP	**Exposure to DoD Research**
eCM	**78** participants and their **22** team advisors (in-service teachers) were exposed to DoD research through the National Judging & Educational Event activities. NJ&EE programming included STEM Tech Expo and invited speakers who highlighted DoD research. Army Corner, highlighting Army STEM research and careers, and was publically accessible at the eCM website.
JSHS	**218** participants and their **58** teachers were exposed to DoD research through the National Symposium activities. National JSHS programming included DoD S&Es, who served as national judges, speakers and presenters who highlighted DoD research. **5,829** students were exposed to DoD research through DoD S&Es who engage at regional JSHS symposia.
Unite	**200** high school participants and **112** program mentors participated in career day events that included learning about the work of DoD STEM personnel and/or DoD research facilities.
JSS	**244** participants in regional competitions and **230** participants in the national completion were exposed to DoD research through JSS activities facilitated by Army S&Es.

Apprenticeship programs like CQL, HSAP, SEAP, and URAP engage participants in DoD research projects, providing opportunities for them to make meaningful contributions as they develop professionally through their mentored research experiences. The AEOP also offers STEM enrichment activities that provide hands-on, interactive experiences to students. For example, DoD S&Es, or NPMs under the mentorship of S&Es, translate DoD research into grade-level appropriate educational activities, allowing GEMS participants to engage in real-world research through the questions and problems addressed by DoD researchers and their research. A number of AEOP programs also implemented activities to expose more participants to the DoD's STEM research interests. These activities highlighted cutting-edge research and careers through DoD STEM- expos, laboratory tours, expert panels, and professional development activities linking school curricular topics to DoD research.

Apprentices and students may have also learned about STEM in the DoD from their mentors. The mentor questionnaire asked mentors to report whether they discussed STEM opportunities in the DoD and other government agencies with apprentices and students in order to support their STEM educational and career pathways. Though there has been some improvement in this area for selected programs (JSHS, Unite) most program mentors reported less agreement on this item than in FY14. However, most programs reported over 50% agreement on this item (CQL, GEMS, HSAP, REAP, SEAP, and Unite). Other programs (JSHS, JSS, and URAP) may need to make this a focus for FY16 and beyond.

Table 22. Percent of Mentors Who Report Discussing STEM Opportunities in the DoD with Apprentices and Students								
CQL	**GEMS**	**HSAP**	**JSHS**	**JSS**	**REAP**	**SEAP**	**Unite**	**URAP**
76% (58%, FY14)	63% (74%, FY14)	60% (100%, FY14)	46% (30%, FY14)	24% (47%, FY14)	60% (63%, FY14)	74% (76%, FY14)	62% (57%, FY14)	38% (53%, FY14)

Apprenticeship programs report over 60% agreement with discussing STEM opportunities in the DoD with apprentices (Chart 10). All programs with the exception of SEAP have increased their level of agreement with this statement since FY14. The most significant increase since FY14 occurred with REAP – while 23% of mentors reported educating apprentices about STEM opportunities with the DoD in 2014, 60% reported doing so in 2015. However, all programs have room for improvement in this area.



Participant attitudes toward Army/DoD research and researchers are detailed in Table 23. In all cases, the proportion responding, "agree" or "strongly agree" to questionnaire items are given. The majority of participants agree that Army/DoD research and researchers develop new, cutting-edge technologies (60-100%) and help advance science and engineering fields (60-100%). These finding are similar to those from 2013.

As in FY14, comparisons of participant responses from AEOP programs at DoD research laboratories (CQL, GEMS, and SEAP), DoD-sponsored college/university laboratories (HSAP and URAP), and non-DoD affiliated college/university

laboratories and settings (REAP and Unite) suggest that experiences at DoD research laboratories and DoD-sponsored college/university laboratories generated greater understandings of and positive attitudes toward DoD research than engagement in non-DoD affiliated university laboratories and other settings. Students who participated in the national JSHS symposium, which included judges, invited speakers and presenters from DoD research laboratories, had considerably more positive attitudes about DoD research than regional JSHS symposia participants. Therefore, strategies and experiences utilized by these programs should be scaled up and used with other AEOP elements to strengthen participant knowledge of DoD STEM research.

Table 23. AEOP Participants' Agreeing with Various Statements about DoD STEM Research

	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	Unite	URAP
DoD researchers advance science and engineering fields	98%	81%	73%	74%	98%	60%	71%	94%	78%	100%
DoD researchers develop new, cutting edge technologies	95%	80%	76%	73%	98%	60%	74%	90%	81%	100%
DoD researchers solve real-world problems	93%	83%	73%	77%	96%	60%	70%	92%	81%	100%
DoD research is valuable to society	93%	81%	70%	75%	95%	60%	73%	96%	82%	100%

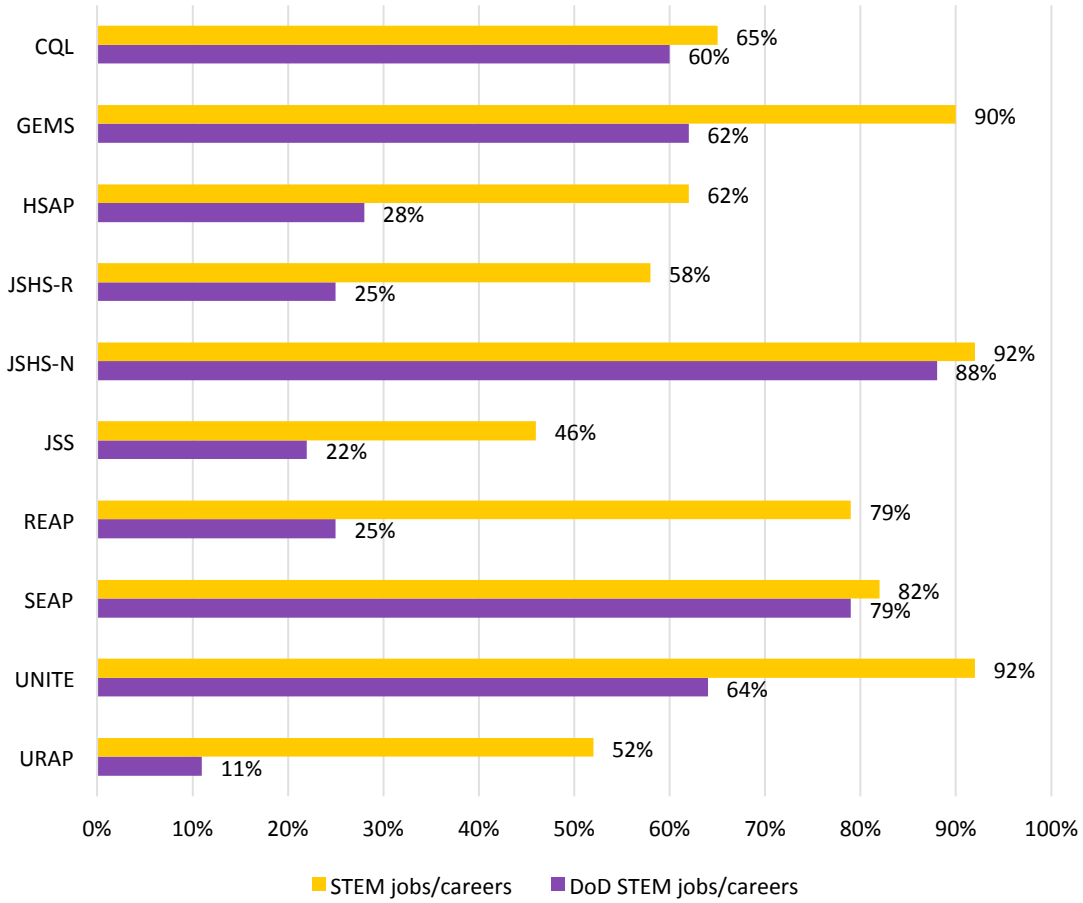
Finding #6: The AEOP exposed students to Army and DoD STEM careers and increased their interest in pursuing a DoD STEM career, though some programs were more effective (e.g., JSHS-N, SEAP, UNITE, GEMS, CQL) at doing so than others (e.g., HSAP, JSHS-R, JSS, REAP, URAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities is the most promising practices for informing participants about specific jobs/careers. Most mentors did not find AEOP electronic resources to be useful for exposing apprentices and students to STEM DoD careers, and continue to call for new resources for improving students' awareness of Army and DoD STEM research and careers.

Efforts to expose participants to the Army and DoD's STEM research interests also serve to emphasize a variety of STEM careers, including those with the Army and DoD, that use and apply similar knowledge, skills, and abilities to those students learn through program activities. Program evaluations assessed how many careers participants perceived learning about during program activities. These data are summarized in Chart 11.

Most 2015 AEOP participants reported learning about 3 or more STEM jobs (46% to 92%; however, Army and DoD STEM careers were not emphasized as often and/or well (11% in URAP to 88% in JSHS-N). As in FY14, comparisons of responses from participants in AEOPs taking place at Army research laboratories (CQL, GEMS, and SEAP), Army-sponsored university laboratories (HSAP and URAP), and non-Army affiliated settings (JSHS-R, TSA-based JSS regionals, REAP, and Unite) reveal that greater proportions of FY15 AEOP participants at Army research laboratories learn about Army and DoD STEM careers than their counterparts at Army-sponsored or non-Army affiliated university laboratories. However, Unite and JSHS-N are the only two non-Army research laboratory settings that had above 50% agreement of other programs. It is a fact that participants at Army research laboratories have substantial exposure to Army and DoD

STEM professionals in their daily work. As Chart 11 details, many of the programs in the AEOP portfolio have room for improvement in promoting STEM and DoD STEM jobs/careers in their programming.

Chart 11: Students Reporting Learning about 3 or More STEM Jobs/Careers in their Program



Awareness of and interest in STEM careers in general and with the DoD was another area that was evaluated for participants (Table 24). Despite having learned about fewer Army and DoD STEM careers compared to STEM careers, the majority of participants reported that they were more aware of DoD STEM research and careers as a result of the program (55% to 95%), with more than 75% agreement for six programs (CQL, GEMS, JSHS-N, REAP, SEAP, and Unite). Most 2015 AEOP participants also credited the programs with increasing their interest in pursuing a STEM career and specifically a STEM career with the DoD. In some cases (CQL, JSHS-N, and SEAP), more students indicated that the program had increased their interest in pursuing a STEM career with the DoD than in general, perhaps because they were already interested in pursuing a STEM career before their participation. Participants also reported having a greater appreciation of DoD STEM research and careers, including over 75% of participants in several programs (CQL, GEMS HSAP, JSHS-N, REAP, SEAP, Unite and URAP).

Table 24. Students Agreeing AEOP Affected Their Attitudes Toward STEM Careers										
	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	Unite	URAP
I am more interested in pursuing a career in STEM	64%	73%	80%	69%	66%	56%	93%	81%	80%	63%
I am more aware of DoD STEM research and careers	93%	81%	68%	59%	95%	55%	80%	90%	78%	74%
I have a greater appreciation of Army or DoD STEM research	91%	83%	89%	61%	89%	53%	82%	94%	77%	82%
I am more interested in pursuing a STEM career with the DoD	77%	65%	60%	49%	70%	46%	74%	83%	72%	59%

In FY14 and FY15 there has been more focus by AEOP programs on supporting mentors with resources to expose participants to DoD STEM careers. Table 25 presents FY15 findings which indicate increased agreement that the AEOP website (32% to 76%) has been useful in achieving this task. Continued agreement from mentors was found regarding student and mentor AEOP program participation helped with exposing students to DoD STEM careers (73-93%). As was the case in FY14 mentors tended not to find some components of centralized AEOP resources (e.g., AEOP social media, 5-15% agreement; and It Starts Here! Magazine, (0% to 27%) useful for this purpose.

Table 25. Resources that Mentors Found Useful for Exposing Apprentices and Students to DoD STEM Careers									
Resource	CQL	GEMS	HSAP	JSHS	JSS	REAP	SEAP	Unite	URAP
Program Administrator Website (TSA, ASEE, AAS, etc.)	NA	NA	60%	34%	95%	53%	NA	27%	56%
AEOP website	41%	56%	60%	11%	32%	76%	38%	45%	56%
AEOP social media	15%	17%	21%	4%	5%	25%	4%	25%	19%
AEOP brochure	21%	41%	43%	9%	29%	62%	25%	39%	26%
It Starts Here! Magazine	6%	3%	NA%	4%	5%	22%	0%	27%	6%
Program administrator or site coordinator	76%	83%	47%	34%	28%	78%	63%	71%	50%
Invited speakers or "career" events	29%	73%	21%	31%	10%	39%	33%	77%	37%
Participation in program	76%	89%	93%	56%	73%	83%	75%	83%	81%

Evaluation findings continue to indicate that AEOP mentors have limited awareness of and often lack resources about Army and DoD STEM careers and the range of AEOPs. As a result, mentors have limited capacity to educate participants about Army and DoD STEM careers and other AEOPs. For example, two mentors said:

> *Many of the [AEOP] programs sound fantastic but I've never heard of them. I've been involved in JSHS for more than 15 years. I would have though I'd be exposed to those programs in some way.* (JSHS Mentor)

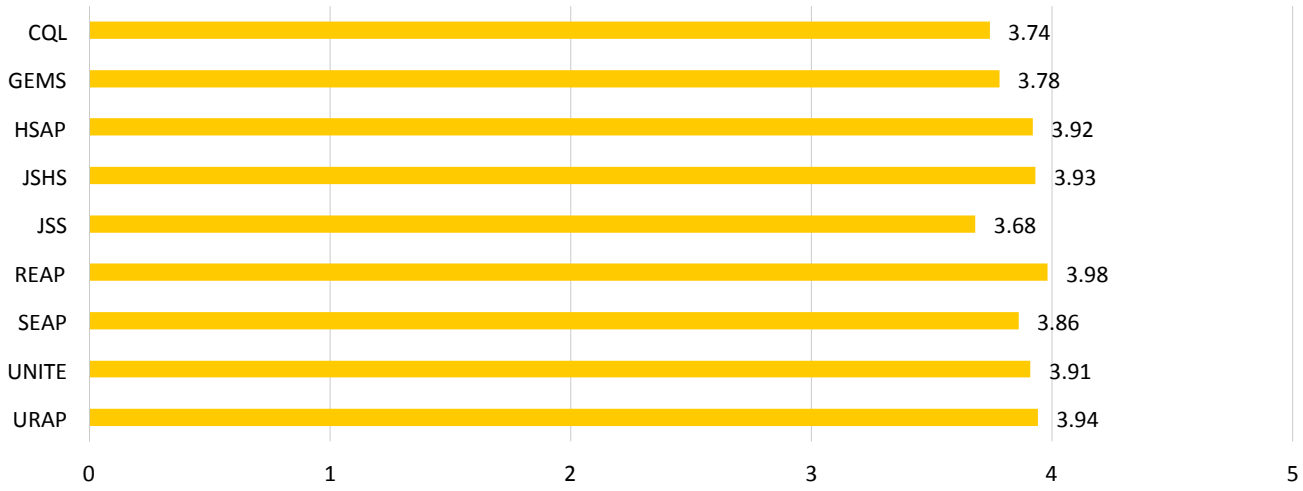
I have not seen [Army career information] at all. (JSS Mentor)

Finding #7: The AEOP programs served to sustain existing STEM educational and career aspirations of participants and to inspire new achievement, including intentions to pursue higher education and STEM careers. In addition, participants report gains in interest in pursuing DoD STEM careers as a result of participation in AEOP (e.g., GEMS, CQL, and JSHS-N).

AEOP participant engagement in STEM activities outside of AEOP or scheduled school classes was also an area that was explored in the FY15 evaluation. The Intentions to Engage in STEM Activities composite (Table 26) included items that asked about things participants may do at home, with family, in clubs, in the community and other settings. Findings indicated that participants in AEOP programs reported continued interest in these types of activities that was about the same as before the program. Chart 12 displays the mean composite scores for the apprentices and students across the AEOP programs.

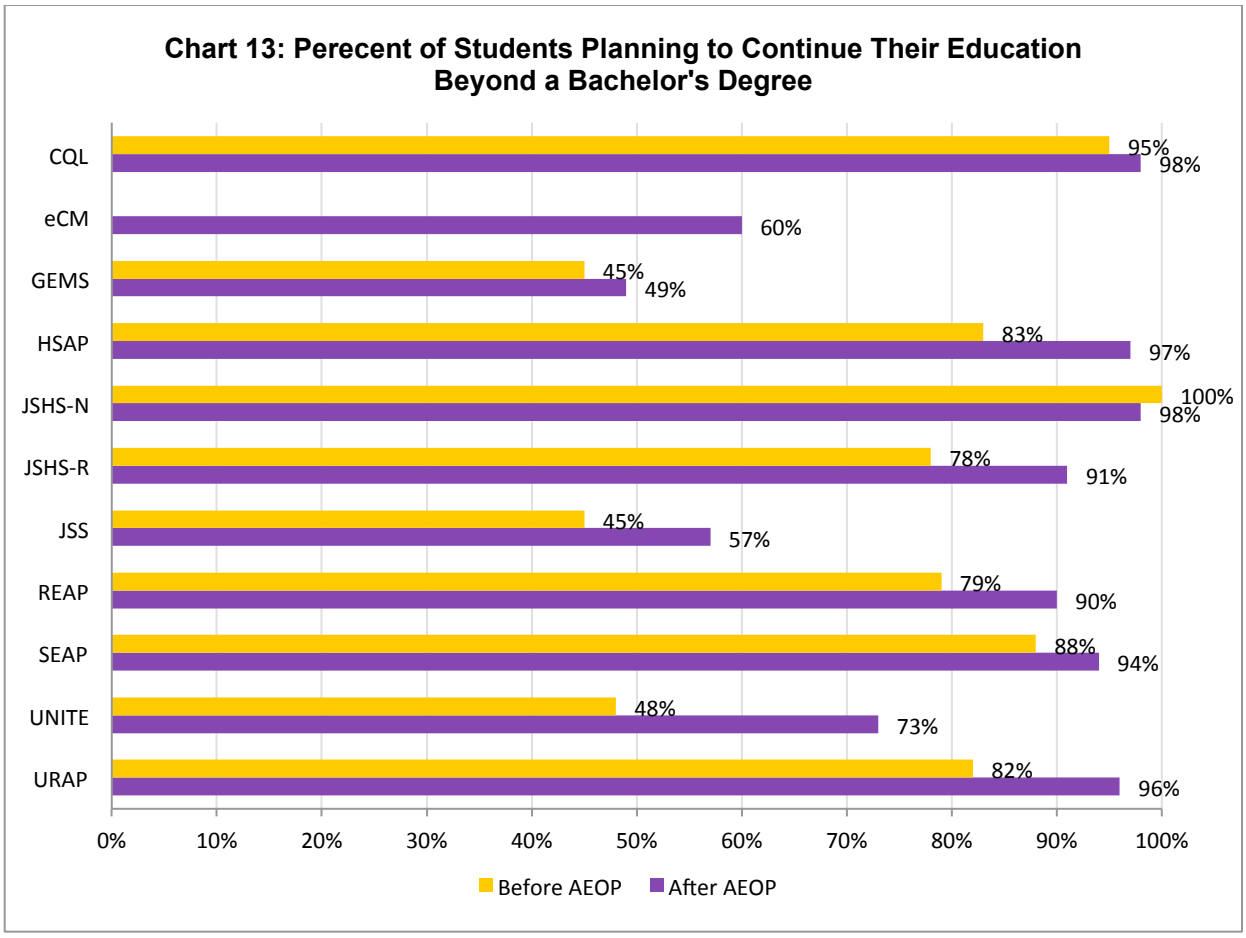
Table 26. Items that form the Intentions to Engage in STEM Activity Composite for CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, URAP
1. Watch or read non-fiction STEM
2. Tinker (play) with a mechanical or electrical device
3. Work on solving mathematical or scientific puzzles
4. Use a computer to design or program something
5. Talk with friends or family about STEM
6. Mentor or teach other students about STEM
7. Help with a community service project that relates to STEM
8. Participate in a STEM camp, club, or competition
9. Take an elective (not required) STEM class
10. Work on a STEM project or experiment in a university or professional setting

Chart 12: Mean Composite Scores for Intentions to Engage in STEM Activities as a Result of AEOP†

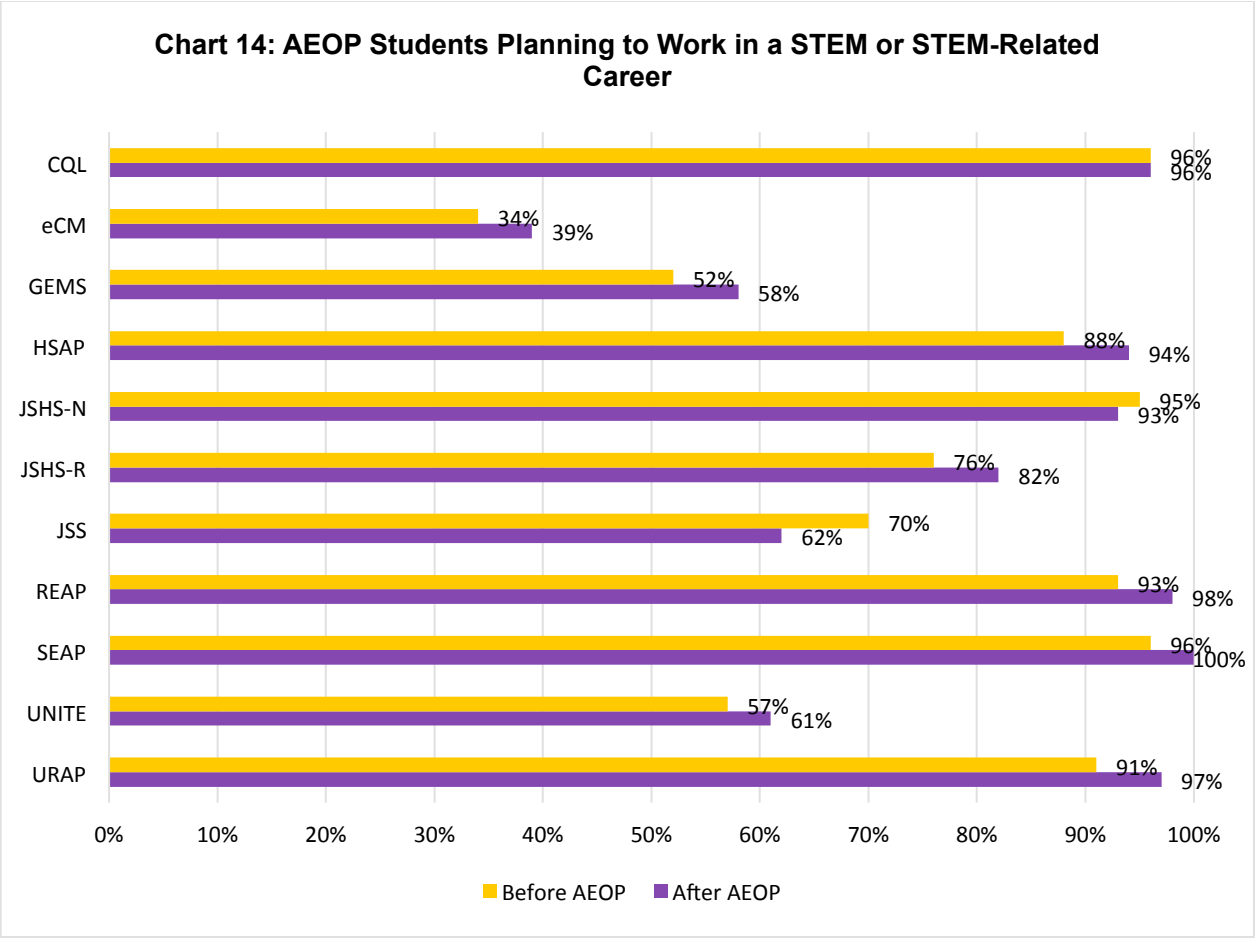


† *Response options for the items forming this composite were: 1 – Much less likely, 2 – Less likely, 3 – About the same before and after, 4 – More likely, 5 – Much more likely.*

The FY15 evaluation included an examination of AEOP program participation influence on students' aspirations to extend their education beyond a bachelor's degree. These data are shown in Chart 13. Participants in most programs, with the exception of JSHS-N, reported increased desire to pursue post-bachelor's degree study. JSHS-N experienced only a slight decrease, from 100% before participation to 98% after participation. eCM participants were only asked the question focused on after-participating in eCM and 60% indicated desire to pursue post-bachelor's study The greatest increases in education aspirations (more than 10% growth in agreement) were revealed for GEMS, HSAP, JSHS-R, JSS, REAP, Unite and URAP.

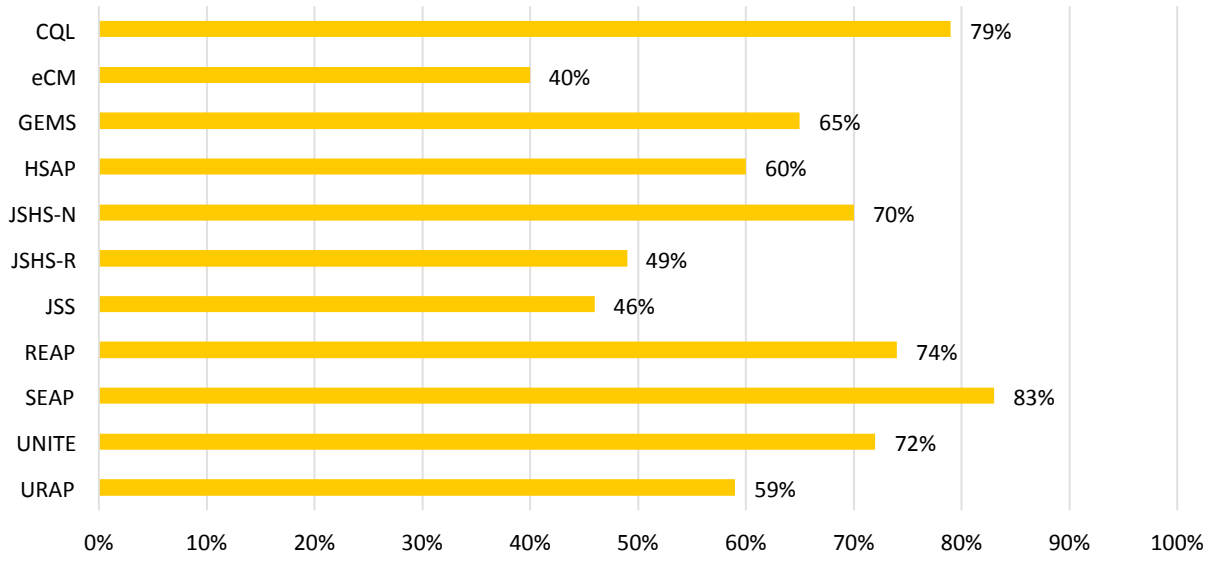


AEOP influence on career goal aspirations was also a focus area of the FY15 evaluation. Participants were asked to reflect on their career goals both before and after participating in the AEOP program. The data were coded into STEM-related and non-STEM-related careers. As can be seen in Chart 14, there were mixed findings on this item. Some program participants reported increased interest in STEM after participation (GEMS, HSAP, JSHS-R, REAP, SEAP, Unite, URAP). However, other program participants reported decreased interest (eCM, JSS, JSHS-N). Program participants reported more than 50% agreement post-participation that they were interested in a STEM career for all programs besides eCM (34% agreement).



The FY15 evaluation also examined AEOP participant interest in pursuing a STEM career with the DoD specifically. Most programs reported more than 50% agreement that they are interested in a STEM career with the DoD (CQL, GEMS, HSAP, JSHS-N, REAP, SEAP, Unite, and URAP). Students from CQL, GEMS, and SEAP (all hosted at Army laboratories), HSAP, URAP, Unite, and REAP (hosted at Army-funded college/university laboratories), and JSHS-N (which included sessions on DoD STEM careers) reported the greatest interest. eCM, JSHS-R, and JSS were the lowest in agreement (40%-49%) and may benefit from utilizing strategies employed by other programs with more success in this area.

Chart 15: Students Indicating AEOP Impacted their Interest in Pursuing a STEM Career with the DoD



Participants in the apprenticeship programs were asked about their interest in DoD STEM careers in both 2014 and 2015. As can be seen in Table 27, apprentice interest in DoD STEM careers is more than 50% for all apprentice programs ranging from 59% to 83% agreement. HSAP overall interest declined 17% in FY15, however.

Table 27. Apprentices' Interest in DoD STEM Careers in 2014 vs. 2015

	2014	2015
CQL	74%	77%
HSAP	83%	60%
REAP	49%	68%
SEAP	68%	83%
URAP	59%	59%

In all AEOP programs, youth and adult participants reported in questionnaires, focus groups, and interviews that the programs afforded students opportunities to clarify, explore, and/or advance their STEM education and career pathways. Students referred to opportunities to explore new STEM topics and fields of interest, clarify and/or expand education or career goals, build, prepare for and preview college studies, engage in professional networking, and experience professional working environments. These opportunities are illustrated in the words of participants:

> *Now I know actually what happens in engineering. I know what the daily life of an engineer looks like. And I know without a shadow of a doubt now, I want to do engineering.* (SEAP apprentice)

I have had an amazing CQL experience. I now have fallen in love with research and have decided on it as a career path, whereas before participating in this program I was not interested in research or research as a career whatsoever. This experience has been life-changing and opened my eyes to many possibilities that are open to me… I have grown as a scientist and as a person and I owe it all to the CQL experience I was fortunate enough to have. I only hope more students can learn about this opportunity and get the same benefit that I have. (CQL apprentice)

I will write [my REAP participation] on my resume. They'll see that I've been doing something outside of school, and this has taught me more than school would, because lots of the lab equipment in the university, I've never even seen at school. (REAP Apprentice)

Just in my observation of the students, it's really powerful for kids whose parents have blue-collar jobs that maybe 30 years ago didn't necessarily need a college degree in order to mobilize, and so they didn't go but they want their kid to go and don't necessarily know how to help them get from point A to point B. In addition to just trying to help them build professional identity, we also did some individual coaching with them. We take a look at where they are in terms of taking math, doing math classes in high school, and just putting some other things on their radar like what level math should you be at by the time you graduate from high school to really get considered for college in engineering, whether it's here at UCCS or anywhere. (Unite Mentor)

Priority Two: STEM Savvy Educators

Mentors play a critical role in the AEOP program, designing and facilitating learning activities, delivering content through instruction, supervising and supporting collaboration and teamwork, providing one-on-one support, chaperoning, advising on educational and career paths, and generally serving as STEM role models. The 2015 AEOP evaluation examined the extent to which adults serving in these capacities used research-based strategies for mentoring, as well as the extent to which apprentices and students were satisfied with their mentors.

Finding #1: AEOP mentors use of effective mentoring strategies overall declined in FY15. These include establishing the relevance of learning activities, supporting the diverse needs of students as learners, supporting student development of interpersonal and collaboration skills, supporting student engagement in authentic STEM activities, and supporting student STEM educational and career pathways.

Mentors were asked on the questionnaire to report use of effective mentoring strategies with participants. These strategies comprised five main areas of effective mentoring:[10]

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

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

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

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

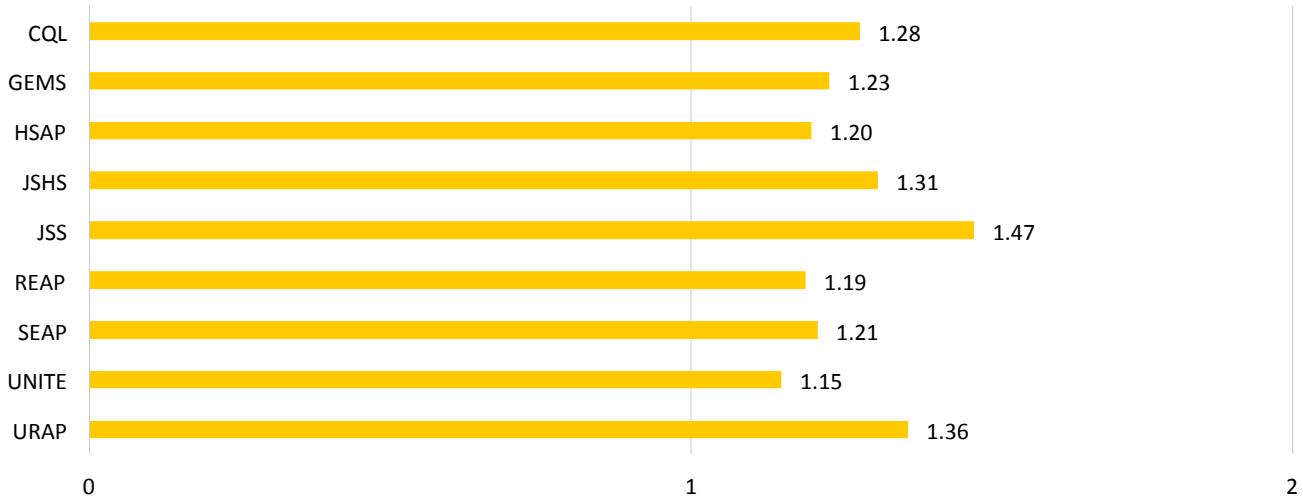
1. Establishing the relevance of learning activities;
2. Supporting the diverse needs of students as learners;
3. Supporting students' development of collaboration and interpersonal skills;
4. Supporting students' engagement in "authentic" STEM activities; and
5. Supporting students' STEM educational and career pathways.[11]

For each area, items were combined into composite variables. The items that form the Establishing the Relevance of Learning Activities composite are shown in Table 28, and mean composite scores are shown in Chart 16. For FY15 there was a decline in use of strategies from FY14 (Table 29). This may indicate need for some type of onboarding, guidelines, or training for mentors to insure they are cognizant of best practice strategies and implementing them with their participants.

Table 28. Items that form the Establishing the Relevance of Learning Activities Composite for CQL, GEMS, HSAP, JSHS, JSS, REAP, Unite, and URAP
1. Become familiar with my student(s) background and interests at the beginning of the program
2. Giving students real-life problems to investigate or solve
3. Selecting readings or activities that relate to students' backgrounds
4. Encouraging students to suggest new readings, activities, or projects
5. Helping students become aware of the role(s) STEM plays in their everyday lives
6. Helping students understand how STEM can help them improve their community
7. Asking students to relate real-life events or activities to topics covered in the program

[11] The student survey asked about a subset of these instructional and mentoring strategies used in the program. Overall, student responses paint a similar picture of the types of practices mentors reported using in 2015. Student data on mentor instructional and mentoring strategies can be found in the individual program reports.

Chart 16: Mean Composite Scores for Establishing the Relevance of Learning Activities†



† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

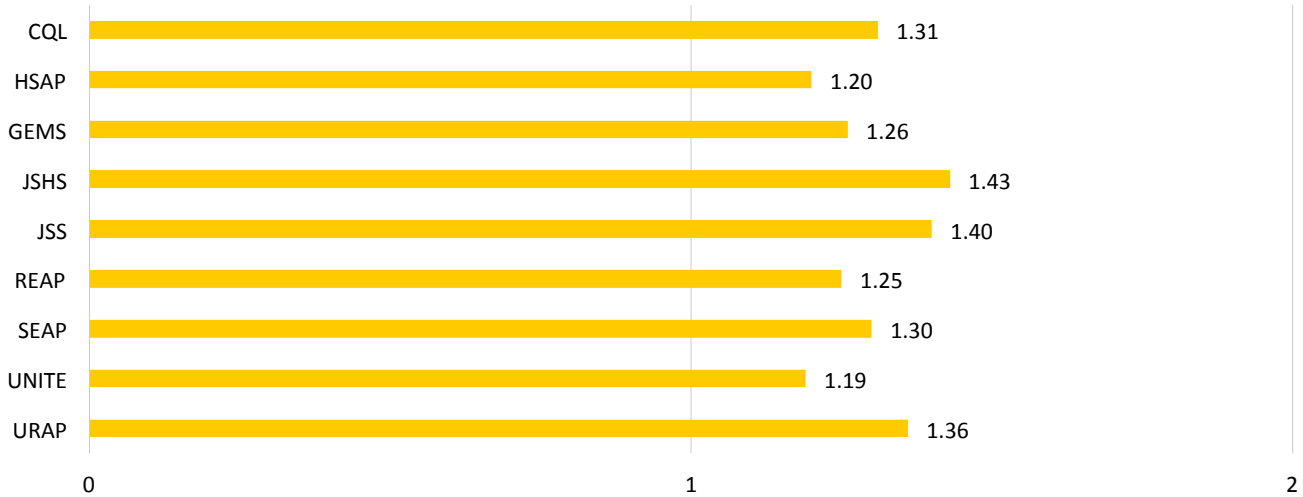
Table 29. Mentor Mean Composite Scores for Establishing the Relevance of Learning Activities in 2014 vs. 2015 and 2015 Overall Percent Agreement

	2014 Composite Mean	2015 Composite Mean	2015 Composite % Agreement
CQL	1.68	1.28	72%
GEMS	1.77	1.23	77%
HSAP	NA	1.20	80%
JSHS	1.76	1.31	73%
JSS	1.78	1.47	53%
REAP	1.77	1.19	81%
SEAP	1.56	1.21	79%
Unite	1.77	1.15	85%
URAP	1.76	1.36	64%

Similarly, the items comprising the Supporting the Diverse Needs of Students as Learners composite are shown in Table 30, and mean composite scores are shown in Chart 17. Again, in FY15 there was a decline in the use of effective practices by mentors in AEOP programs (Table 31).

Table 30. Items that form the Supporting the Diverse Needs of Students as Learners Composite for CQL GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP
1. Identify the different learning styles that my student(s) may have at the beginning of their program
2. Interact with students and other personnel the same way regardless of their background
3. Use a variety of teaching and/or mentoring activities to meet the needs of all students
4. Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM
5. Providing extra readings, activities, or learning support fro students who lack essential background knowledge or skills
6. Directing students to other individuals or programs for additional support as needed
7. Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM

Chart 17: Mean Composite Scores for Supporting the Diverse Needs of Students as Learners†



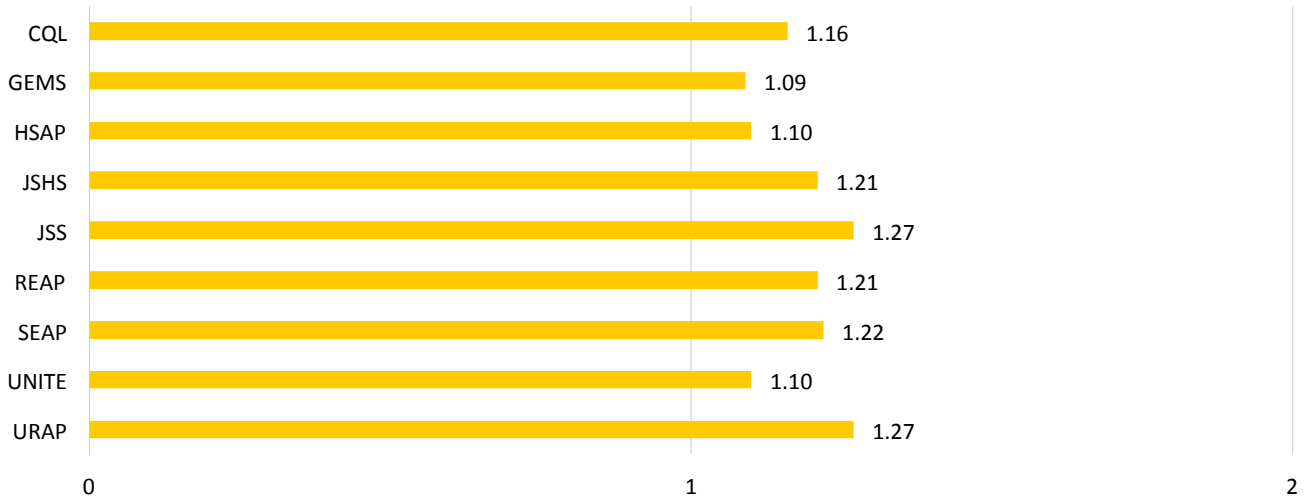
† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

Table 31. Mentor Mean Composite Scores for Supporting the Diverse Needs of Students as Learners in 2014 vs. 2015 and 2015 Overall Percent Agreement			
	2014 Composite Mean	2015 Composite Mean	2015 Composite % Agreement
CQL	1.77	1.31	70%
GEMS	1.77	1.20	74%
HSAP	NA	1.20	80%
JSHS	1.78	1.43	65%
JSS	1.88	1.40	60%
REAP	1.77	1.25	75%
SEAP	1.67	1.30	70%
Unite	1.72	1.19	82%
URAP	1.77	1.36	64%

The third area of mentoring strategies form the composite, Supporting Student Development of Collaboration and Interpersonal Skills (Table 32). Mean composite scores for this area are found in Chart 18, which indicate a decline in use of effective strategies from FY14 by mentors. A comparison of scores from FY14 and FY15 are found in table 33.

Table 32. Items that form the Supporting Student Development of Collaboration and Interpersonal Skills Composite for CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP
1. Having student(s) tell others about their backgrounds and interests
2. Having student(s) explain difficult ideas to others
3. Having student(s) listen to the ideas of others with an open mind
4. Having student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own
5. Having student(s) give and receive constructive feedback with others
6. Having my student(s) work on collaborative activities or projects as a member of a team
7. Allowing my student(s) to resolve conflicts and reach agreement within their team

Chart 18: Mean Composite Scores for Supporting Student Development of Collaboration and Interpersonal Skills†



† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

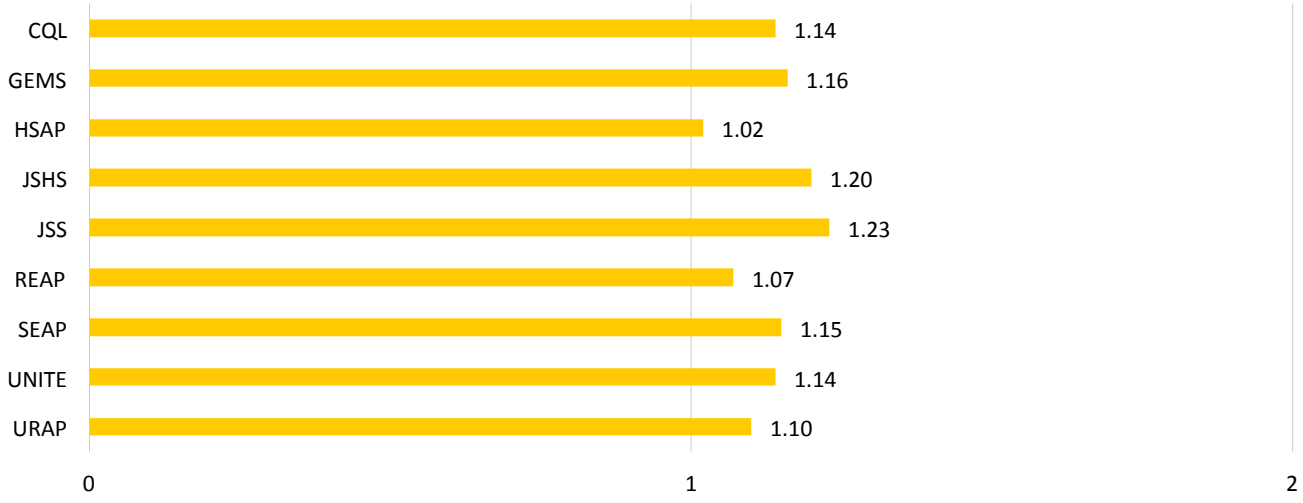
Table 33. Mentor Mean Composite Scores for Supporting Student Development of Collaboration and Interpersonal Skills in 2014 vs. 2015 and 2015 Overall Percent Agreement

	2014 Composite Mean	2015 Composite Mean	2015 Composite % Agreement
CQL	1.78	1.16	84%
GEMS	1.94	1.09	91%
HSAP	NA	1.10	90%
JSHS	1.78	1.21	75%
JSS	1.84	1.27	73%
REAP	1.79	1.21	79%
SEAP	1.63	1.22	78%
Unite	1.88	1.10	90%
URAP	1.83	1.27	73%

The fourth set of mentoring strategies focused on supporting student engagement in "authentic" STEM activities; the items are shown in Table 34. Findings for this composite in FY15 (Chart 19) also revealed a decline of mentor use of these strategies in AEOP programs. A comparison of FY15 and FY14 scores are found in Table 35.

Table 34. Items that form the Supporting Student Engagement in "Authentic" STEM Activities Composite for CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP
1. Teaching (or assigning readings) about specific STEM subject matter
2. Having my student(s) search for and review technical research to support their work
3. Demonstrating laboratory/field techniques, procedures, and tools for my student(s)
4. Supervising my student(s) while they practice STEM research skills
5. Providing my student(s) with constructive feedback to improve their STEM competencies
6. Allowing students to work independently to improve their self-management abilities
7. Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)
8. Encouraging students to seek support from other team members

Chart 19: Mean Composite Scores for Supporting Student Engagement in "Authentic" STEM Activities†



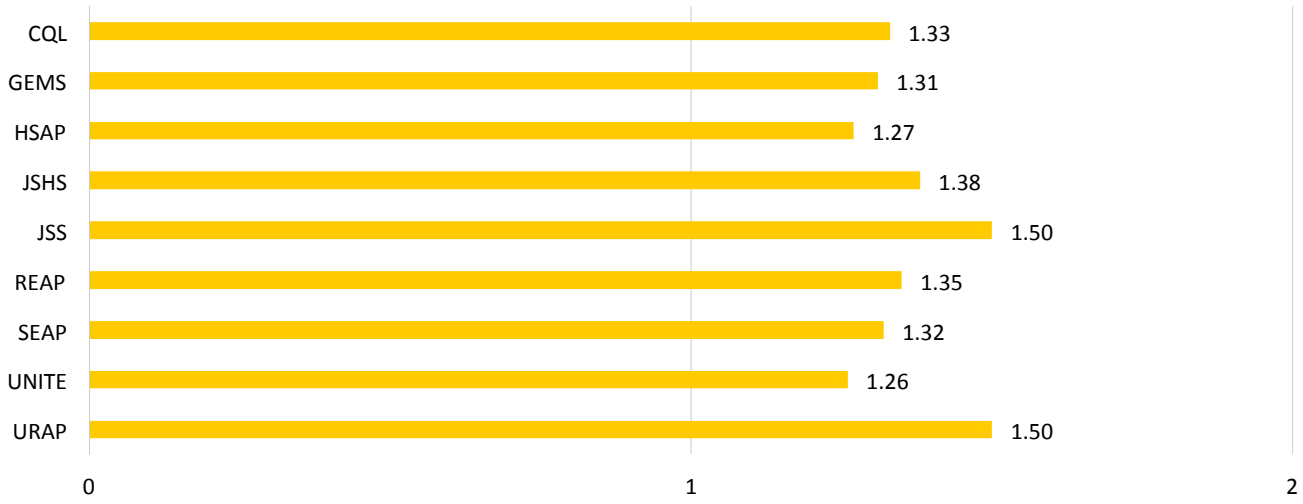
† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

Table 34. Mentor Mean Composite Scores for Establishing the Relevance of Learning Activities in 2014 vs. 2015 and 2015 Overall Percent Agreement			
	2014 Composite Mean	**2015 Composite Mean**	**2015 Composite % Agreement**
CQL	1.93	1.14	86%
GEMS	1.85	1.16	84%
HSAP	NA	1.02	98%
JSHS	1.86	1.20	76%
JSS	1.91	1.23	77%
REAP	1.86	1.07	93%
SEAP	1.90	1.15	85%
Unite	1.81	1.14	86%
URAP	1.96	1.10	90%

The final set of mentoring strategies focused on supporting student STEM educational and career pathways. The items making up this composite are shown in Table 35, and mean composite scores are shown in Chart 20. Findings indicate a decrease in scores in this composite area for AEOP programs in FY15, as compared with FY14 (Table 36).

Table 35. Items that form the Supporting Student STEM Educational and Career Pathways Composite for CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, Unite, and URAP
1. Asking my student(s) about their educational and/or career goals
2. Recommending extracurricular programs that align with students' goals
3. Providing guidance about educational pathways that would prepare student(s) for a STEM career
4. Recommending Army Educational Outreach Programs that align with students' educational goals
5. Discussing STEM career opportunities within the DoD or other government agencies
6. Discussing STEM career opportunities in private industry or academia
7. Discussing the economic, political, ethical, and/or social context of a STEM career
8. Recommending student and professional organizations in STEM to my student(s)
9. Helping students build a professional network in a STEM field
10. Helping my student(s) with their resume, application, personal statement, and/or interview preparations

Chart 20: Mean Composite Scores for Supporting Student STEM Educational and Career Pathways†



† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

Table 36. Mentor Mean Composite Scores for Establishing the Relevance of Learning Activities in 2014 vs. 2015 and 2015 Overall Percent Agreement

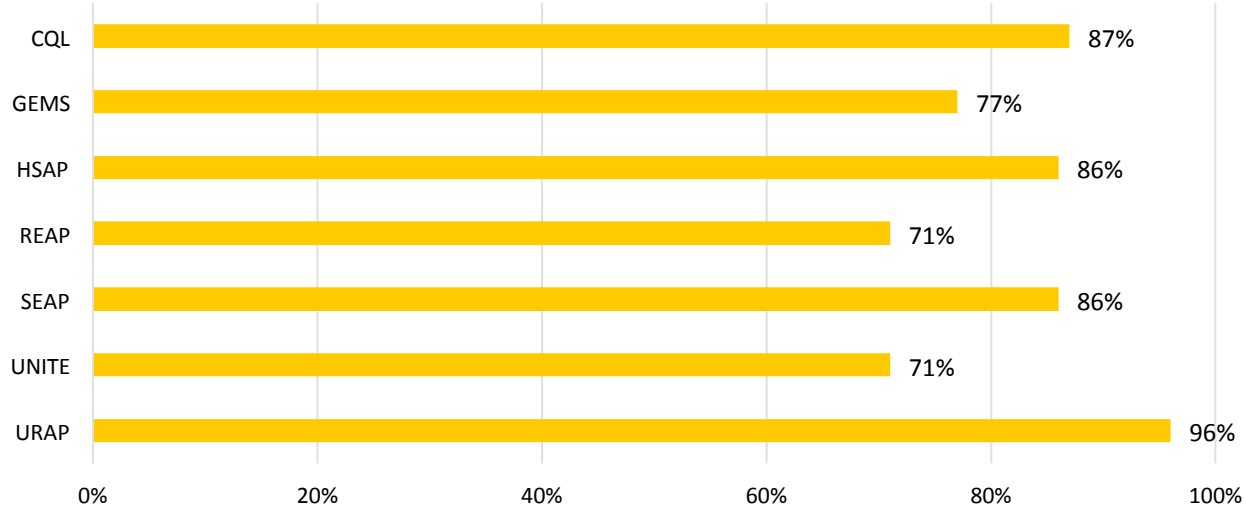
	2014 Composite Mean	2015 Composite Mean	2015 Composite % Agreement
CQL	1.61	1.33	66%
GEMS	1.72	1.31	69%
HSAP	NA	1.27	73%
JSHS	1.61	1.38	62%
JSS	1.68	1.50	51%
REAP	1.69	1.35	65%
SEAP	1.61	1.32	68%
Unite	1.69	1.26	74%
URAP	1.63	1.50	50%

Overall, 2015 AEOP mentors declined in their reported use of effective mentoring practices to help establish the relevance of activities, support the needs of diverse learners, develop mentees' collaboration and interpersonal skills, and engage mentees in authentic STEM activities. This is an area that should be addressed AEOP portfolio-wide with potential trainings/onboarding and expectation setting with mentors in FY16 and beyond.

Finding #2: Across the AEOPs, most apprentices and students report being satisfied with their mentors and the quality of instruction they received.

The FY15 evaluation included an examination of participant satisfaction with mentorship during their AEOP program experience. This indicator is a good way to gauge student perceptions of quality of mentoring experience – as a positive relationship will result in a more meaningful and potentially more impactful experience that may have sustained duration following the program. In FY15, all AEOP program participants reported at least the same level or increased satisfaction with their mentors and quality of instruction from FY14 (Table 37). As can be seen in Chart 21, a large majority of students across AEOP elements indicating being "very much" satisfied with this aspect of their experience. As in FY14, FY15 URAP participants were most likely to report being very much satisfied (96%).

Chart 21: Apprentices/Students "Very Much" Satisfied with Instruction or Mentorship During Program†



† *Only programs who work directly with a mentor (non-teacher) were asked this question.*

Table 37. Participants "Very Much" Satisfied with Instruction or Mentorship During Program 2014 vs. 2015		
	2014	**2015**
CQL	72%	87%
GEMS	70%	77%
HSAP	71%	86%
REAP	71%	71%
SEAP	75%	86%
Unite	54%	71%
URAP	86%	96%

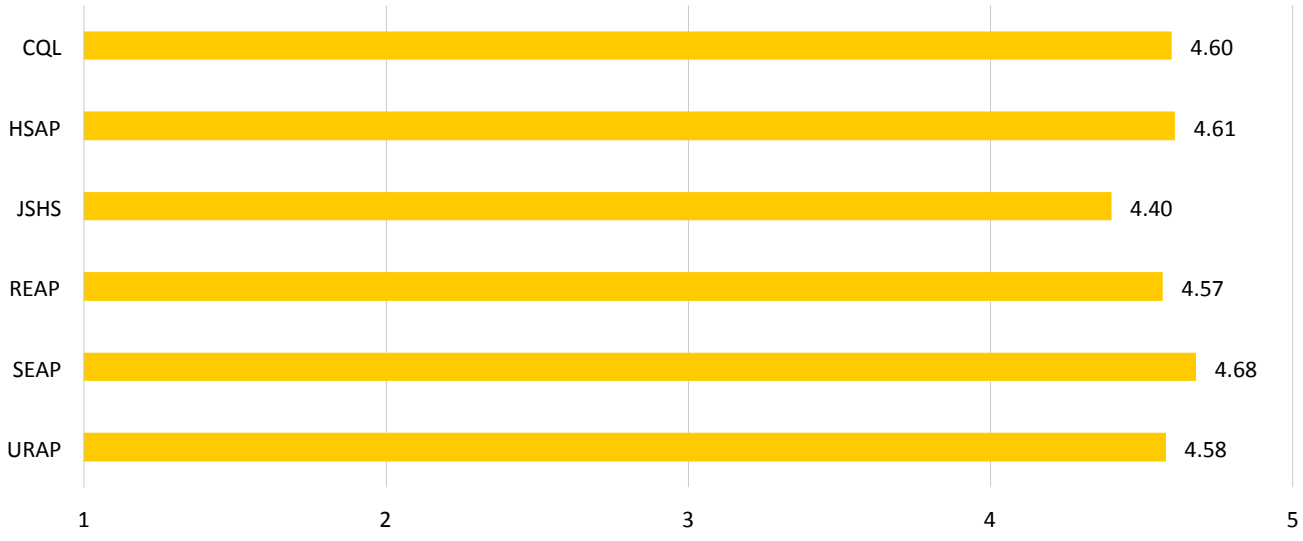
The 2015 student questionnaire for apprentice programs (CQL, REAP, SEAP, and URAP) and JSHS participants also asked about a number of aspects of the students' experience with their mentors. These items are shown in Table 38 and were used to create a "Mentor Satisfaction" composite variable. As can be seen in Chart 22, scores on this composite were high, indicating that participants were very satisfied about the quality of the mentoring they received. This data was not collected for Unite in FY15.

Table 38. Items that form the Mentor Satisfaction Composite for CQL, HSAP, JSHS, REAP, SEAP, and URAP
1. My working relationship with my mentor
2. My working relationship with the group or team[†]
3. The amount of time I spent doing meaningful research
4. The amount of time I spent with my research mentor
5. The research experience overall

[†] *This question was not included on the JSHS survey.*

[††] *The Unite survey did not include these questions in FY15.*

Chart 22: Mean Composite Scores for Mentor Satisfaction[†]



[†] *Response options for the items forming this composite were: 0 – Did not experience, 1 – Not at all, 2 – A little, 3 – Somewhat, 4 – Very much.*

Priority Three: Sustainable Infrastructure

While the AEOP Consortium took a number of steps in 2015 to better develop a sustainable infrastructure, additional efforts will likely be needed. The implementation of a centralized application system (CVENT) across all AEOP elements in 2015 began to advance the AEOP's ability to capture accurate and consistent data on all applicants as well as both youth and adult participants.

<u>Finding #1</u>: As in FY14, the AEOP evaluation, with the exception of eCM, was standardized across program elements to help ensure a focus on program-wide priorities, improvement efforts, and utilize best practices in the evaluation of informal STEM education programs. In FY16 eCM will become aligned with the rest of the AEOP portfolio and will be evaluated by Purdue University in the umbrella evaluation. Though there was some focus in FY15 on improving participation in evaluation activities (i.e., AEOP participant and mentor surveys) at regional and national levels, continued focus in this area will improve the representativeness of the evaluation data and provide a clearer picture of AEOP impacts.

The FY15 Lead Organization (LO) of the AEOP CA, Virginia Tech, provided objective assessment of most programs in the AEOP portfolio and of the AEOP portfolio following a centralized evaluation plan that includes annual data collection, analysis, and reporting. The data that was collected was analyzed and processed into FY15 reports by the new evaluation team at Purdue University. The AEOP Evaluation is informed by and strives to adhere to best practices for rigorous program evaluation. These practices include:

- Questions, methods, and assessments designed to align with Army, DoD, and Federal STEM priorities as well as with individual program objectives;
- A set of common metrics and measures employed across all AEOP programs that align output and outcome measures with AEOP objectives and that are inventoried by the Office of Science and Technology Policy;[12]
- Assessments adapted from and informed by existing instruments of the field, and when assessments must be designed by the evaluation team, appropriate measures will be taken to assess and improve assessment performance of those measures before deployment;
- Annual evaluation of the individual programs of the AEOP portfolio—including both process and outcomes evaluation—to ensure the utility of evaluation findings and recommendations in program revision and decision-making; and
- Evaluation plans, including methods and assessments, will be reviewed and revised annually to respond to changing AEOP or program priorities and evaluation resources, and emerging evaluation theory and practice.

Due to the fact that some programs had low response rates on questionnaires, it will be important to consider ways to improve the response rate in the future through methods that may include having individual programs emphasize the importance of completing the questionnaires, and, when feasible, administering the questionnaires during the program so there is a "captive" audience. Another step that might improve response rates is reducing the actual and perceived response burden. Both the adult and youth questionnaires have estimated response times of 45 minutes.[13] In particular, consideration should be given to whether the parallel nature of the student and mentor questionnaires is necessary, and whether items should be asked only of the most appropriate data source. In FY16 the evaluation team will begin the process of revising questionnaires with the goal of implementing more refined versions in the FY17 evaluation.

[12] Office of Science and Technology Policy, "2010 Federal STEM Education Inventory Data Set" (Washington, D.C., 2012)

[13] When asked about potential improvements to URAP, one apprentice wrote "This survey is the worst part about URAP -- please shorten it for the sake of future URAP undergraduates."

Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in 2014, the 2015 evaluation indicates that the most effective marketing of AEOP elements happened at the local level and was facilitated by site coordinators, regional directors, and/or local mentors. Centralized efforts to market the AEOP through the AEOP Consortium or program administrators were notably less effective than site-specific work. Many students expressed interest in continued participation in the AEOP, though most often repeating the program they were currently in. Further, those who reported learning about other AEOPs indicated doing so from program activities or their mentor; however, many mentors reported not being knowledgeable about other AEOPs.

Table 39 summarizes 2015 AEOP communication activities produced by the CAMs, LO, and/or Consortium members.

Table 39. AEOP Communications Activities	
Internal Communications Activities	• Bi-weekly meetings between LO and CAMs, focused on developing and implementing communications plan (social media calendar, press releases, success stories, etc.). • Quarterly updates from LO to Consortium, focused on activities and events for exhibiting and generation of social media content. • Updates to the AEOP website, as requested by Consortium. . • Friday Message from LO to Consortium, focused on weekly updates and requests for content for social media and success stories. • Production of monthly or event-specific communications reports including data collected through the Vocus PR Management tool. • Coordination between LO and eCM Communications Managers.
External Communications Activities	• Review and revision AEOP brochure to accurately reflect AEOP. • Daily postings at social media channels (Facebook and twitter). • Exhibiting for AEOP by the LO at major events, such as U.S.A. Science & Engineering Festival (JSHS-N) and eCM National Judging & Educational Event (NJ&EE), as well as by Consortium members at numerous conferences/meetings/roadshows, such as the NSTA and TSA regional conferences and roadshows held at Army installations. • Distribution of AEOP-branded instructional supplies to program participants and at outreach events, including pencils, social media cards, brochures, rack cards, rite-in-the-rain notebooks, and lab coats (disposable and cloth). • Integration of AEOP brand into all program-specific marketing materials and signage (event banners, program/event-specific web sites, STEM research kits, printed materials, etc.) • 2015 AEOP Student Research Abstract Book (electronic). • News releases highlighting specific 2015 AEOP achievements and events: White House Science Fair, JSHS-N winners, Regional eCM winners, National eCM winners, National JSS race announcement, National JSS winners, REAP student selected to present research at American Chemical Society meeting, and Unite helps students find their STEM future, and eCM teams and mentors receive awards at White House.

The 2015 AEOP evaluation surveys systematically inquired about the role AEOP external communication activities played in participants' awareness of the AEOP. Despite increased investment and attention to external communications

regarding AEOP opportunities, friends, teachers and or professors, or someone who works at the university or school I attend continue to be the top way that most participants learn about programs (Table 40). HSAP, JSHS-R, JSHS-N, JSS, REAP, and URAP all report their teacher/professor or school/university connections were the most predominant way they learned about their selected programs in FY15. CQL participants reported a shift in their primary means of learning about AEOP from someone who works at an Army laboratory in FY14 to a friend in FY15. Similarly, a shift for HSAP occurred as in FY14 the program administrator website and/or AEOP website were the most reported means of learning about AEOP – but in FY15 teacher/professor and/or school/university were the most frequent means of information about AEOP opportunities. Unite participants reported a shift in the primary means of learning about AEOP from an immediate family member in FY14 to a past participant of the program in FY15. SEAP continued to be the same source in FY15 with family member being the predominant means of learning about AEOP. In FY14 participants were asked about the role of social media in learning about AEOP opportunities and reported almost no impact (0%-5%) in reaching new program participants. This item was not included in the FY15 survey – but should be considered for inclusion in future evaluations (FY16 and beyond) as the presence of AEOP on social media is continuing to grow.

Table 40. How Students Learned about their AEOP Program

	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	Unite	URAP
Friend	32%	27%	18%	0%	8%	7%	17%	22%	11%	6%
Friend or co-worker of a family member	17%	6%	6%	0%	0%	2%	5%	16%	2%	NA
Family member	NA	27%	10%	5%	3%	2%	16%	39%	8%	3%
Past participant of program	19%	28%	0%	14%	15%	3%	16%	36%	18%	17%
School or university newsletter, email, or website	14%	13%	10%	20%	26%	11%	24%	17%	13%	7%
Someone who works with the Department of Defense	32	15%	0%	1%	4%	1%	1%	35%	0%	2%
Teacher or professor/Someone who works at the school or university I attend	26%	10%	48%	30%	72%	11%	32%	23%	11%	33%
Website: AEOP	8%	13%	NA†	0%	1%	1%	11%	25%	3%	NA†
Someone who works with the program	18%	6%	26%	9%	9%	1%	15%	31%	16%	17%
Someone who works at school/university I attend	26%	10%	48%	30%	30%	11%	7%	23%	11%	33%
Other	4%	7%	0%	4%	3%	2%	8%	2%	4%	0%
Choose not to report	NA†	NA†	0%	3%	1%	9%	0%	0%	2%	0%

†*Data is not available for this item. Inconsistent data collection across programs.*

Mentors were also asked in the FY15 evaluation to report on the means that they learned about the AEOP program(s). In Table 41, findings for FY15 are presented. CQL and SEAP mentors (both hosted on-site at Army Research Labs) indicated

workplace communications as their primary means of recruitment to work with AEOP – a change for both from FY14 when the predominant means of learning about AEOP was from a colleague. It would seem that communications regarding AEOP has shifted for these two programs beyond word of mouth (colleagues) to more formal communications within the Army workplace. Other mentors from JSS, REAP, and URAP indicated that websites for programs (i.e., TSA, AAS, etc.) were the primary means of knowledge about AEOP for them. This was a change for REAP which reported in FY14 that colleagues were the main form of information about AEOP. Mentors from GEMS, JSHS, and Unite learned about AEOP from past participants. This was true in FY14 as well for GEMS and JSHS. Findings indicate that word of mouth (e.g., colleague, past participants) and also program websites (not the AEOP website) were the primary means of how mentors learned about their given AEOP programs. The more localized, personal recruitment means seem to be paying the greatest dividends for AEOP program mentor recruitment.

Table 41. How Mentors Learned about their AEOP Program

	CQL	GEMS	JSHS	JSS	REAP	SEAP	Unite	URAP
Colleague	27%	14%	1%	4%	22%	4%	21%	0%
News story or other media coverage	22%	NA	NA	NA	NA	NA	NA	NA
Past participant	3%	28%	29%	7%	24%	30%	64%	0%
School, university, or professional organization newsletter, email, or website	8%	20%	3%	4%	10%	0%	0%	21%
Site host/director/Someone who works with program	3%	28%	17%	NA	22%	13%	0%	11%
Social media	0%	1%	NA	NA	0%	0%	0%	0%
Someone who works at an Army laboratory	NA	NA	NA	NA	NA	NA	0%	0%
Someone who works with the Department of Defense	16%	18%	20%	7%	2%	0%	0%	6%
State or national educator conference	NA	NA	NA	0%	NA	NA	NA	0%
STEM conference or STEM education conference	0%	NA	NA	NA	5%	0%	0%	0%
Student	8%	NA	NA	NA	0%	0%	0%	-%
Supervisor or superior	16%	NA	NA	NA	27%	22%	0%	11%
Friends	NA	23%	0%	NA	NA	NA	21%	NA
Family member	NA	19%	1%	NA	NA	NA	14%	NA
Friend or co-worker of family member	NA	8%	1%	NA	NA	NA	NA	NA
Community group or program	NA	1%	NA	NA	NA	NA	NA	NA
Website: AEOP	19%	11%	3%	4%	20%	22%	14%	32%
Website: Program or Program Administrator	NA	NA	NA	64%	31%	NA	0%	58%
Workplace communications	32%	NA	NA	NA	2%	44%	0%	0%
Other	5%	NA	9%	4%	5%	0%	0%	0%

When asked about factors motivating their participation, interest in STEM was mentioned by many students across all AEOP programs. However there were some differences in motivating factors seen across program types. Students in the 2015 AEOP competition programs (JSS, JSHS, eCM) reported that "having fun," greatly motivated their decision to participate in these programs. Students in the enrichment (GEMS, Unite) and apprenticeship (SEAP, HSAP, REAP, URAP, CQL) programs cited several factors as "very much" motivating in their decision to participate in these programs, including:

- Learning in ways that are not possible in school;
- Desire to learn something new or interesting;
- Desire to expand laboratory or research skills;
- Opportunity to explore a unique work environment; and
- Opportunity to use advanced laboratory techniques/technology.

The intent of the AEOP initiatives is to build a pipeline of opportunities for students in STEM beginning in elementary and continuing across their high school and post-secondary study into STEM careers. Recent efforts have been made to strengthen communication regarding AEOP programs to potential and current participants. The FY15 evaluation examined two aspects of the AEOP pipeline: 1) past participation in AEOPs, and 2) interest in future participation in AEOPs. As can be seen in Table 42, some programs have been more successful at recruiting participants with previous AEOP experience than others. For example, a sizeable proportion of 2015 SEAP, Unite and REAP participants reported previous experiences in a variety of AEOPs. However, eCM, JSS and URAP participants reported very little to no previous participation in AEOP programs. This is less surprising with JSS and eCM being upper elementary to 8th/9th grade programs. More concerning is the lack of participation reported (0%) for URAP students in other AEOPs, indicating this is their first encounter with AEOP.

Table 42. AEOP Participants Reporting Having Participated in Other AEOPs

	Current AEOP									
	Competition Programs			Summer Programs		High School Apprenticeships			College Apprenticeships	
	eCM	JSS	JSHS	GEMS	Unite	HSAP	REAP	SEAP	URAP	CQL
CQL	5%	2%	2%	NA†	NA†	3%	5%	32%	2%	84%
eCM	___‡	1%	1%	3%	NA	1%	2%	4%	NA‡	NA‡
GEMS	3%	5%	7%	34%	20%	35%	4%	29%	NA‡	NA‡
HSAP	0%	0%	0%	25%	0%	75%	0%	0%	NA‡	NA‡
JSHS	___‡	___‡	___‡	___‡	___‡	___‡	___‡	___‡	NA‡	NA‡
JSS	0%	100%	NA†	0%	0%†	0%	0%	0%	NA‡	NA‡
REAP	2%	1%	8%	28%	27%	3%	77%	2%	NA‡	NA‡
SEAP	1%	0%	0%	0%	20%	38%	0%	36%	NA‡	NA‡
Unite	NA†	NA†	6%	0%	NA†	35%	18%	6%	NA‡	NA‡
URAP	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%

† *It is not possible for students to have participated in these programs due to age restrictions.*
†† *This data was not collected for JSHS in FY15.*

In regards to future interest in AEOP program participation participants were asked to indicate their level of interest in each of the applicable programs in the portfolio. Table 43 presents the percentage of current AEOP participants that indicated they were "interested" or "very interested" in other AEOP programs. Most program participants were interested in other AEOPs with the exception of JSS whose participants reported less than 10% interest for all other AEOPs besides GEMS (11%) and REAP (10%). A trend that was indicated in FY14 continues in FY15. This is the trend of SEAP participants to show interest in CQL (51%) and HSAP students to demonstrate interest in URAP (50%). REAP students also indicated interest in URAP (44%). The apprentice programs clearly have generated interest for continuing the apprenticeship pipeline in AEOP. It is recommended that the AEOP LO/CAM examine their strategies and employ some of these within the competition and STEM programs to attempt to grow the pipeline focus across the portfolio

Table 43. AEOP Participants Reporting Substantial[†] Interest in Participating in Other AEOPs

	Current AEOP									
	Competition Programs			Summer Programs		High School Apprenticeships			College Apprenticeships	
	eCM	JSS	JSHS	GEMS	Unite	HSAP	REAP	SEAP	URAP	CQL
CQL	NA[‡]	NA[‡]	NA[‡]	16%	26%	15%	NA[‡]	NA[‡]	12%	55%
eCM	___[‡‡]	11%	14%	25%	13%	16%	15%	16%	14%	12%
GEMS	10%	11%	11%	61%	10%	19%	20%	24%	17%	17%
HSAP	15%	16%	20%	18%	30%	NA[‡]	29%	18%	50%	15%
R-JSHS	___[‡‡]	NA[‡]	60%	19%	14%	23%	24%	26%	27%	19%
N-JSHS	___[‡‡]	NA[‡]	83%	10%	7%	10%	22%	22%	23%	15%
JSS	6%	62%	8%	11%	8%	8%	10%	9%	4%	6%
REAP	15%	20%	21%	22%	34%	29%	74%	22%	44%	23%
SEAP	NA	NA[‡]	9%	27%	30%	17%	46%	67%	24%	51%
Unite	___[‡‡]	NA	22%	27%	56%	30%	34%	30%	25%	27%
URAP	___[‡‡]	NA[‡]	NA[‡]	NA[‡]	NA[‡]	NA[‡]	NA[‡]	NA[‡]	63%	19%

[†] *It is not possible for students to participate in these programs due to age restrictions.*
[‡‡] *This data was not collected on the indicated surveys.*
[‡‡‡] *For all programs except eCM, the data represent participants indicating "very much" interest; for eCM, data represent participants indicating "very interested" or "interested."*

As in FY14, the FY15 evaluation suggest that across the AEOP, all groups (e.g., youth participants, mentors) engaged in AEOP programs have limited awareness of AEOP programs other than those in which they are currently participating. Yet participant interest exists that would benefit from greater awareness. The Army, program administrators, site and event coordinators, mentors, and other volunteers share the responsibility for exposing participants to other AEOP initiatives and for encouraging continued participation in programs for which apprentices qualify. Continued guidance by program administrators is needed for educating site and event coordinators, mentors, and other volunteers about AEOP opportunities, in order that all participants leave with an idea of their next steps in AEOP.

Summary of Findings

The 2015 AEOP evaluations collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to outcomes aligned with AEOP and program objectives. A summary of findings is provided in Table 44.

Table 44. Summary of Findings

Priority 1: STEM Literate Citizenry *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	• Finding #1: In FY15 the AEOP provided outreach to 38,039 participants through its comprehensive portfolio of programs. This number represents an overall decrease in number of participants compared to FY14 (41,802) that can be attributed to decline in participation for a few of the AEOP competition programs (i.e., eCM, JSHS, JSS). There were 34,420 students captured in FY15 AEOP competitions, which represents 3,562 fewer participants than FY14. However, the AEOP apprenticeship portfolio experienced overall growth in participation with 684 apprentices in 2015 (compared to 585 in FY14). Specifically, CQL increased both number of participants as well as placement rate (394 apprentices representing a 78% placement rate). Similarly, HSAP (49 apprentices, 18% placement rate) experienced growth and SEAP remained steady with the same number of participants as in FY14 (92). REAP and URAP had slight declines in participation in FY 15 (REAP - 101 compared to 117 in FY14; URAP - 48 compared to 59 in FY14). Student STEM enrichment activities (i.e., CII, GEMS, and Unite) also declined in participation overall, as CII enrollment alone was 44% lower than in FY14 (465 compared to 860). Unite experienced a 29% decrease in participation (200 in FY15 versus 280 in FY14). On a positive note, GEMS increased participation in FY15 with 2,270 students enrolled compared to 2,095 in FY14. There were a total of 2,935 students enrolled in STEM enrichment activities in FY15 (compared to 3,235 in FY 14). Despite efforts to include more participants in AEOP activities, FY15 enrollment data reiterated previous years' findings that there is unmet need for youth and adults in the United States and beyond, with 6,418 applicants who were not accepted into the programs. • Finding #2: While the AEOP continued to emphasize participation of underserved and under-represented groups in associated apprenticeship, competition, and enrichment programs, achieving this goal continued to be a challenge in FY15. Participation of females and racial and/or ethnic minorities increased or remained constant in eCM, GEMS JSHS-N, and SEAP. However, other programs in the AEOP portfolio experienced declines in participation of one or both of these groups. The participation rate of females in CQL increased from FY14 to FY15 (25% to 40%) and JSS enrolled more racial and/or ethnic minorities (13% to 28%). REAP and Unite, AEOP programs designed to specifically target underserved and under-represented groups maintained their enrollment of 60% or more of racial and/or ethnic minorities. One concerning finding is the over 20% decrease in female participation in Unite, as compared to FY14 (66% and 45% respectively). Further, competitions and programs hosted at Army/DoD laboratories that do local recruiting should examine their recruitment practices to insure that participants from all backgrounds are represented in the applicant pool and are competitive for AEOP enrollment status.

Priority 1: STEM Literate Citizenry *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base.*	• Finding #3: In FY15, as in FY14, the AEOP provided participants with more frequent exposure to real world, hands-on, and collaborative STEM activities than they are exposed to in regular schooling. • Finding #4: As in FY14, students participating in the AEOP programs in FY15 reported that the experience improved their STEM-specific and 21st Century STEM skills competencies. They also reported gains in their abilities to use the science and engineering practices described in the Next Generation Science Standards (NGSS), as well as increases in their STEM confidence and identity. • Finding #5: The AEOP's efforts to engage students in and/or expose them to DoD research continues to be a challenge. While students reported positive attitudes toward DoD STEM research and researchers, there were mixed findings related to mentors discussing DoD STEM research, with some programs experiencing declines from FY14 in this area and mentors discussing STEM opportunities in the DoD with apprentices and students. • Finding #6: The AEOP exposed students to Army and DoD STEM careers and increased their interest in pursuing a DoD STEM career, although some programs were more effective (e.g., JSHS-N, SEAP, UNITE, GEMS, CQL) at doing so than others (e.g., HSAP, JSHS-R, JSS, REAP, URAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities is the most promising practice for informing participants about specific jobs/careers. Most mentors did not find AEOP electronic resources to be useful for exposing apprentices and students to STEM DoD careers, and continue to call for new resources for improving students' awareness of Army and DoD STEM research and careers. • Finding #7: The AEOP programs served to sustain existing STEM educational and career aspirations of participants and to inspire new achievement, including intentions to pursue higher education and STEM careers. In addition, participants reported gains in interest in pursuing DoD STEM careers as a result of participation in AEOP (e.g., GEMS, CQL, and JSHS-N).
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	• Finding #1: AEOP mentors' reported use of effective mentoring strategies overall declined overall in FY15. These strategies include establishing the relevance of learning activities, supporting the diverse needs of students as learners, supporting student development of interpersonal and collaboration skills, supporting student engagement in authentic STEM activities, and supporting student STEM educational and career pathways. • Finding #2: Across the AEOPs, most apprentices and students report being satisfied with their mentors and the quality of instruction they received.
Priority 3: Sustainable Infrastructure *Develop and implement a cohesive, coordinated, and sustainable STEM*	• Finding #1: As in FY14, the AEOP evaluation, with the exception of eCM, was standardized across program elements to help ensure a focus on program-wide priorities, improvement efforts, and utilization of best practices in the evaluation of informal STEM education programs. In FY16 eCM will become aligned with the rest of the AEOP portfolio and will be evaluated by Purdue University in the umbrella evaluation. Though there was some focus in FY15 on improving participation in evaluation activities (i.e., AEOP participant and mentor surveys) at regional and national levels, continued focus in this area will improve the representativeness of the evaluation data and provide a clearer picture of AEOP

education outreach infrastructure across the Army.	impacts. CII was not included in the AEOP evaluation in FY15. • Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in FY14, the FY15 evaluation indicates that the most effective marketing of AEOP elements occurred at the local level and was facilitated by site coordinators, regional directors, and/or local mentors. Centralized efforts to market the AEOP through the AEOP Consortium or program administrators were notably less effective than site-specific work. Many students expressed interest in continued participation in the AEOPs, most frequently expressing interest in repeating the program in which they were currently enrolled. Participants who reported learning about other AEOPs indicated doing so primarily from program activities or their mentors although many mentors reported a lack of knowledge about other AEOPs.

What AEOP participants are saying…

*"**SEAP** and **CQL** have been the most influential academic experiences of my life. I cannot thank AEOP enough for helping young students like me experience work like this that benefits me in so many ways. I have a much better idea of real careers I could follow to put my capabilities to their best use. I have had a great experience this summer, and I hope to continue working in AEOP programs".* – CQL Apprentice

*"**[CQL]** provides a great opportunity for our over-achieving college students who demonstrate a desire and technical capability to become our next wave of STEM professionals in DoD. "*– CQL Mentor

*"I am extremely grateful for being chosen to participate in this program. Before **GEMS**, my knowledge of the military and its research laboratories was very minimal, but after this camp, I feel satisfied with my attained knowledge…I now feel excited about he research going on here at WSMR. The instructors and modules carried an enthusiasm I hope to carry when I pursue STEM."* – GEMS Student

I thought **[e-CYBERMISSION]** *was a good way to strengthen my scientific knowledge in what I'm interested in. It also helps me learn the fundamental[s] and the process needed to come up with a scientific solution* –eCYBERMISSION Student

*"Every summer I participate as a **GEMS** teacher I am blown away by the abilities of the students that participate. They are fully engaged and have a great learning experience. It also furthers my learning as an educator."* – GEMS Mentor

*"Yesterday was actually my last day in the lab and it was one of the saddest things because I can honestly say that my experience with **HSAP** this summer was one of if not the best summer experience that I had. I think that, specifically, that the opportunity that this program provides in the way that it encourages independence and free thinking for people like me who are basically high school students. Really develops the sort of mindset that you need going forward being in high school or in college whether or not you decided to go into research."*– HSAP Apprentice

*"For us, **[HSAP]** is also wonderful. Most of my colleagues here still kept contact with the high school students and they very often write them letters to support different stages. This kind of experience to me is also wonderful."*– HSAP Mentor

*"Participating in **JSHS** was among the most defining moments of my high school career. I learned so much about different STEM fields from listening to all of the speakers and student presenters. I also learned a lot about the different AEOP programs and am very interested in the **SMART** program especially. Additionally, the feedback I got from my judges were really helpful in developing future plans for my project. My **JSHS** experience will always be one I look back to with the*

fondest memories. Thank you for making it possible. – JSHS Student

*"***[JSHS]** *is the best event I've found to introduce students with a passion for STEM to careers in STEM. They come back energized, excited about science and what it looks like beyond a high school curriculum."* – JSHS Mentor

*"***[JSS]** *is AWESOME! I learned a lot about STEM through JSS "* – JSS Student

"Very pleased. **[JSS]** *is an excellent program [with] great details to ensure students understand that both their engineering design process and production are equally important."* – JSS Mentor

"**[REAP]** *has provided me with a one in a lifetime opportunity, especially as a high school student. This program has given me the ability to work within a lab setting. This, overall, gave me the idea of what I want to pursue in the future career wise, whether it's becoming a medical doctor or a genetic researcher. I very much enjoyed working with the other students in this program, and also getting a chance to work with a microbiology professor as my mentor. I would have worked this program, even without the stipend, but it's an added bonus and will go towards gas money so I will be able to go to most of my school events and participate in more afterschool activities. Moreover, this REAP program has given me memories and an experience that I will never forget and hopefully will be able to use the knowledge I have gained from completing the REAP program in the future."* - REAP Apprentice.

"I have had a number of **REAP** *students work in my laboratory over the last 10 years. They have always been outstanding students who have a real thirst for knowledge. By giving them a research experience early in their careers the REAP program strongly encourages them to pursue a career into science. By enabling to work with others at various levels (undergraduates, graduate students and professors) it gives them a view of what it takes to become a professional scientist and the path that they can take to obtain that goal. I'm very happy with the REAP program and consider it to be a very valuable one for encouraging American youth to go into STEM fields.."* – REAP Mentor

"I was extremely satisfied with my **SEAP** *experience. It was a lot different than anything I have ever done before, and also one of the most rewarding things I have ever done. While in the program I was able to learn much more about STEM and many scientific procedures…I am very grateful I had the opportunity to learn so much more in such a friendly environment. One of the things that really stood out to me was how kind everyone was, not just my mentor but all the other adults in the lab. I was taught that it was okay to make a mistake, and that science is founded upon making mistakes and learning from them. like me who want nothing more than to experience work in a STEM field while also serving their country."* – SEAP Apprentice

"I am really happy with the candidates that presented themselves in the **[SEAP]** *application process. The student that came to us was very excited to get started and has worked really hard to learn and gain new experiences and knowledge. I have enjoyed having this student and look forward to additional work with her this coming school years."* – SEAP Mentor

"I am very appreciative for the opportunity to go into the **Unite** *program. It taught me skills I will take with me all throughout life. I hope to continue on to the* **REAP** *program and continue learning with these amazing programs.."* – Unite Student

*"***[Unite]** *was a wonderful opportunity to expose students from under-represented groups to important STEM topics and to encourage their involvement and excitement in high performance computing. I look forward to participating in the program again in the future"* – Unite Mentor

"This **[URAP]** *experience was great. Communication with my mentor was awesome leading up to and during the program. My mentor was able to answer all my questions and teach me everything I needed to be successful in the program. I gained a lot of knowledge in chemistry that will help me become more well-rounded as genetic engineer. The*

research I participated in is not in the curriculum for my degree program so I feel that I obtained a lot of extra knowledge that will give me a professional edge in the future. I gained a lot of experience working in the lab with other scientists and got a feel for how working full time in a lab will be once I graduate. My mentor also shared his experience in choosing a path for his education that helped me in thinking about my direction after obtaining my bachelor's degree. ." – URAP Apprentice

It was great to have a **[URAP]** *student join my group and participate in our projects. [The apprentice] worked hard, and learned quite a lot over the summer. Unfortunately, we had some equipment issues that prevented him from seeing the project to completion, but this is very common in our area and he got to learn just how difficult cutting edge research can be. This experience will benefit him as he attends UCLA as a Physics major in the Fall, and will also help as he becomes involved with research in graduate school."* – URAP Mentor

Recommendations

1. **Increase and broaden participation in selected AEOP programs.** Overall enrollment in AEOP programs decreased by 4,103 participants in FY15 despite concerted efforts to grow enrollment, increase placement rates, and broaden diversity within and across the AEOP. An exception to this finding was the increased overall enrollment in AEOP apprenticeship programs, led by CQL and HSAP growth, though SEAP enrollment remained constant at FY14 levels and REAP and URAP enrollment declined slightly.

   Three of the programs that have no enrollment caps but are contingent upon funding limitations ((AEOP competition programs eCM, JSHS, JSS) experienced declines in enrollment in FY15. This finding reveals the need for broader recruitment and marketing of AEOP competition programs. JSHS-Regional sites tend to have disproportionate participation from the local area around the lead institution, so strategies to reach out and support students to travel longer distances to compete may be one strategy to employ. JSS is currently only open to TSA chapter members and JSS is only one of over 60 potential STEM competitions TSA hosts. It is recommended that TSA consider means to include students whose teachers or schools may not be TSA chapter members. eCM's success with marketing and growing enrollment in recent years contributed to this program having largest group of participants in the AEOP portfolio. Additional investments in growing and maintaining enrollment for eCM should be considered.

   Enrollment in the AEOP STEM enrichment programs varied by program. While enrollment in the GEMS program increased in FY15, Unite experienced a relatively large decrease in enrollment (280 versus 200 in FY14). Like JSS, Unite is administered by TSA and additional strategies should be considered to grow enrollment and increase the diversity of students participating in the program.

   An examination of the AEOP portfolio overall reveals that despite investments in marketing and outreach to underserved and under-represented groups, there has been little progress toward growing the diversity of the AEOP portfolio across programs in FY15 with the exception of some programs (i.e. CQL, JSS) that exhibited slight

growth. Other programs' enrollment remained steady at FY14 levels or showed slight increases in participation of one more underrepresented groups (REAP, GEMS, SEAP, JSHS-N). One concerning finding was the 20% decrease in participation of females in Unite (66% in FY14 and 45% in FY15), a program that specifically targets under represented populations. Moreover, findings of this evaluation affirm the need to continue to invest in recruitment and marketing efforts/strategies to grow the participation of students from underrepresented groups.

A final area of need that was revealed through the FY15 evaluation is the focus on connections with Army/DoD laboratories as the primary means for recruiting apprentices for CQL/SEAP programs. It is strongly recommended that site leads utilize the Cvent system for selecting participants for these programs to protect the competitiveness of securing coveted spots in highly popular apprentice programs with low placement rates.

2. **Improve marketing and grow awareness of AEOP.** As was the case in FY14 a substantial proportion of AEOP participants expressed interest in future participation in AEOPs but at the same time reported having little knowledge of individual programs within the AEOP portfolio outside of the program in which they were currently enrolled. It is clear from the FY15 evaluation that current efforts (e.g. distributing the AEOP brochure, AEOP program websites, AEOP website) to expose participants to the various programs within the portfolio are not adequate. It is recommended that the new LO (Battelle Memorial Institute) work in concert with the new marketing firm (Widmeyer) and individual programs in the consortium to develop program materials (i.e. AEOP slide deck, activities to be used within programs as part of content of program) that will purposefully and collectively provide participants with a clear understanding of the AEOP program opportunities. Further, AEOP should consider expanding its strategic outreach initiative effort in increasing awareness of, and participation in AEOP through partnerships with like-minded organizations, especially those with connection to underserved and underrepresented populations. The focus of the AEOP consortium should be on providing participants with an awareness of the pipeline of AEOP programs and should explicitly focus on providing details of each program, application procedures, timelines, and benefits of participation so that participants can make informed decisions about future participation. Furthermore, mentors reported little knowledge of the AEOP portfolio. Similar efforts should be made to prepare mentors and program staff with a variety of easily accessible materials and information that can be readily shared with students and other adults.

3. **Raise awareness of Army/DoD STEM careers and research.** As was the case in FY14, some AEOP program participants did not gain a firm understanding of Army/DoD STEM careers (e.g. HSAP, JSHS-R, JSS, REAP, URAP). This is especially concerning since three of the programs (HSAP, REAP, and URAP) are apprenticeship programs, although they are not situated at an Army/DoD laboratory. Participants in programs that were housed at Army/DoD sites (e.g. SEAP, GEMS, CQL) reported better rates of awareness of Army/DoD STEM careers. The same was true of JSHS-N, an event that explicitly includes interaction with Army/DoD professionals. It is recommended that all programs examine their instructional/programmatic content and make an effort to build in more experiences for participants to interact with Army/DoD professionals in a variety of settings. Additionally, it is recommended that overarching materials be developed by the LO/consortium that can be used

within programs to expose participants to Army/DoD STEM careers (i.e. slide decks, videos profiling Army/DoD STEM personnel/careers, webinars, etc.).

4. **Increase the use of effective mentoring strategies across the AEOP portfolio.** Participants in the FY15 reported decreased use of effective mentoring strategies across the portfolio compared to FY14. This is cause for concern as there is a strong research base that clearly links the use of these mentoring strategies with improved outcomes of the mentor/apprentice relationship in formal settings (i.e. CQL, SEAP, URAP, HSAP, REAP) and in less formal settings (other AEOP programs). It is strongly recommended that the AEOP portfolio generate orientation and training resources for mentors in the various AEOP settings (apprenticeships, competitions, enrichment programs). These resources should be used in FY16 and beyond to better prepare mentors with the expectations for mentoring in the AEOP programs and support mentors in increasing their effectiveness.

5. **Improve the response rates for evaluation questionnaires and participation in site visit activities.** Overall participation in the AEOP evaluation continues to be at a lower than desired. The standardization and rigor of the evaluation continued to improve in 2015, however response rates for the apprentice/student and mentor questionnaires were poor in most AEOP programs, with just over 5,000 out of 60,000 youth and adult participants responding to questionnaires. It is recommended that all AEOP programs provide on-site (as applicable) time during the program for both participants and mentors to complete the program questionnaires. Furthermore, since the questionnaire is the primary means of information regarding the progress of AEOP each year, we recommend making participation mandatory for all participants in AEOP programs. Site visit data collection has also been very challenging. Despite program efforts to recruit students and mentors for interviews and focus groups, participation has been less than desired. Programs should work with the evaluation team to determine what supports and incentives will make site visit data collection processes more successful.

Appendices

Appendix A: 2015 AEOP Evaluation

Methods and Design

The AEOP Evaluation used mixed methods approaches[14,15,16] that allow for broad generalization from "quantitative" trends generated in larger surveys of AEOP participants and in-depth focusing of the evaluation through the "qualitative" insights generated through observation and interview of smaller samples of participants. Evaluation activities included critical review of program documentation, participant questionnaires, focus groups or interviews, and on-site observations. Triangulation is used to improve the validity of findings by drawing information from different data sources (e.g., IPAs, students, and "mentors"), different methods of inquiry (e.g., program documentation, survey, focus group and interview data), and different investigators.[17] For example, in evaluation reports evaluators cite major trends from the qualitative data—emergent themes with high frequencies in respondents addressing them—to provide additional evidence of, explanation for, or illustrations of survey data. Evaluators pose plausible explanations when divergence between data sources or data types was evident; any such explanations are subject to further exploration in iterative evaluation efforts. Periodically, more unique perspectives are reported and identified when they provide an illustration that distinctly captures the spirit of the AEOP, or a sentiment that is so antithetical to the AEOP mission that it warrants further investigation.

AEOP Evaluation endeavors to consistently employ the most rigorous designs possible accounting for the informal nature of AEOP CA educational program, the expansive variety of activities offered by different AEOP programs and sites, as well as the limited resources available for AEOP evaluation activities. AEOP evaluation has primarily employed designs described by the Academic Competitiveness Council as "Other Designs:"[18] those that do not employ the most rigorous "scientific" randomized control trials and quasi-experiments. AEOP Evaluation uses pre-post program designs, retrospective pre-post designs, and post-program only designs. In both pre-post and retrospective pre-post designs, changes in self-perceptions of outcome measures (e.g., confidence in applying a STEM research skill, from pre- to post-program) can be measured and the significance of that change can be investigated with appropriate statistical analyses. These and more rigorous designs are most methodologically appropriate for programs in which a treatment is more clearly defined and consistently delivered to a group of participants, such as in the curriculum-based summer programs. Post-program only designs are less useful for indicating whether participants have changed during the program, so efforts were also made to corroborate student perceptions of activities and program effects with those of mentors. These designs are currently used for programs in which the treatment is less clearly defined and where greater variations occur in the delivery to a group of participants, such as in the apprenticeship programs.

Measures and Sampling

[14] John Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (Thousand Oaks, CA: Sage Publications, 2003)
[15] Michael Patton, Qualitative Research & Evaluation Methods (Thousand Oaks, CA: Sage Publications, 2001)
[16] Jennifer Greene and Valerie Caracelli, Eds. "Advances in mixed method evaluation," New Directions for Evaluation, 1997, 74.
[17] Michael Bamberger, Jim Rugh, and Linda Mabry. Real World Evaluation (Thousand Oaks, CA: Sage Publications, 2006)
[18] Op. cit., U.S. Department of Education

Reviews of programs implemented were conducted and reported by some IPAs and provided to the LO in an effort to triangulate reviews of program implementation with other data.

Questionnaires, focus groups, interviews, and on-site observations were used to assess program implementation, primarily through participants' perceptions of program activities, and also to provide participants' self-assessments of program effects.

- Surveys were administered to participants online and in paper formats depending on each program site's ability to provide access to computers. All participants of the primary audiences for the program are invited to participate in these surveys, often through emails sent by the evaluation team, IPAs, or site coordinators. Questionnaires consisted of self-report items with likert-type scales as well as opened or constructed-response "qualitative" items.
- On-site focus groups are conducted with a strategic sample of sites and participants. Different sampling strategies were used, depending on the context of the program. Purposive sampling was used for assembling focus groups when large numbers of participants were available to join the focus group at a site. In this case, participants were selected to ensure equal representation of males and females and a range of age/grade levels, race/ethnicity, and STEM interests. Convenience sampling—all participants are invited to join the focus group without regard to diversity represented by the group—was employed when small numbers of participants were available at a site.
- Phone interviews were conducted to maximize participation for programs in which on-site visits are less cost-effective such as programs having many sites and with small numbers of participants at each site. Purposive sampling was used for identifying phone interview candidates to ensure diversity in geography (program sites), participant demographics, and STEM interests. When used, phone interviews were employed in addition to focus groups.
- Onsite observations were conducted whenever in-person focus groups were conducted. While observations were unstructured (i.e., not formal observation protocol), they included assessment of critical aspects of participant engagement in AEOP programming.

Data Collection and Analysis

Data collection occurred proximal to program activities. Questionnaires were released toward or after the conclusion of program activities and remained open for a period of 10–30 days. Focus groups (onsite and online) and phone interviews were conducted during program activities, but, when possible, toward the conclusion of program activities to maximize referent experiences.

Quantitative and qualitative data were compiled and analyzed after all data collection had concluded. Evaluators summarized quantitative data with descriptive statistics such as frequencies, means, and standard deviations. Where appropriate evaluators conducted inferential statistics to study any differences in participants' pre-post program outcomes, differences between participants' perceptions of program and school, and differences between different participant groups' perceptions or outcomes that could demonstrate the potential effect of their participation in an AEOP. Inferential statistics were used to identify statistically and practically significant differences. Statistical

significance indicates whether a result is likely due to programming rather than due to chance alone. Statistical significance is determined with t, Z, McNemar, ANOVA, or Tukey's tests, with significance defined at $p < 0.05$. Because statistical significance is sensitive to the number of respondents, practical significance, also known as effect size, is used to indicate the relative strength of each observed effect. Practical significance is determined with Cohen's *d* or Pearson's *r* greater than .250, which is considered weak but "substantively important".[19] Statistically and/or practically significant findings were noted in the reports and reported in appendices or footnotes. For brevity of this report, significant effects are often noted as such, with no additional details.

Evaluators analyzed qualitative data from constructed-response questionnaire items and focus group data for emergent themes. These data were summarized by theme and by frequency of participants addressing a theme. When possible, two raters analyzed each complete qualitative data set. When not possible, a portion of the data set was analyzed by both raters to determine and ensure inter-rater reliability. Thus, the summary of themes and frequency represent consensus ratings.

To the extent possible, findings were triangulated across data sources (students and mentors), data types (quantitative and qualitative), and evaluation personnel. Triangulation enhances the credibility of findings synthesized from single data sources or data types. For example, evaluators cite major trends from the qualitative data—emergent themes with high frequencies in respondents addressing them—to provide additional evidence of, explanation for, or illustrations of quantitative data. We have posed plausible explanations when divergence between data sources or data types is evident; any such explanations are worthy of further exploration in the full study and, potentially, in future evaluation efforts.

Reporting and Dissemination

Data, findings, and recommendations were presented to each program and the Army in a formal summary report. Full study reports were delivered to programs and the AEOP from March 2015 through May 2015. Individual Program Administrators (IPAs) were provided 7 days to provide critical review and a response (if desired) of their program evaluation. Any responses provided were attached as an appendix to the final report submitted to the Army. Revised reports were provided to IPAs for a second round review. The Army CAMs also participated in two rounds of report revisions. Full reports will be made available on a public page of the AEOP website.

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

Appendix B: 2015 College Qualified Leaders (CQL) Evaluation Executive Summary

The College Qualified Leaders (CQL) program, managed by the American Society for Engineering Education (ASEE) in 2015, is an Army Educational Outreach Program (AEOP) that matches talented college students and recent graduates (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentice training that is unparalleled at most colleges. CQL allows alumni from Gains in the Education of Mathematics and Science (GEMS) and Science and Research Apprentice Program (SEAP) to continue their relationship with the mentor and/or laboratory, and also allows new college students to enter the program. CQL offers apprentices the provision of summer, partial year, or year-round research at the Army laboratory, depending on class schedules and school location. CQL apprentices receive firsthand research experience and exposure to Army research laboratories. CQL fosters desire in its participants to pursue further training and careers in STEM while specifically highlighting and encouraging careers in Army research.

This report documents the evaluation of the FY15 CQL program. Virginia Tech, in collaboration with ASEE, collected the FY2015 evaluation data for the CQL program. Purdue University, the new evaluation lead, prepared the FY 2015 evaluation reports, which addressed questions related to program strengths and challenges, benefits to participants, and CQL's overall effectiveness in meeting AEOP and program objectives. The assessment strategy for CQL included surveys for students and mentors, eight interviews with apprentices, and an annual program report compiled by ASEE.

2015 CQL sites included the US Army Research Laboratory – Aberdeen Proving Ground (ARL-APG), the US Army Research Laboratory – Adelphi (ARL-A), the Walter Reed Army Institute of Research (WRAIR), the US Army Medical Research Institute for Infectious Diseases (USAMRIID), the US Army Aviation & Missile Research Development and Engineering Center – Redstone Arsenal (AMRDEC), the Engineering Research and Development Center Construction Engineering Research Laboratory (ERDC-CERL), the US Army Medical Research Institute of Chemical Defense (USAMRICD), the US Army Center for Environmental Health Research (USACEHR), the Defense Forensic Science Center (DFSC), the U.S. Army Engineer Research & Development Center – Geospatial Research Laboratory (ERDC-GRL), and the Engineering Research and Development Center in Vicksburg, MS (ERDC-MS).

2015 CQL Fast Facts	
Description	STEM Apprenticeship Program – Summer or school year, at Army laboratories with Army S&E mentors
Participant Population	College undergraduate and graduate students
Number of Applicants	507
Number of Students (Apprentices)	394
Placement Rate	78%
Number of Mentors (Army S&Es and other adult mentors)	369
Number of Army Research Laboratories	11

Number of Colleges/Universities	120
Number of HBCU/MSIs	12
Total Cost	$4,212,439
Stipend Cost	$4,159,634
Cost Per Student Participant	$10,691

It should be noted that the CQL program requires a one-to-one mentor to apprentice ratio. In FY15, as in FY14, the number of apprentices exceeded the number of mentors, indicating that this requirement was not met.

Summary of Findings

The FY15 evaluation of CQL collected data about participants; their 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.

2015 CQL Evaluation Findings	
Participant Profiles	
CQL had some success at serving students of historically underrepresented and underserved populations.	The number of females participating in CQL increased substantially in FY15. Enrollment data indicate that 40% of all participants were female in FY15, an increase of 15% from FY14 (only 25% female enrollment). Although females continued to participate at a lower rate than males (in FY15 60% of participants were males, 40% were females), this increase in the participation of female students—a population that is historically underrepresented in engineering fields – is a significant gain.
	CQL continued to serve students from historically underrepresented and underserved race/ethnicity groups, however the majority of enrolled apprentices identified themselves as "White" or "Asian." An area of growth for CQL was in the number of apprentices identifying themselves as Black or African American, which tripled from FY14 (9 in 2014 or 6% versus 27 in 2015 or 10%). CQL participants represented a total of 12 historically Black colleges and universities (HBCUs) and other minority serving institutions (MSIs), an increase of 14% over FY14. Conversely, participation of Hispanic or Latino students decreased in FY15, with 3% of apprentices identifying themselves as Hispanic or Latino in FY15 versus 9% in FY14. In sum, only 13% of enrolled participants identified themselves as being from an underrepresented or underserved minority groups, indicating that work remains to be done in devising strategies to recruit apprentices from these groups.

CQL made limited progress in recruiting past AEOP program participants.	Questionnaire data indicate that few responding apprentices had participated in other AEOP programs previously (93% to 98%). About 84% of apprentices noted participation in CQL at least once (although it's not clear whether the one time was including or in addition to current participation), and about 30% had participated more than once. While 32% of students had participated in SEAP at least once, only 13% had participated in GEMS in the past, representing a decline as compared to alumni participation in FY14 when 37% of participants were alumni of SEAP and 18% were alumni of GEMS.
CQL succeeded in reaching and exceeding its targeted number of program applicants.	There were 695 total applicants for CQL in FY15, a 12% increase from FY14. The applicant pool exceeded the target set in FY14 for 650 applicants in 2015, indicating that outreach efforts to grow number or applicants were successful. Likewise, there was an increase of 12% in enrolled participants in FY15 as compared to FY14. In CQL, student participation is dependent upon the number of available mentors. Therefore, the expansion in program participation is also attributable to the corresponding 12% increase in the number of mentor participants from FY14 to FY15. Even with this growth in the number of mentors, however, CQL fell short of meeting its required one-to-one mentor to apprentice ratio (there were 369 mentors and 394 apprentices in FY15, resulting in a mentor to apprentice ratio of .94:1).
Actionable Program Evaluation	
Pre-existing relationships continue to be a key factor in CQL recruitment.	Mentor questionnaire respondents indicated students were most commonly recruited through colleagues, personal acquaintances, university faculty, and contact from the student.
	Apprentice questionnaire respondents indicated that they most commonly learned about CQL from someone who works at an Army laboratory, teachers or professors, immediate family members, university resources, friends, mentors, or past CQL participants. In addition, apprentice interview data support the notion that pre-existing relationships are instrumental in growing awareness of CQL.
CQL apprentices were motivated to participate in CQL by a variety of factors.	Apprentices were motivated to participate in CQL by a wide variety of factors, reporting that the strongest motivators were interest in STEM, the desire to expand laboratory and research skills, and the opportunity to learn something new and interesting. Other highly motivating factors included the opportunity to use advanced laboratory technology, figuring out education or career goals, and interest in Stem careers with the Army. Interview data also suggested that apprentices were motivated by the opportunity to gain job and research experience.
CQL engaged apprentices in meaningful STEM learning.	Most apprentices (55-88%) reported learning about STEM topics, applications of STEM to real-life situations, STEM careers, and new discoveries in STEM on most days or every day of their CQL experience.
	Frequent opportunities to engage in a variety of STEM practices were provided to apprentices on most days or every day during their CQL experience. For example, 83% reported participating in hands-on STEM activities; 71% practicing using laboratory procedures, and tools; 71% working as part of a team; 72% carrying out an investigation; and 75% analyzing and interpreting data or information.
	CQL provided more frequent opportunities for apprentices to learn about STEM and be engaged in STEM practices than reported experiences within their typical school settings.

	Mentors reported using a wide variety of strategies to help make learning activities relevant to apprentices, support the needs of diverse learners, develop apprentices' collaboration and interpersonal skills, and engage apprentices in authentic STEM activities.
CQL promotes apprentice awareness of DoD STEM research and careers.	Nearly all CQL participants reported learning about at least one STEM career, and 44% reported learning about 4 or more. Similarly, 100% of students reported learning about at least one DoD STEM job, with 60% reporting they learned about 3 or more, an increase over FY14 results. Apprentices reported that mentors and the CQL experience contributed the most to this impact.
Apprentices' awareness of other AEOP scholarship programs increased, but CQL can improve mentor and apprentice awareness of and marketing of other AEOP opportunities.	Most mentor questionnaire respondents reported that participation in CQL or the CQL program administrator or site coordinator were the most useful resources for students to learn about AEOP initiatives. However, mentors overall reported limited awareness of AEOP initiatives. The majority of responding mentors (57%-81%) reported no exposure or experience with AEOP informational resources including the AEOP website, the It Starts Here! Magazine, the AEOP brochure, and AEOP social media. In spite of this, a large majority of responding mentors (95%) reported discussing URAP with apprentices, while 54% discussed NDSEG and 27% discussed SMART. The number of apprentice respondents who had heard of SMART and NSDEG (74% and 61% respectively) increased over FY14 levels and surpassed FY15 goals. Additionally, 49% of apprentices reported having heard of URAP.
The CQL experience is valued by apprentices and mentors, although program administration continues to be an area for improvement.	A large majority of responding apprentices reported satisfaction with their mentors and experiences during the CQL program. For example, over 90% of responding apprentices reported being at least "somewhat" satisfied with their mentor, the time they spent with their mentor, and the research experience overall.
	Both apprentices and mentors were asked about their overall satisfaction with the CQL program in an open-ended item on the questionnaire. Almost all respondents had positive perceptions of the program. However 28% of apprentices described some level of dissatisfaction with administrative aspects of the program. In particular, apprentices noted difficulties in communicating with program administrators, problems receiving stipend payments, and delays in getting security clearance and computer access. When asked how the program could be improved, 65% of apprentice respondents cited that improvements could be made in administrative tasks such as stipend payments, communication, security clearance, and computer access.
Outcomes Evaluation	
CQL apprentices reported gains in their STEM knowledge and competencies.	Apprentices reported substantial gains in their STEM knowledge. A majority of respondents reported large or extreme gains in their knowledge of what everyday research work is like in STEM, how professionals work on real problems in STEM, research conducted in a STEM topic or field, in-depth knowledge of a STEM topic, and the research processes, ethics, and rules for conduct in STEM.
	Apprentices also reported gains in their STEM competencies, including the following: carrying out procedures for an investigation and recording data accurately; supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge; identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts; carrying out procedures for an experiment and recording data

	accurately, supporting an explanation with relevant scientific, mathematical and/or engineering knowledge; asking a question that can be answered with scientific experiments; considering different interpretations of data; integrating information from technical or scientific texts and other media to support explanations of an observation; communicating about experiments in different ways; and identifying the strengths and limitations of explanations in terms of how well they describe or predict observations.
CQL participants reported gains in apprentices' 21st Century Skills.	A clear majority of apprentices reported large or extreme gains in several critical workplace skills including the ability to make changes when things do not go as planned, learning to work independently, communicating effectively with others, sticking with a task until it is complete, and viewing failure as an opportunity to learn.
CQL participants reported increased confidence and identity in STEM.	Apprentices reported gains in their confidence and STEM identity, including large or extreme gains in feeling prepared for more challenging STEM activities, having a sense of accomplishing something in STEM, having confidence to try out new ideas or procedures, and having a desire to build relationships with mentors in STEM fields.
CQL participants reported increased interest in future STEM engagement.	Apprentices also reported that that they were more likely to engage in additional STEM activities outside of school after participating in CQL. A majority of apprentices indicated that they were more likely to work on a STEM project or experiment in a university or professional setting, talk with friends or family about STEM, mentor or teach other students about STEM, work on a STEM project or experiment in a university or professional setting, and use a computer to design or program something.
CQL influenced apprentices' education aspirations, but did not change their career aspirations.	Apprentices were asked about their education aspirations both before and after their participation in CQL. After CQL, apprentices indicated being more likely to go further in their schooling than they would have before, with the greatest change being in the proportions of apprentices who wanted to get a Ph.D. (28% before CQL, 38% after) and who wanted to get a medical related degree (27% before CQL, 36% after).
	Apprentices were asked to indicate what kind of work they expected to be doing at age 30 both before and after their participation in CQL. Although the vast majority of apprentices indicated interest in a STEM-related career, there was not distinct shift in career aspirations from before CQL to after.
CQL participants reported limited awareness of AEOP initiatives, but apprentices indicated interest in future AEOP opportunities.	Apprentices and mentors reported limited awareness of other AEOP initiatives with the exception of scholarship programs such as SMART and NDSEG. A large majority of apprentices (80%) were at least somewhat interested in participating in CQL in the future. More than half of apprentice respondents (52%) reported being at least somewhat interested in participating in SMART in the future while 47% indicated being at least somewhat interested in NDSEG, and 25% indicated being at least somewhat interested in URAP. Apprentices reported that their CQL participation and their mentors had the most impact on their awareness of AEOPs.
CQL apprentices have positive opinions about DoD researchers and research.	Apprentice perceptions of DoD researchers and research was overwhelmingly positive. A large majority of apprentices reported that they agreed or strongly agreed that DoD researchers solve real-world problems (93%), DoD researchers advance science and engineering fields (98%), DoD research is valuable to society (93%), and DoD researchers develop new, cutting edge technologies (95%).

Recommendations

Evaluation findings indicate that FY15 was a successful year overall for the CQL program. Most notably, the program experienced a 12% growth in both apprentice and mentor participation, surpassing the goal set in 2014. In addition, the number of apprentices identifying themselves as Black/African American tripled from FY14 to FY15, a significant step toward achieving the AEOP goal of expanding participation among underrepresented groups. The increase in participation of females from 25% to 40% from FY14 to FY15 is also a notable achievement. Efforts to inform students about other AEOPs appear to be improving as well, as the number of participants who had heard of SMART and NSDEG increased to 74% and 61% in FY15 (up from 64% and 54% in FY14). Apprentices and mentors alike continue to report high levels of satisfaction with the program and mentor-apprentice relationships, and both groups report strong apprentice gains in STEM competencies and knowledge as a result of the CQL experience.

While these successes 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. In spite of the increase in the number of CQL participants from underrepresented groups, work remains to be done in achieving the CQL program goal of broadening the talent pool in STEM fields. It is noteworthy that in 2015, 27 participants, or 10%, identified themselves as Black or African American, representing a substantial increase from the 9 participants (6%) in 2014. The program may want to build upon this success by expanding successful strategies such as outreach to HBCUs/MSIs and implementing other new methods to actively recruit students nationwide. Although there was an increase in the number of female CQL participants in 2015, females continue to participate at lower rates than males, and targeting outreach efforts to women's colleges and groups such as Association for Women in Science (AWIS) and Society of Women Engineers (SWE) may increase the participation of females. Since some students noted that their late notice of acceptance created difficulties in securing housing, and several indicated that assistance in locating housing would be beneficial in facilitating the participation of geographically diverse apprentices, the program may wish to consider whether some support in locating housing can be incorporated into the application and acceptance process in order to attract a broader demographic pool of students. Additionally, by more actively recruiting beyond communities with an Army site, the program is likely to receive more applications, including more from groups that are historically underrepresented and underserved in STEM fields.

2. In addition, the program may want to consider how students are recruited and subsequently selected to serve as apprentices since personal relationships continue to play a key role in how students are recruited into CQL. The IPA may wish to revise recruitment and selection practices by, for example, masking applicants' names during application reviews, establishing a selection panel, and instituting other measures to ensure that applicants are selected on the basis of their qualifications and aptitudes rather than on the basis of their connections to research laboratories/personnel.

3. In order to continue to work toward the AEOP goal of broadening the STEM talent pool, the program should continue its work in phasing out the practice of granting apprenticeships to graduate students. Since these individuals already hold a STEM degree, they are existing members of the STEM talent pool and their participation in CQL does not promote the goal of broadening this pool.

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

1. While efforts to recruit mentors were met with success as indicated by the 12% increase in mentor participation from 2014 to 2015, apprentice participation continues to be limited by the number of available mentors. It is notable that even with the increase in mentor participation, CQL failed to meet its program requirement of a one-to-one mentor to apprentice ratio. In order to broaden participation and provide more opportunities to qualified candidates, mentor participation must continue to grow, and the program should ensure that the one-to-one mentor to apprentice ratio is met in order to ensure that each apprentice receives the high quality mentoring the program strives to provide. In order to grow and retain the pool of mentors, the program may want to consider what incentives it can provide for mentor participation. Such incentives could include highlighting the potential benefits of apprentice involvement in mentors' projects, publicizing the work of apprentice-mentor teams, publicizing the professional accomplishments of former CQL apprentices, and recognizing mentors who exemplify outstanding mentorship practices. Questionnaire responses indicated that mentors would welcome more support, both in terms of support and instruction in mentorship and by receiving targeted feedback from apprentice questionnaires. As a result, it may be productive to consider what supports can be put in place to help mentors efficiently and effectively utilize their apprentices and to assist them in fostering their mentoring skills. For example, mentors may benefit from ideas for ways in which apprentices can productively contribute to ongoing research. In addition, potential mentors should be made aware of these supports as an added incentive to participate in CQL.

2. In order to create a robust pipeline of AEOP programs in which students progress from other AEOP programs into CQL and beyond, the program may want to consider innovative ways to work with other AEOP programs to create a more seamless continuum of programs. Apprentice questionnaire data indicate that most apprentices had not participated in other AEOPs and, in fact, the proportion of CQL participants who were alumni of GEMS and SEAP declined from FY14 to FY15. In addition, CQL mentors and apprentices reported only limited knowledge of AEOP programs other than CQL. Apprentice responses indicating the importance of mentors in learning about other AEOPs attest to the importance of mentors in conveying information to apprentices and efforts should be made to ensure that mentors are informed about the range of AEOPs. Because of the time constraints these mentors face in working with apprentices, however, the program should also consider ways to educate apprentices about AEOP opportunities that do not rely on mentors. For instance, information about AEOPs could be incorporated into orientation materials, provided during the student symposium, and incorporated into alumni communications. Given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with targeted program information.

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

1. Administrative difficulties were noted in both FY14 and FY15 and, while students were positive overall about their CQL experiences, problems with receiving stipends in a timely fashion, lack of computer access, and security clearance issues colored the experience of over a quarter of all apprentices. There is evidence that these issues, particularly the late stipend payments, could impact program goals negatively as some students indicated that these problems served as a disincentive to future participation in CQL. Likewise, some mentors reported expending considerable time in assisting students with remedying pay issues. As the Academy of Applied Science assumes the administration of CQL, it should be mindful of these issues and leverage its past experience with administering apprenticeship programs to streamline processes and improve communication with apprentices. Some mentors also suggested measures to streamline the recruiting and selection process. These suggestions focused on automating the selection process and reducing the amount of paperwork involved. Other suggestions included beginning the security clearance and computer access processes earlier so that these are complete before the start of the apprenticeship.

2. The continued low response rates for both the student and mentor questionnaires (32% and 10% in FY15) raise questions about the representativeness of the results. The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities. In addition, the evaluation instruments may need to be streamlined to reduce the time commitment of respondents.

Appendix C: 2015 eCYBERMISSION (eCM) Evaluation Executive Summary

The FY15 evaluation of eCYBERMISSION (ECM) was conducted by David Heil and Associates, Inc. Beginning in FY16 the eCM evaluation will be conducted by Purdue University and will be aligned with the other programs in the AEOP portfolio.

eCM is sponsored by the U.S. Army, and managed by the National Science Teachers Association (NSTA). Since the program's inception in 2002, more than 100,000 students from across the United States, U.S. territories, and Department of Defense Educational Activities (DoDEA) schools worldwide have participated in eCM. The program is a web-based science, technology, engineering, and mathematics (STEM) competition designed to engage sixth- to ninth-grade students in real-world, problem-solving Mission Challenges that address local community needs through the use of either scientific practices or the engineering design process. eCM teams work collaboratively to research and implement their projects, which are documented and judged via the submission of Mission Folders hosted on the eCM website.

This report, prepared by the National Science Teachers Association, documents the administration of 2015 eCM. The intent is to provide key data points from 2015 eCM as well as a contextualized understanding of administrative decisions and program achievements. This material will be used in future program planning and incorporated into the 2015 eCM evaluation report.

In 2015, eCM provided outreach to 27,955 students who registered for the eCM competition. The number of registered eCM students in 2015 represents an 5.8% decrease over the 29,682 student registrants in 2014. Of the students who registered for the 2015 competition, 4,280 Mission Folders were completed and submitted. This signifies a 3% decrease over the 4,412 Mission Folders that were submitted in 2014.

2015 eCYBERMISSION Fast Facts	
Description	STEM Competition – Nationwide (including DoDEA schools), web-based, including one national event
Participant Population	6th-9th grade students
Number of Applicants/Students	27,955 registered and 4,280 completed mission folders (of whom 22 teams including 78 sutdents were selected to attend the National Judging and Educational Event, NJ&EE)
Placement Rate	N/A (all students who register are participants)
Submission Completion Rate	63.3%
Number of Adults (Team Advisors and Volunteers – incl. S&Es and Teachers)	4,350
Number of Team Advisors (Predominantly math and science teachers)	1,749
Number Volunteers (Ambassadors, Cyberguides, Virtual Judges)	2,601

Number of Army S&Es	549
Number of Army/DoD Research Laboratories	38
Number of K-12 Teachers (incl. pre-service)	2,298
Number of K-12 Schools	1,337
Number of K-12 Schools – Title I	709
Number of Colleges/Universities	71
Number of DoDEA Students	694
Number of DoDEA Teachers	48
Number of Other Collaborating Organizations	53
Total Cost	$3,053,788
Mini-grant Costs	$191,901
Scholarships/Awards Cost	$568,944.85
STEM Research Kits Cost	$135,769.90
Cost of National Event (NJ&EE)	$277,238.14
Administrative Cost to NSTA	$1,879,933.50
Cost Per Student Participant	$109.24

Summary of Findings

The FY15 evaluation of eCM collected data about participants; their 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.

Table 3. FY15 eCM Annual Program Plan – Objectives and Accomplishments

I. Increase number of student and teacher registrants and submissions. *(Supports Priority 1, Objectives a, b, c, e, & f; Priority 2, Objective a; and Priority 3, Objective b.)*

- Leverage existing partnership within NSTA and AEOP CA for program promotion.
- Targeted outreach to highly populated areas.
- Establish partnerships with academia, local, and state educational agencies, and other federal agencies.

FY15 Target:

- 30,000 students and 1,900 Team Advisors registered
- 5,500 team submissions

5 Year Target:

- 35,000 students and 2,000 Team Advisors registered
- 7,000 team submissions

FY15 Results:

- 27,955 students registered
- 1,749 Team Advisors registered
- 4,280 team submissions

Activities to Achieve Objective:

- Targeted outreach that included selecting specific conferences and district outreach (district outreach for grades 6–9 in areas that have had low participation or high poverty levels/Title I schools, exhibited and presented at conferences for STEM educators and administrators)
- Targeted telemarketing campaign in the fall
- Awarded "mini-grants" to individual teachers, schools, and districts to encourage implementation of eCYBERMISSION into classrooms
- Established a partnership with SECME, Inc. to include eCYBERMISSION as one of its national-level competitions
- Established monthly newsletters to help Team Advisors on how to submit Mission Folders

II. Increase participation of students (%) from Title I schools. *(Supports Priority 1, Objectives a, b & c and Priority 3, Objective b.)*

- Targeted outreach to Title I schools.

FY15 Target: 55% of schools are Title I

5 Year Target: 60% of schools are Title I

FY15 Results: 709 schools were identified as Title I: 63.4% of Public schools are Title I; 53.7 % of **all** (includes private, DoDEA, home, and public) schools are Title I

Activities to Achieve Objective: Outreach to targeted schools, mini-grant priority was to Title I schools.

III. Increase number of volunteers / Army volunteers. *(Supports Priority 2, Objective d.)*

- Establish partnerships with Army organizations, academia and/or federal agencies to register volunteers.
- Enhance volunteer training.
- Provide a platform for volunteers to share best practices and communicate success stories.

FY15 Target: 2,800 volunteers registered

Table 3. FY15 eCM Annual Program Plan – Objectives and Accomplishments (cont'd)

5 Year Target: 3,000 volunteers registered

FY15 Results: 2,601 volunteers registered

Activities to Achieve Objective: Roadshows, telemarketing campaign, and advertisements geared to target audiences.

IV. Team Advisor retention. *(Supports Priority 2, Objectives a, b, & c and Priority 3, Objective c.)*

- Target retention campaign to maintain 50% or above annual retention of Team Advisors.

FY15 Target: 50%

5 Year Target: 75%

FY15 Results: 23.9% retained from FY14

Activities to Achieve Objective: Priority was given to mini-grant participants who participated in the previous year to receive the grant a second year. Telemarketing campaign and emails to Team Advisors who had not registered prior to the pre-registration deadline that competed in FY14.

V. Increase number of classroom-integrated programs. *(Supports Priority 1, Objectives a, b, & c; Priority 2, Objectives a, b, & c; and Priority 3, Objective b.)*

- Provide teacher and school mini-grants.
- Pilot virtual, live interactions between Army scientists and engineers with eCM classrooms.

FY14 Results: 7 teachers, 4 schools, and 4 district mini-grants

FY15 Target: 30 total mini-grants
5 Year Target: 60 total mini-grants
FY15 Results: A total of 203 Team Advisors received grants in FY15. These were broken into the following categories: Level 1 grants (individual grants give to Team Advisors registering between 50 and 499 students) were given to 151 Team Advisors. Level 2 grants (grants given to districts and schools registering between 500 and 2,000 students) were given to 52 Team Advisors.
Activities to Achieve Objective: Face-to-face meetings with teachers at conferences or district visits. Collecting names at conferences who would be interested in receiving grant information.

Recommendations

1. Increase awareness and interest in AEOPs by targeting Team Advisors. Students identified Team Advisors, who had only a nominal awareness, as an important source of information regarding STEM and other AEOP opportunities. eCM personnel should, therefore, focus their efforts to disseminate and advertise other AEOPs to the Team Advisors. Program correspondence should announce or invite Team Advisors to promote AEOPs or share information regarding how lessons learned through eCM could be expounded upon or scaffold with other AEOP opportunities. The eCM website should additionally have a page dedicated to "Additional STEM Opportunities" that is prominently displayed in the website's tab menu.

2. Provide students and Team Advisors a brief introductory video that highlights the location and purpose of online eCM resources. Both student and focus group participants reported only limited awareness of the variety of resources provided by the eCM website, which the eCM project team should address by developing a brief (three to five minute) eCM introductory video.

3. Enhance program communications by posting blog updates more regularly and further prioritizing Mission Control and CyberGuides' timely feedback to teams. A common theme identified within the Team Advisors' feedback was program communication. As a means of further supporting the Team Advisors and students throughout the competition, the eCM team should commit more time to regularly updating the blogs with relevant information, tips, additional tutorials regarding the website, information about other AEOPs, and other eCM-related content. By posting blogs more frequently, eCM will engage the Team Advisors and students, provide useful direction and information, and increase project success and program satisfaction. eCM should also improve communications between program personnel and students by further emphasizing Mission Control and CyberGuides' timely response to teams' inquiries.

4. Address Team Advisors' frustration with eCM judging by providing more feedback regarding the rational of Mission Folders' final scores and encouraging their review as a team activity. While Team Advisors valued the judging rubrics, numerous Team Advisors commented on the lack of clarity and limited feedback during the judging process, which often caused frustration. eCM should improve the judging process and further encourage students' academic

development, confidence, and understanding of the iterative nature of scientific practices and the engineering design process by providing clearer explanations of final Mission Folder scores and the strengths and weakness of each project.

5. Introduce more examples of military research and researchers into program examples, communications, and website highlights. eCM should use the breadth of military STEM research and researchers to generate cadres of regional STEM role models that demonstrate the diversity and social impact of military research. By showcasing the ethnic and regional diversity of military research personnel in project examples, in inspirational videos housed on the eCM website, or in program communications, the eCM team would increase students' awareness of individuals with similar ethnic, socioeconomic, and regional backgrounds who have succeeded and contributed to society via participation in military research.

6. Enhance the NJ&EE experience by further supporting students' preparation for NJ&EE through earlier and more frequent communications, in addition to ensuring the events' overall organization by adhering more closely to the NJ&EE schedule. Communication and organization were both themes that frequently appeared within the focus group and NJ&EE survey data. This finding indicates that the eCM team needs to invest more time in finalizing the event's schedule and preparing students and Team Advisors for NJ&EE.

7. Enhance the NJ&EE experience by increasing the team's understanding of the exact schedule and activities of the Washington, D.C., excursion day, in addition to providing interested teams the opportunity to spend more time exploring the Capitol at their discretion, liability, and cost. The schedule of the day spent in Washington, D.C., should be presented in more detail to students and Team Advisors, and preferably before their attendance at the NJ&EE.

Appendix D: 2015 Gains in the Education of Mathematics & Science (GEMS) Evaluation Executive Summary

GEMS, administered by the American Society for Engineering Education (ASEE), is a non-residential summer STEM enrichment program for elementary, middle, and high school students hosted at Army laboratories on site or in close coordination off site with the area Army laboratories. The overarching mission that drives the GEMS program is to interest youth in STEM through a hands-on Army laboratory experience that utilizes inquiry-based learning and Near Peer mentoring. Although they operate under a shared mission, GEMS sites are free to include different topics in their curricula that highlight the mission of the laboratory and may set, in addition to the overall program goals, individual laboratory goals. Instead of having a specific model and curriculum forced on individual sites, they are able to design curricula (using the hands-on, experiment-based model) and procedures that make sense considering the specialties of their facility and available resources. GEMS programs run from one to four weeks in length.

In 2015, GEMS provided outreach to 2,270 students and 94 Near-Peer Mentors at 11 different sites. The number of GEMS students in 2015 represents an 8% increase in enrollment over the 2,095 student participants in 2014. Consistent with historical data, many of the GEMS sites received applications from more qualified students than they could serve.

This report documents the evaluation of the FY15 GEMS program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for GEMS included questionnaires for students and mentors, 4 focus groups with students and 3 with mentors, and an annual program report compiled by ASEE.

2015 GEMS Fast Facts	
Description	STEM Enrichment Activity - at Army laboratories, hands-on
Participant Population	5th-12th grade students (secondary audience: college undergraduate Near-Peer Mentors, teachers)
Number of Applicants	4161
Number of Students	2270
Placement Rate	54.55%
Number of Adults (incl. NPM, RT, S&Es)	464
Number of Near-Peer Mentors (NPM)	94
Number of Resource Teachers (RT)	51
Number of Army S&Es	272
Number of Army Research Laboratories†	11
Number of K-12 Teachers	42
Number of K-12 Schools	894
Number of K-12 Schools – Title I	184
Number of Colleges/Universities	40
Number of HBCU/MSIs	4

Number of DoDEA Students	N/A
Number of DoDEA Teachers	9
Total Cost	$812,395.17
Stipend Cost	$679,461.27
Supplies & Equipment (GEMS sites)	$0
Administrative Cost to ASEE	$132,933.90
Cost Per Student Participant	$357.88

[†] *The United States Army Medical Research Institute of Chemical Defense (USAMRICD) collaborates with the US Army Research Laboratory (ARL-APG) to host GEMS at Aberdeen Proving Grounds*

Summary of Findings

The FY15 evaluation of GEMS collected data about participants; their 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.

2015 GEMS Evaluation Findings	
Participant Profiles	
GEMS served students from populations historically underrepresented in STEM, although there is room for growth in this area.	In FY15, 45% of enrolled participants were female, indicating that GEMS successfully attracted participation from female students a population historically underrepresented in engineering fields; this participation rate is comparable to the FY14 female participation rate of 44%. While this rate of female participation is higher than in some other AEOPs (for example JSS, with FY15 female participation of 27%), it still falls short of the approximately 50% rate that would mirror the overall female population.
	Students from historically underrepresented and underserved minority race/ethnicity and low-income groups participated in GEMS. In FY15, 22% of participating students identified themselves as Black or African American, a rate identical to this group's participation in FY14. Participation for students identifying themselves as Hispanic or Latino was 9%, a small increase from the 7% of students identifying with this group in FY14. A small proportion (11% in FY15 versus 12% in FY14) of students continued to report qualifying for free or reduced-price lunch (FRL) – a common indicator of low-income status.
	GEMS served students across a range of school contexts, although no enrolled students identified themselves as attending urban schools, and 81% of participants identified their school setting as suburban.
GEMS attracted more applicants and served more students in FY15 as compared	GEMS met and exceeded its FY15 target of receiving 3750 applications (4,161 applications were received in FY15, an increase of 20% over the number of applications in FY14), providing some evidence that the program met its goal of disseminating information about GEMS to a diverse audience. Furthermore, 8% more

to FY14.	students were enrolled in FY15 than in FY14.
GEMS increased the number of near-peer mentors in the program but did not attract more resource teachers.	GEMS served the increased population of students with a slight increase in the number of near-peer mentors (NPMs) in the program, although the program failed to meet its FY15 target of 95 NPMs and 55 RTs. In FY15, 94 NPMs participated in GEMS, a 3% increase over FY14 when 92 NPMs participated. The number of RTs remained at 51 for FY15.
Actionable Program Evaluation	
GEMS marketed the program in a number of ways, but there is little evidence of specific outreach efforts to schools and organizations serving groups historically under-represented in STEM.	While ASEE and GEMS sites employed multiple strategies to disseminate information about the GEMS program, there is little evidence of efforts to reach specific groups such as females and other demographic groups historically under-represented in STEM. Outreach efforts included attending the following events: National Summer Learning Conference, 2015 ASEE Annual Conference, and Thomas Jefferson Science and Tech High School. Email blasts were sent to over 4,000 teachers, guidance counselors, and principals in areas near participating GEMS labs, and promotional materials were mailed to teachers upon request.
	Students most frequently learned about the GEMS through personal connections including past participants (28%), family members (27%) and friends (27%). In spite of this, only 3% of students indicated that such personal connections (recommendations from past participants) motivated them to participate once they had learned about the program.
GEMS students reported being motivated to participate by the learning opportunities and fun provided by the program.	Students were most frequently very motivated to participate in GEMS by their interest in STEM (76%), a desire to learn something new and interesting (62%), learning in ways that are not possible in school (30%), and having fun (28%).
GEMS students reported engaging in meaningful STEM learning through team-based and hands-on activities.	Students reported engaging in a number of STEM activities on most days or every day of their GEMS experience. Between 75% and 88% of students reported learning about STEM topics, careers, cutting-edge research, and applications of STEM to real-life situations, communicating with other students about STEM, and interacting with STEM professionals on most days or every day of their GEMS experience.
	Students reported engaging in a variety of STEM practices during their GEMS experience. For example, 94% reported working as part of a team, 92% participating in hands-on activities, and 82% using laboratory procedures and tools on most days or every day.
	Students reported that they had more opportunities to learn about STEM and engage in STEM practices in their GEMS experience than they typically have in school.

	Mentors reported using strategies to help make learning activities relevant to students, support the needs of diverse learners, develop students' collaboration and interpersonal skills, and engage students in "authentic" STEM activities.
GEMS informed students about STEM careers in general and, to a lesser extent, about DoD STEM careers specifically.	Nearly all students (98%) reported learning about 1 or more STEM careers during GEMS with 87% reported learning about 3 or more STEM careers. In contrast, 87% of students reported learning about 1 or more DoD STEM career and 62% reported learning about 3 or more. This is a slight increase from FY14 when 84% had heard about at least 1 DoD STEM career and 61% reported hearing about 3 or more of these careers.
	Most responding mentors (86%) reported asking students about their educational and career interests and 90% reported providing guidance about educational pathways that will prepare students for a STEM career. A lesser number, 63%, specifically discussed STEM career opportunities within the DoD or other government agencies.
	Other than simply participating in GEMS, students found their GEMS mentors and invited speakers or career events during GEMS to be the resources most impactful on their awareness of DoD STEM careers. Most students (37%-94%) had not experienced AEOP resources such as the website, brochure, social media, and It Starts Here! magazine.
GEMS has an opportunity to improve student and mentor awareness of other AEOPs.	Mentors reported discussing AEOPs with students although almost half (48%) indicated that they did not discuss specific AEOP initiatives. Besides GEMS and the GEMS Near Peer Mentor program, the most commonly discussed programs were SEAP (66%) and CQL (66%). Fewer than a quarter of mentors discussed any other AEOPs with students, and only 10% discussed UNITE and JSHS, programs for which students are eligible in high school.
	Mentors reported that the most useful resources for exposing students to AEOP were participation in GEMS, program administrators or site coordinators, and invited speakers or career events. A large proportion of mentors had no experience with AEOP on social media (76%) and the It Starts Here! Magazine (91%) although 60% were familiar with the AEOP brochure and 40% found it at least somewhat useful for exposing students to other AEOPs.
Students and mentors value the GEMS experience.	Most students indicated being somewhat or very much satisfied with GEMS program features including the stipend, mentorship, and availability of program topics. Students also offered positive comments about their overall satisfaction with the program, most often describing their learning in GEMS, the personal connections they made with mentors and peers, and having fun.
	Mentors also reported being satisfied with most program features, including stipends, program location, support for instruction and mentorship, and invited speakers and career events.

Outcomes Evaluation	
GEMS students reported positive impacts on their STEM knowledge and competencies.	The vast majority of students reported at least some gains in their STEM knowledge as a result of participating in GEMS. These gains were reported in areas such as knowledge of how scientists and engineers work on real problems in STEM, knowledge of what everyday research work is like in STEM, and in depth knowledge of a STEM topic. These impacts were identified for both males and females and across all races/ethnicities.
	Students also reported impacts on their abilities in a number of STEM practices, including carrying out procedures for an investigation and recording data accurately, communicating about experiments and explanations in different ways, and using knowledge and creativity to propose a testable solution for a problem.
GEMS participants reported gains in students' 21st Century Skills.	Nearly all students reported some level of gains in their 21st Century Skills. For instance, 97% reported gains in their ability to work well with students of all backgrounds, make changes when things do not go as planned, and communicate effectively with others. Likewise, 97% of students reported gains in including others' perspectives when making decisions, and 94% gained in viewing failure as an opportunity to learn.
GEMS participants reported gains in their confidence and identity in STEM, and in their interest in engaging in STEM in the future.	The majority of students (89-96%) reported some gain in areas related to their STEM identity, defined as confidence in one's ability to succeed in STEM. Over half of students reported large or extreme gains in their sense of accomplishing something in STEM (69%), their desire to build relationships with mentors who work in STEM (63%), feeling prepared for more challenging STEM activities (71%), thinking creatively about a STEM project or activity (70%), connecting STEM topics to or fields to their personal values (59%), interest in a new STEM topic (63%), and deciding on a path to pursue a STEM career (51%).
	Students also reported gains in the likelihood that they would engage in STEM activities in the future, both in and outside of school. For example, most students indicated that, as a result of GEMS, they were more likely to participate in a STEM camp, club, or competition, work on a STEM project or experiment in a university or professional setting, tinker with a mechanical or electrical device, and take an elective STEM class.

Students reported higher education aspirations after participating in GEMS, although their career aspirations showed little change.	When students were asked to think back on how far they wanted to go in school before participating in GEMS, 40% indicated that they had wanted to finish college, and 53% that they had wanted to get more education after college. After GEMS, there was an upward shift in students' education aspirations, with 29% wishing to finish college and 66% wanting to get more education after college.
	A substantial portion of responding students expressed interest in STEM-related careers both before and after participating in GEMS. For example, 15% indicated aspiring to a career in engineering before GEMS and 17% after, with another 10% interested in becoming a scientist or researcher before GEMS and 12% after.
Although GEMS students are largely unaware of other AEOP initiatives, students showed some interest in future AEOP opportunities.	In spite of results indicating that most students were unaware of other AEOP initiatives, the majority of students indicated interest in participating in future AEOP programs. For example, approximately 1/3 of students responded that they had some level of interest in participating in JSHS, UNITE, CQL, and the GEMS Near Peer Mentor Program. Most participants (91%) credited GEMS with increasing their interest in participating in other programs.
GEMS participants reported positive opinions of DoD research and DoD researchers and reported increases in their awareness of their interest in pursuing a STEM career with the DoD.	A large majority of students had positive opinions of DoD research and researchers. For example, 81% of students agreed that DoD researchers advance science and engineering fields and that DoD research is valuable to society, and 80% agreed that DoD researchers develop new, cutting edge technologies.
	Most students reported that GEMS contributed to their awareness of DoD STEM research and careers (81%) and a greater appreciation of Army of DoD STEM research (83%). Two-thirds of students indicated that they are more interested in pursuing a STEM career with the Army or DoD after participating in GEMS.

Recommendations

Evaluation findings indicate that FY15 was a successful year overall for the GEMS program. Notable successes for the year include increases in participant applications and enrollment, continued participation by groups traditionally under-represented in STEM fields, and high levels of mentor and student satisfaction with the programs. Both students and mentors reported gains in students' STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the GEMS experience, and students emerged from the program more aware of Army and DoD STEM careers.

While these successes 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. GEMS served 2,270 students in FY15, an 8% increase over FY14. This provides some indication that the program attended to evaluator recommendations that existing sites expand their capacity to accommodate more students in

order to meet existing needs and interest in communities that are already served by GEMS programs. In spite of this, however, only 55% of applicants were placed in FY15 as compared to 63% in FY15. This disparity is likely due to the 20% increase in program applications from FY14 to FY15, however this indicates continued unmet need in the program. The large number of applications the program receives provides some evidence that the GEMS program could successfully be expanded to accommodate the considerable amount of unmet need and interest that persists with qualified students. Therefore, the FY14 recommendation that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interest in more communities is repeated. Additionally, evaluators continue to recommend that existing sites expand their capacity to accommodate more students in order to meet existing needs and interest in communities that are already served by GEMS programs. The program should consider increasing the number of existing GEMS sites' administrative staff, teaching staff, physical infrastructure, and mentor participation as this is likely the most effective way to increase existing sites' capacities to meet the very large needs and interest of potential GEMS participants.

2. Both GEMS and AEOP objectives include expanding participation of populations historically underrepresented in STEM, however there was little change in these groups' participation from FY14 to FY15 and little evidence that ASEE targeted marketing of GEMS to these groups in FY15. In FY14, the program reported outreach efforts to organizations that serve these underrepresented groups (for example the Society of Women Engineers and the Hispanic Association for Colleges and Universities), however this sort of targeted outreach was not undertaken in FY15. Additionally, it is notable that no students reported attending a school located in an urban area in FY15. Because of the relationship between urban school enrollment and low-income status, forging partnerships with urban schools may result in expanding the participation of this demographic (operationalized as students receiving free-and-reduced price lunch in the evaluation). It is likely that GEMS will need to expand targeted marketing while implementing more aggressive marketing and recruitment practices. The program may wish to particularly consider targeting outreach to low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations. The program and individual GEMS sites may need to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes. For instance, GEMS may consider offering commuting accommodations (e.g., bus transportation) that make participation more feasible for underrepresented and underserved populations that live further from GEMS sites.

3. Both the FY13 and FY14 evaluation included recommendations to ensure that "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately selected into the program over other qualified applicants who have no previous association with the GEMS site. Given the large proportions of students who reported learning about GEMS through personal connections, this recommendation is repeated for FY15, and the program is urged to consider strategies to ensure that students without personal connections to sites have access to the GEMS program.

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

1. The GEMS program failed to reach its FY15 target of 55 resource teacher participants in FY15 and fell short of its near-peer mentor goal by one. The program's ability to serve increasing numbers of students is limited by the number of mentors available, and therefore strategies to recruit additional RTs and NPMs and should be considered. It is also noteworthy that nine students (5% of the respondent sample) indicated in an open-ended questionnaire item that they felt the program could be improved by having more teachers, mentors, and/or teaching time. The number of staff that can be hired is, of course, subject to budgetary constraints, and this should be taken into consideration with any plans for program expansion.

2. Given that students were largely unaware of other AEOPs, yet identified their mentors as a key resource for information about AEOP opportunities, mentors should be provided with more comprehensive information about AEOP initiatives. Many mentors reported having no experience with AEOP resources. The program may therefore wish to incorporate information about other AEOPs into mentor orientation materials.

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

1. In order to create a robust pipeline of AEOP programs in which students progress from other AEOPs into GEMS and beyond, the program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. Although many students expressed interest in participating in other AEOP programs, a substantial proportion had never heard of AEOP initiatives outside of GEMS. Since students reported that their mentors were key resources for learning about AEOPs, the program may want to work with GEMS sites to ensure that all mentors as well as students have access to structured opportunities that both describe the other AEOPs and provide information to students on how they can apply to them. In addition, since many mentors reported not having experienced most AEOP resources, it may be useful for the program to familiarize mentors with these resources and how these can be used to provide students with more information about other AEOPs.

2. Mentors also play a key role in exposing students to Army and DoD STEM careers. Evaluation data indicate 37% of mentors did not discuss Army or DoD STEM career opportunities with students. It may, therefore, be useful for the program to familiarize mentors with resources available to expose students to DoD STEM careers. While students indicated that invited speakers were a key resource for learning about DoD STEM careers, 27% of mentors indicated that they had not experienced this, and substantial percentages of mentors also indicated that they had not experienced AEOP resources such as the AEOP brochure. The program may, therefore, wish to incorporate these resources into orientation materials for mentors. It may also be useful to familiarize mentors with strategies to increase the likelihood that the program will have a long-term impact on students' decisions to pursue STEM. Examples of these strategies include interactions with role models with similar backgrounds as the students and coaching on the type of 21st Century Skills (for example, communication skills) needed to be successful in STEM careers.

3. The FY15 GEMS participation in the evaluation questionnaire is an area for concern. Response rates for both students and mentors were considerably lower than in FY14, and ongoing low response rates for mentors raise questions about the representativeness of the results. Continued efforts should be undertaken to improve participation in completion of the questionnaire, particularly for mentors. The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities. In addition, the evaluation instruments may need to be streamlined as perceived response burden could affect participation.

Appendix E: 2015 High School Apprenticeship Program (HSAP) Evaluation Executive Summary

The High School Apprenticeship Program (HSAP), managed by the U.S. Army Research Office (ARO), is an Army Educational Outreach Program (AEOP) commuter program for high school students who demonstrate an interest in science, technology, engineering, or mathematics (STEM) to work as an apprentice in an Army-funded university or college research laboratory. HSAP is designed so that students (herein called apprentices) can apprentice in fields of their choice with experienced scientists and engineers (S&Es, herein called mentors) full-time during the summer or part-time during the school year.

Students receive an educational stipend equivalent to $10 per hour, and are allowed to work up to 300 hours total. The students contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the program, the students prepare final reports for submission to the US Army Research Office Youth Science programs office. In 2015, HSAP provided outreach to 49 apprentices and their 35 mentors at 28 Army-sponsored university or college laboratory sites (herein called HSAP sites).

This report documents the evaluation of the 2015 HSAP program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for HSAP included post-program questionnaires distributed to all apprentices and mentors, individual interviews with four apprentices, and an online focus group with three mentors.

2015 HSAP Fast Facts	
Description	STEM Apprenticeship Program – Summer, in Army-funded laboratories at colleges/universities nationwide, with college/university S&E mentors
Participant Group	9th-12th grade students
Number of Applicants	267
Number of Students (Apprentices)	49
Placement Rate	18%
Number of Adults (Mentors)	35
Number of K-12 Schools	42
Number of K-12 Schools – Title I	20
Number of College/University S&Es	28
Number of College/Universities	28
Number of HBCU/MIs	7
Total Cost	$148,687.50
Total Stipends	$128,250.00
Cost Per Student Participant	$3,304.17

Response rate for the post-program apprentice survey was good at 72%, but was down from 80% response rate in 2014. However this is a marked improvement from a 63% response rate in FY13. The response rate for the mentor survey was much higher than 29% in 2014 at 61% in 2015. Although both apprentice and mentor response rates were above 50%, they still have a large margin of error in terms of being able to generalize from the sample to the HSAP population.

Summary of Findings

The FY15 evaluation of HSAP collected data about participants; their 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.

2015 HSAP Evaluation Findings	
Participant Profiles	
HSAP continues to be a popular and selective program which serves students of historically underrepresented and underserved populations.	HSAP has been extremely successful in reaching out to more high school students. In 2014, there were only 84 applicants to HSAP, and in 2015 there were 267 applicants – a 318% increase. The ARO office utilized direct email to targeted schools, which produced a significant increase in applications. As a result, there were 10 more participants in HSAP for FY15 and a 6% increase in the placement rate for applicants. Further, the growth in participants yielded inclusion of 10 more high schools in the HSAP program in FY15 and 20 of the participating high schools were Title I.
	HSAP experienced continued success in providing outreach to students from historically underrepresented and underserved race/ethnic and low-income groups. Twenty-one additional sites were added from 2014 with an increase from placing HSAP sites at 7 HBCU/MIs in 2015 (an increase from 2 HBCU/MI sites in 2014).
	Approximately half of the respondents in the HSAP program were from race/ethnicity categories other than White.
HSAP is more cost effective in 2015.	The cost per apprentice decreased over $500 per person in 2015 from the previous year. This may be due to the large increase in applicants and in site proposals.
Actionable Program Evaluation	
HSAP marketing and recruitment continue to be mainly from personal contacts.	Most HSAP apprentices learn about the program from personal contacts such as a teacher. Only after this contact occurs, do the apprentices learn about the program from the website.
	Marketing via social media such as Facebooks, Twitter or Pinterest were the least frequently used sources for learning about HSAP specifically and AEOP generally.
HSAP gives apprentices unique and authentic ways to learn about STEM that are not available in school.	Data gathered during registration indicate that apprentices were motivated to participate in HSAP by the desire to learn something new or interesting, because of their interest in STEM, and to learn in ways not possible in school.

HSAP offers opportunities for high school students in authentic STEM learning that provides insight into college and beyond.	Most responding apprentices reported learning about applications of STEM to real-life situations, cutting-edge STEM research, and STEM topics on most days or every day of their HSAP experience. Further, they reported an increased understanding of college-level STEM research.
	Apprentices reported their mentors were available for them throughout the HSAP experience.
	Apprentices reported active engagement in doing STEM during the HSAP program. All STEM practices were experienced by the HSAP apprentices the majority of most days or every day.
HSAP mentors were less aware of DoD STEM research and careers than STEM careers/research in general. However, many were interested in participating in other AEOP opportunities.	91% of HSAP apprentices learned about at least one general STEM job/career, but only 62% learned about at least one specific DoD STEM job/career. Apprentices are aware of other AEOP opportunities and are interested in participation. When asked how interested they are in participating in future AEOP programs, more than 50% of the apprentices report an interest in URAP (71%), SMART (56%), and NDSEG (59%). A smaller portion of HSAP apprentices are interested in pursuing CQL (39%), and GEMS Near Peers (10%).
HSAP was highly valued by apprentices and mentors alike.	Most apprentices and mentors reported being satisfied with their HSAP experience, including communications from Army Research Office, and the application/ registration process. Mentors reported in the interview that they felt having high school students in their laboratories was a valuable professional development experience.
Outcomes Evaluation	
HSAP apprentices gained STEM knowledge and skills, and expect to use their STEM knowledge and skills extensively in the future.	Apprentices reported large or extreme gains on their knowledge of how professionals work on real problems in STEM, what everyday research work is like in STEM, a STEM topic or field in depth, and research conducted in a STEM topic or field.
	Apprentices reported increased abilities to do STEM, including such things as communicating information about their design processes and/or solutions in different formats and supporting a proposed explanation with relevant scientific, mathematical, and/or engineering knowledge.
HSAP had positive impacts on apprentices' 21st Century Skills.	The majority of responding apprentices reported large or extreme gains in their ability to work collaboratively with a team and to have patience with the slow pace of research.
HSAP positively impacted apprentices' confidence and identity in STEM, and had a significantly higher impact on minority apprentices STEM identity.	An overwhelming majority of apprentices reported large or extreme gains in their preparedness for more challenging STEM activities, confidence to do well in future STEM courses, feeling like part of a STEM community, and feeling responsible for a STEM project or activity.
	All apprentices reported that HSAP had a positive influence on their STEM identify and confidence in doing STEM, however, there was a significant difference based on race/ethnicity with minority apprentices expressing greater impacts on STEM Identity compared to non-minority apprentices.

HSAP raised students' education aspirations and positively influenced career aspirations.	After participating in HSAP, responding apprentices indicated being more likely to go further in their schooling than they would have before HSAP, particularly in the pursuit of a terminal degree such as a Ph.D.
	Apprentices were asked to indicate what kind of work they expected to be doing at age 30, with the majority indicating interest in a STEM-related career, both before and after HSAP. However, more apprentices indicated that after HSAP they were more likely to pursue mathematically oriented careers such as engineering and physical science.
HSAP raised apprentice awareness and appreciation of DoD STEM research and careers and how these careers affect the larger community.	Approximately three-quarters of apprentices agree or strongly agree that DoD researchers develop new, cutting edge technologies, solve real-world problems, advance science and engineering fields, and that their research is valuable to society.

Recommendations

Evaluation findings indicate that 2015 was a successful year for the HSAP program. HSAP had a 318% increase in the number of apprentice applicants and had a very competitive 19% acceptance rate of the apprentice applicants, which indicates there is great interest in this program. From the high quality applicants (mentors and apprentices), there were 38 mentors and 49 apprentices selected. HSAP has experienced some success in recruiting diverse apprentices, as half of the respondents to the questionnaire reported a race/ethnicity category other than White. Apprentices and mentors overwhelmingly reported satisfaction with HSAP experience. Mentors indicated they use innovative and research-based strategies to engage apprentices in STEM activities, and by engaging the apprentices; they help graduate students become better educators. The apprentices similarly report increased ability to engage in STEM activities and have STEM identities, due to the HSAP experience. Notably, there was a significant increase based on race/ethnicity with minority apprentices expressing greater impacts on STEM Identity compared to non-minority apprentice. Additionally, engaging in more hands-on STEM experiences motivated the apprentices, which was delivered by their HSAP experience.

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

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

1. AEOP objectives include expanding participation of historically underrepresented and underserved populations. Between 2014 and 2015, HSAP has engaged more apprentices who identify with a typically underrepresented group in STEM, which is a positive trend. Additionally, it is positive that the HBCU/MI sites increased from 2 in 2014 to 7 in 2015. Future marketing efforts could focus on the need for a more diverse pool of STEM professionals, and take the opportunity to showcase the diversity of mentors in electronic and printed materials.

2. Similar to past years, in HSAP, recruitment of apprentices is largely accomplished with personal interactions, either by knowing a teacher who is familiar with AEOP or a personal friend who has received an email about HSAP. As a result, the ability of HSAP to recruit underserved or underrepresented populations of students depends upon the diversity of the high schools in which recruitment takes place. Thus, HSAP may want to emphasize recruiting a more diverse pool of mentors and apprentices, perhaps specifically targeting more urban schools or schools who receive Title 1 funding. A focused and strategic plan to engage a more diverse pool of apprentices could ultimately improve the diversity of the STEM pipeline, based on the large impact that HSAP has on STEM knowledge, skills, and identity.

3. HSAP is very effective in giving apprentices authentic opportunities to engage in STEM professional activities, and for mentors to build the next generation of STEM professionals. Mentors are particularly skilled in being able to engage high school students into their laboratory by giving them meaningful learning experiences and asking them to report on their work to graduate students and STEM professionals. Although mentors are particularly skilled in their area of expertise, mentors can be more effective in helping students understand the big picture of how STEM can improve community. Only 54% of mentors reported communicating how STEM can improve community. Only 52% of the mentors highlighted the under-representation of women and racial and ethnic minority populations in STEM as well. Mentors can be provided ways to incorporate how STEM topics affect the larger community in a systematic way by the program, so that the bigger picture of how STEM fits into society can be explicitly emphasized.

4. Similar to recommendation #3, given the goal of exposing apprentices to Army/DoD STEM research and careers, the program may want to build in systematic opportunities to provide this information to their apprentices. More than half of apprentices who completed the survey reported that they did not learn about any DoD STEM jobs/careers during HSAP. Perhaps more importantly, only a few mentors were aware of specific Army/DoD STEM research and careers and even fewer mentors explicitly discussed this with their apprentices. This lack of awareness is a barrier in communicating about Army/DoD STEM research and careers. In an effort to increase and standardize the information provided to apprentices, it would be beneficial to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about Army STEM careers and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific Army/DoD STEM research and careers. The application to be a HSAP site or a mentor could ask for their plan to explicitly discuss these resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines), thus developing a network of ongoing opportunities for the apprentices.

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

1. Apprentices and mentors who participate in HSAP are only aware in a general way that other programs in AEOP exist. When asked, the mentors and apprentices could not name many of the other AEOP programs. Apprentices

rated the HSAP program (88%) and their mentors (89%) at somewhat or very much impactful on their awareness of AEOPs. However, the majority of HSAP apprentices reported not experiencing the AEOP brochure and AEOP social media. Social media efforts, in particular, require constant updates and focused attention on messaging to gain attention. Since most HSAP applicants hear about the program through another individual, having a social media presence may increase the likelihood that an apprentice or mentor may hear about the program from other person who learned about it on Facebook, Twitter, or Pinterest. A recommendation for the FY16 years and beyond would be for the HSAP program mentors to provide time for apprentices to complete the survey during their apprenticeship meeting time. This will provide a more accurate measure to gauge how effective HSAP activities and communications are in growing awareness of AEOPs.

Appendix F: 2015 Junior Science & Humanities Symposium (JSHS) Evaluation Executive Summary

The Junior Science & Humanities Symposia Program (JSHS), administered by the Academy of Applied Science (AAS) on behalf of the Services, is an AEOP pre-collegiate science, technology, engineering, and mathematics (STEM) research competition for high school students. JSHS is co-sponsored by the Army, Navy and Air Force. JSHS encourages high school students to engage in original research in preparation for future STEM career pathways. In regional (R-JSHS) and national (N-JSHS) symposia, students present their research in a forum of peer researchers and practicing researchers from government (in particular the DoD), industry, and academia.

This report documents the evaluation of the FY15 JSHS program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for JSHS included questionnaires for students and mentors; four focus groups with R-JSHS students and two with mentors, rapid interviews with 9 R-JSHS students, 14 mentors, and 4 JSHS alumnae; and an annual program report compiled by AAS.

Regional symposia were held in 46 university campus sites nationwide. The top five students in each region received an invitation to participate and compete at NJSHS, an all-expense-paid trip hosted by the Services. Of these five, the top two students were invited to present their research as part of the national competition; the third place student was invited to display a poster of his/her research in a competitive poster session; and the fourth and fifth place students were invited to attend as student delegates with the option to showcase their research in a non-competitive poster session.

2015 JSHS Fast Facts	
Description	STEM Competition - Nationwide (incl. DoDEA schools), research symposium that includes 46 regional events and one national event
Participant Population	9th-12th grade students
Number of Applicants	9,347 students and 1,003 teachers self-reported by each of the the 46 sites
Number of Students	5,829 Regional Participants (of whom 218 were selected to attend the National JSHS Symposium)
Placement Rate	62%
Number of Adults (Mentors, Regional Directors, Volunteers – incl. Teachers and S&Es)	3,203
Number of Army and DoD S&Es	300
Number of Army/DoD Research Laboratories	65
Number of K-12 Teachers	1,003
Number of K-12 Schools	1,020
Number of K-12 Schools – Title I	148
Number of College/University Personnel	1,240

Number of College/Universities	120
Number of Other Collaborating Organizations	134
Total Cost	$1,884,434
National Symposium Cost	$339,410
Regional Symposia Support Cost	$705,904
Scholarship/Award Cost	$387,270
Cost Per Student Participant	$323.28

Summary of Findings

The FY15 evaluation of JSHS collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to AEOP's and JSHS's objectives and intended outcomes. A summary of findings is provided in the following table.

2015 JSHS Evaluation Findings	
Participant Profiles	
JSHS continued to serve students from historically underrepresented and underserved populations. However, there is room for growth in diversity of participants, as well as in program participation overall.	JSHS experienced a 30% decrease in applications to the program and a 21% decrease in participants overall in FY15. JSHS was successful in attracting participation of female students—a population that is historically underrepresented in engineering fields. Regional symposia registration data indicate that over half (56%) of JSHS participants in reporting symposia were female. JSHS had limited success in attracting students from historically underserved minority race/ethnicity and low-income groups. Regional symposia registration data indicate that 9% of students in reporting regions identified themselves as Black/African American and as Hispanic/Latino. Somewhat smaller proportions of student questionnaire respondents identified themselves as Black/African American or Hispanic or Latino (R-JSHS 5%; N-JSHS 3%). While 10% of R-JSHS questionnaire respondents identified themselves as Hispanic/Latino, only 3%
	of N-JSHS respondents identified with this group. The vast majority of N-JSHS student questionnaire respondents (92%) reported that they did not qualify for free or reduced-priced lunches – a commonly used indicator of low-income status. In contrast, 16% of R-JSHS respondents reported qualifying for free or reduced-price lunch. Students from 148 Title I schools participated in JSHS at the regional and national levels, although the program failed to meet its FY15 goal of 20% participation by Title I schools.

	Most regional student questionnaire respondents attended public schools (R-JSHS 77%; data unavailable for N-JSHS students). Although well over a third of respondents attended schools in urban or rural settings (R-JSHS 41%; N-JSHS 43%), which tend to have higher numbers or proportions of underrepresented and underserved groups, over half attended suburban schools (R-JSHS 59%; N-JSHS 58%).
	There was a 30% decrease in the number of applicants in FY15 as compared to FY14, and overall participation was 21% lower in FY15. The program failed to meet its FY15 goal of a 10% increase in the number of participating high schools and, in fact, there was an 8% decline in the number of schools participating in FY15.
	Students participated in regional symposia at 12 HBCU/MSIs nationwide.
JSHS engaged an extensive group of adult participants as mentors, STEM ambassadors, and volunteers, although there is little indication of racial/ethnic diversity among adult participants.	Approximately 1,000 in-service teachers, 35 pre-service teachers, 1,200 college/university personnel (a 33% decrease from the 1,800 college/university personnel who participated in FY14), 300 Army/DoD scientists/engineers, and 460 other adult volunteers served as research mentors or STEM ambassadors in JSHS. Of those who responded to the questionnaire, a large majority (73%) identified themselves as White, with the 3% identifying as Black/African American and 7% as Hispanic/Latino.
Actionable Program Evaluation	
JSHS marketing seems to target K-12 teachers/schools primarily and teacher recommendations appear to be particularly important for student recruitment.	JSHS employed multi-faceted marketing and recruitment strategies to participate in regional symposia. Efforts originating with AAS and regional JSHS directors included personal contact with teachers and high school administrators, printed and electronic promotional materials distributed by direct mail and email, university websites, and targeted marketing at other STEM-related regional initiatives (for example university chapters of the National Society of Black Engineers and the Society of Women Engineers).
	Teacher information appears to be crucial for recruiting students into JSHS. Nearly a third of students reported learning about the JSHS program from someone who works at the school they attend (R-JSHS 30%; N-JSHS 30%). Other significant sources were school or university newsletters (R-JSHS 26%; N-JSHS 20%). Personal connections such as past program participants were another fairly frequently cited source of information (R-JSHS 14%; N-JSHS 15%).

Many students are motivated to participate in JSHS by an interest in STEM and the desire to learn something new.	Both R-JSHS and N-JSHS students were most frequently motivated to participate in JSHS an interest in STEM (R-JSHS 26%; N-JSHS 41%). The next most frequently mentioned highly motivating factor was a desire to learn something new (R-JSHS 16%; N-JSHS 18%). Although students tended to learn about JSHS from their teachers or school staff, this was not reported as a highly motivating factor for participation (R-JSHS 10%; N-JSHS 9%).
JSHS students reported engaging in meaningful STEM learning through hands-on and collaborative activities, although N-JSHS and female students reported learning significantly more than other R-JSHS and male students.	The majority of R-JSHS and N-JSHS students reported in engaging in a variety of activities on most days or every day of their JSHS experience. For instance, 76% of R-JSHS students and 91% of N-JSHS students reported learning about new STEM topics, 75% of R-JSHS and 88% of N-JSHS reported communicating with other students about STEM topics, and 70% of R-JSHS and 85% of N-JSHS students reported interacting with scientists or engineers on most days or every day of their JSHS experience. The differences between N-JSHS and R-JSHS students in overall learning about STEM were statistically significant and female participants reported learning significantly more in JSHS than did males.
	Students reported engaging in a variety of STEM practices during their JSHS experience. For example, students reported participating in hands-on activities (R-JSHS 47%; N-JSHS 60%), identifying problems to investigate (R-JSHS 49%; N-JSHS 56%), and drawing conclusions from an investigation (R-JSHS 52%; 50% N-JSHS) on most days or every day of their JSHS experience.
	R-JSHS and N-JSHS students reported having greater opportunities to learn about STEM in JSHS than they typically have in school. However, responding students from both groups also reported slightly lower levels of engagement in STEM practices in their JSHS experience than they typically have in school.
	Mentors reported using a diversity of strategies to help make learning activities relevant to students, support the needs of diverse learners, develop collaboration and interpersonal skills, and engage students in "authentic" STEM activities.
JSHS informed students about STEM careers in general and, to a lesser extent, about DoD STEM careers specifically. The number of adults working in JSHS decreased in FY15.	Students reported learning about STEM careers in their JSHS experience, although R-JSHS students reported learning about fewer DoD STEM careers than about general STEM careers. While 58% of R-JSHS and 92% of N-JSHS students reported learning about 3 or more STEM jobs or careers, only 25% of R-JSHS had learned about 3 or more DoD STEM careers while 88% of N-JSHS students had learned about 3 or more DoD STEM careers. Only 2% of N-JSHS students reported learning about DoD STEM careers while 47% of R-JSHS students had not learned about any of these careers.

	The overall number of adults supporting the JSHS program delivery decreased by 17% in FY15. Although 84% of mentors reported providing guidance about educational pathways that will prepare students for STEM careers, less than half of mentors (46%) reported discussing STEM career opportunities with the DoD or other government agencies with their students. It should be noted, however that these responses represent an increase in these type of mentor activities from FY14 when only 30% reported discussing STEM careers within the DoD or other government agencies and 18% reported recommending other AEOPs to students.
Students and mentors valued the JSHS experience, although students were less satisfied with judging practices than with other JSHS features.	Large majorities of both R-JSHS students and N-JSHS students reported being very much satisfied with features of their research experience including their working relationship with mentors (80% R-JSHS; 89% N-JSHS) and the research experience overall (78% R-JSHS; 89% N-JSHS).
	Students responding to open-ended questionnaire items particularly valued opportunities to connect with like-minded peers afforded by JSHS and identified providing more of these opportunities as an area for improvement.
	The majority of responding mentors indicated being either somewhat or very much satisfied with those program features they experienced. Student oral presentations were a particular area of satisfaction for mentors, with 90% of responding mentors reporting being at least somewhat satisfied with this feature. Many mentors also commented on the benefits the program in open-ended questionnaire responses, emphasizing the opportunity for students to engage in real-world STEM learning and research and networking with STEM professionals and other students.
	In FY15, JSHS participants' dissatisfaction with the judging process and feedback from judges increased from FY14. Student participants were less satisfied with judging than with other features of JSHS. Over a quarter (30%) of both N-JSHS students expressed that they were not at all satisfied with judging processes at R-JSHS (increased from 3% respectively in FY14 for R-JSHS participants and 0% N-JSHS participants regarding their experience at R-JSHS). Additionally, 30% of R-JSHS and 25% of N-JSHS participants were not satisfied with feedback received from judges (compared to 11% and 21% respectively in FY14. Judge selection and judging practices were also a theme in students' open-ended responses on the questionnaire, where students identified this as an area in need of improvement. In contrast, only 5% of responding mentors indicated that they were not satisfied with the judging process as a feature of JSHS.
Outcomes Evaluation	

JSHS students reported positive program impacts on their STEM knowledge and competencies.	A majority of R-JSHS and N-JSHS students reported large or extreme gains on their in-depth knowledge of a STEM topic or field; knowledge of research, processes, ethics, and rules for conduct in STEM; knowledge of what everyday research work is like in STEM; knowledge of how scientists and engineers work on real problems in STEM; and knowledge of research conducted in a STEM topic or field. N-JSHS students tended to report greater impacts than did R-JSHS students in these areas.
	Many students also reported extreme impacts on their STEM competencies, or abilities to "do STEM." Over half of both R-JSHS and N-JSHS students reported extreme gains in their abilities to do things such as communicate about their experiments and explanations in different ways (63% R-JSHS; 80% N-JSHS), organize data in charts and graphs to find patterns and relationships (64% R-JSHS; 72% N-JSHS); use knowledge and creativity to suggest a testable explanation for an observation (66% R-JSHS; 65% N-JSHS), and ask a question that can be answered with one or more scientific experiments (59% R-JSHS; 63% N-JSHS).
JSHS participants reported gains in students' 21st Century Skills.	Most responding students reported large or extreme gains in nearly all 21st Century Skills. These skills included communicating effectively with others (73% R-JSHS; 79% N-JSHS), viewing failure as an opportunity to learn (73% R-JSHS; 69% N-JSHS), and setting goals and reflecting on performance (69% R-JSHS; 78% N-JSHS). Overall, N-JSHS students and females reported significantly greater impacts on their 21st Century Skills than did R-JSHS students and males.
JSHS participants reported gains in their confidence and identity in STEM, and in their interest in engaging in STEM in the future.	A majority of both R-JSHS and N-JSHS students reported large or extreme gains in factors associated with confidence and STEM identity. Students reported these gains in areas such as feeling more prepared for more challenging STEM activities (68% R-JSHS; 80% N-JSHS), desire to build relationships with STEM mentors (71% R-JSHS; 72% N-JSHS), and confidence to try out new ideas or procedures on their own (70% R-JSHS; 73% N-JSHS), Overall, N-JSHS and female students reported significantly larger gains than R-JSHS and male students in STEM identity and confidence.

	Students also reported being more likely to engage in additional STEM activities both in and outside of school. A majority of students indicated that as a result of JSHS, they were more likely to engage in activities such as working on a STEM project or experiment in a university of professional setting (80% R-JSHS; 75% N-JSHS); taking an elective STEM class (66% R-JSHS; 61% N-JSHS), and mentor or teach other students about STEM (70% R-JSHS; 71% N-JSHS). Overall, N-JSHS and female students reported significantly larger gains than R-JSHS and male students in these areas. Another impressive finding was that 26% of N-JSHS students indicated plans to write or co-write a paper that will be published in a research journal. This indicates the impact of their JSHS experience goes well beyond the actual engagement with the program itself.
JSHS students reported higher education aspirations after participating in JSHS, although their career aspirations showed little change.	After participating in JSHS, students indicated being more likely to go further in their schooling than they would have before JSHS. For R-JSHS students, the proportion of students wanting to complete college increased from 92% to 99% from before JSHS to after JSHS participation. The proportion of N-JSHS students aspiring to a combined M.D./Ph.D. increased from 18% before JSHS to 33% after.
	Students were asked to indicate what kind of work they expected to be doing at age 30, both before and after JSHS participation. A vast majority of students aspired to STEM careers both before and after JSHS participation, although there was a decrease in the number of students who were undecided about their career aspirations (13% to 7% R-JSHS; 8% to 5% N-JSHS).
Although JSHS students were largely unaware of other AEOP initiatives, students showed some interest in future AEOP opportunities.	Most students and mentors were unaware of other AEOP initiatives, however 52% of R-JSHS students and 79% of N-JSHS students indicated that participating in JSHS contributed to their awareness of other AEOPs, and most (50% R-JSHS; 67% N-JSHS credited JSHS with increasing their interest in participating in other AEOPs in the future.
	Most mentors had not participated in and were not aware of AEOP initiatives other than JSHS. Only 36% of mentors reported recommending other AEOPs to students that align with student goals.
	Besides participation in JSHS, students credit invited speaker and career events (41% R-JSHS; 76% N-JSHS) and their JSHS mentors (26% R-JSHS; 13% N-JSHS) with impacting their awareness of other AEOPs at least somewhat. Over a third (36%) of N-JSHS students also credited the AEOP brochure with impacting their awareness of other programs at least somewhat, however only 14% of R-JSHS students reported that the brochure impacted their awareness and 74% of R-JSHS students reported never hearing about the AEOP brochure.

JSHS participants reported positive opinions of DoD research and DoD researchers and reported increased interest in pursuing a STEM career with the DoD.	The participation of Army/DoD laboratories grew to 65 in FY15, a 7% increase from FY14. Nearly all N-JSHS students and about three-quarters of R-JSHS students expressed agreement that DoD research is valuable to society, that DoD researchers solve real-world problems, that DoD researchers develop new, cutting edge technologies, and the DoD researchers advance science and engineering fields. In addition, nearly half of R-JSHS students (49%) and 70% of N-JSHS students indicated that participating in JSHS increased their interest in pursuing a STEM career with the DoD.

Recommendations

Evaluation findings indicate that FY15 was a successful year overall for the JSHS program. Notable successes for the year include the continued high participation rate for females, continued participation by other groups traditionally under-represented in STEM fields, and high levels of mentor and student satisfaction with the programs. Both students and mentors reported participant gains in STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the JSHS experience, and students emerged from the program with more interest in pursuing Army and DoD STEM careers.

While these successes 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 applicant placement rate increased from 55% to 62% from FY14 to FY15, it is concerning that there was a 30% decrease in the number of applicants in FY15 as compared to FY14, and overall participation was 21% lower. It is recommended that JSHS track the number of applicants and placement rates at each regional site to insure more consistent placement rates across the portfolio (i.e., Illinois – Chicago had only 20% placement rate compared to 100% at other sites such as South Carolina). One strategy would be for AAS to work with regional sites to support increasing their capacity to accept more participants in the low placement rate regions.

2. The program failed to meet its goal of a 10% increase in the number of participating high schools and, in fact, there was an 8% decline in the number of schools participating in FY15. Of the 46 regional events held, 18 regions showed a 27% increase over the previous year in the total number of participating high schools. Another 14 regions showed a 37% decrease since FY14. While there are a variety of intervening factors associated with these phenomena, including weather impacts, competing activities, and impacts of school budget cuts on students' ability to travel, program administrators should be mindful of these decreases in participation and particularly the effect they may have on engaging students from underserved and underrepresented populations.

3. AAS may want to support states to reach out and cast broader nets for recruiting participants – beyond the local area of the competition or host. The program may wish to investigate student recruitment practices from the

regions that demonstrated growth in FY15 and identify scalable recruitment and marketing strategies that could be applied across regions. Likewise, the program may wish to investigate strategies from regions with decreasing participation with the aim of identifying longitudinal changes in regional practices that may have affected student participation rates. Some recommended strategies to grow the diversity of student participants to increase the number of underrepresented students include conducting outreach to schools with high populations of underrepresented students to make them aware of JSHS and reaching out to academically prepared and competitively eligible underrepresented students to encourage actual participation in JSHS.

4. AEOP objectives include expanding participation of populations historically underrepresented in STEM careers. Since no program-wide demographic data was available from FY14, however, it is not possible to determine whether there was any change in participation of these groups from FY14 to FY15. Collecting demographic information on students participating in the R-JSHS through Cvent will enable a more accurate representation of the JSHS participation pool and concerted efforts should be made by program administrators to ensure that demographic data for all JSHS participants is compiled annually. JSHS failed to meet its FY15 goal for attracting Title I schools (associated with low-income status students) to the program. Of the 1,020 schools participating 15% were Title I schools, falling short of its FY15 goal of 20%. The program should continue to collect information and strategies from specific regional symposia as well as other AEOPs that successfully attract underrepresented and underserved students. This information should be disseminated to the larger JSHS community of regional directors. Additionally, the program may with to consider ways to build on previous efforts to strengthen its outreach to schools that serve large proportions of underrepresented groups of students (e.g., urban schools, Title I schools). JSHS might also consider the possibility of engaging with target districts through the AEOP's strategic outreach initiative opportunities, which provide limited financial support to assist in the ability of a target community to engage with the AEOPs.

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

1. The frequency with which students expressed dissatisfaction with judging practices and judging feedback during their JSHS experience (including the increased dissatisfaction from FY14 to FY15) suggests that there may be a need to direct additional resources to judge recruitment and training. While participation of DoD STEM personnel was constant from FY14 to FY15, there was a 33% decrease in the participation of college/university personnel from FY14 to FY15. The program may wish to further investigate practices of regions that were successful in attracting larger numbers of and greater diversity of judges with the aim of identifying practices that may be scaled across regions. Additionally, the program may wish to consider whether current judging practices established by the program are adequate to ensure standardization of judging practices nationwide and consider additional methods to standardize judging and reduce students' perception of judging bias. The program may wish to consider, for instance, creating judging rubrics, providing enhanced judging training or orientation, and providing methods for judges to easily provide both oral and written feedback to students. Currently, the feedback at regional level JSHS competitions is varied and is mostly verbal in format.

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

1. In order to create a robust pipeline of AEOP programs in which students' progress from other AEOPs into JSHS and beyond, the program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. One finding that is cause for concern is that although many participants expressed interest in other AEOP programs, most students had never heard of AEOP programs outside of JSHS. Large numbers of students at R-JSHS events reported not having seen the AEOP brochure. This is especially concerning since the FY15 APR indicates that AEOP resources were distributed to all regional symposia. Coupled with this is student reliance on teachers or mentors for information about AEOPs and mentor reports of having little familiarity with AEOPs other than JSHS. The program may wish to consider devising methods to disseminate AEOP information directly to teachers and mentors before the regional events as well as communicating expectations to regional symposia concerning the distribution of AEOP materials at events to ensure that all mentors, teachers, and students have access to structured opportunities that both describe the other AEOPs and provide information to students on how they can apply to them.

2. Evaluation data indicate that nearly half (47%) of R-JSHS students did not hear about any Army or DoD STEM career opportunities during their JSHS experience. Since R-JSHS mentors were reported to be a useful source of information about DoD STEM careers it would be useful for the program to devise ways to familiarize mentors with resources available to expose students to DoD STEM careers. A large majority of N-JSHS (80%) students indicated that invited speakers or career events were a key resource for learning about DoD STEM careers, however over a third (35%) of R-JSHS students reported not having experienced these resources. Because of the potential marked impact of this resource on student awareness of DoD STEM careers, the program may wish to consider innovative ways to connect regional students with DoD STEM professionals, including creating web-based video profiles of DoD STEM professionals, creating virtual lab tours hosted by DoD STEM professionals, and devising strategies to facilitate regional symposia's efforts to engage DoD STEM professionals as speakers at events.

3. The R-JSHS experience comprises the entirety of the JSHS experience for most students, however consistent differences between R-JSHS and N-JSHS student responses suggest that N-JSHS may have a greater impact on students than R-JSHS. While some of these differences are likely due to initial differences in interest and/or ability between students who are selected to go on to N-JSHS and those who are not, other differences may be related to differences in the availability/quality of mentor support or the availability/quality of activities at each symposium. The program should consider what guidance and support can be provided to regional directors, mentors, and other supporters of R-JSHS to facilitate the identification of mentors (particularly in rural areas and other areas with logistical barriers to accessing university and other professional STEM resources), active engagement in STEM activities, useful feedback from judges, and feelings of success that support a positive STEM identity among students who are not selected for N-JSHS.

4. Participation in the AEOP evaluation continues to be an area of concern. While student and mentor participation rates rose slightly from FY14 to FY15, the continued relatively low rates of participation threaten the generalizability of results. Improved communication with individual program sites about expectations for the evaluation may help. A recommendation was made in the FY14 evaluation report as follows: "Given the large number of participants in the Regional competitions, it may be worth randomly sampling students to respond to the questionnaire, and rechanneling efforts into getting a high response rate from the sample." Although there is no indication that this recommendation was acted upon in FY15, it may be a strategy to consider going forward. It is recommended that JSHS consider requiring regional sites to provide time for participants to complete the AEOP evaluation questionnaire during regional symposia.

Appendix G: 2015 Junior Solar Sprint (JSS) Evaluation Executive Summary

Junior Solar Sprint (JSS), managed by the Technology Student Association (TSA), is an Army Educational Outreach Program (AEOP) science, technology, engineering, and mathematics (STEM) education program where 5th-8th grade students apply scientific understanding, creativity, experimentation, and teamwork to design, build, and race solar electric vehicles. JSS activities occur nationwide, in classrooms and schools, through extracurricular clubs and student associations, and as community-based events that are independently hosted and sponsored. The AEOP's JSS programming is designed to support the instruction of STEM in categories such as alternative fuels, engineering design, and aerodynamics. Through JSS, students develop teamwork and problem-solving abilities, investigate environmental issues, gain hands-on engineering skills, and use principles of science and math to create the fastest, most interesting, and best crafted vehicle possible. Students have the opportunity to participate in JSS through TSA chapters and Army-hosted locations across the country.

This report documents the evaluation of the FY15 JSS program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for JSS included questionnaires for students and mentors, 2 focus groups with students, 1 focus group with mentors, rapid interviews with 8 students and 9 mentors, and an annual program report compiled by TSA. In 2015, students participated in JSS through 17 TSA-affiliated state competitions, three regional Army laboratory-hosted locations, and one national competition in Grapevine, TX.

2015 JSS Fast Facts	
Description	STEM Competition - Solar car competition regional events at 3 Army laboratories, 17 TSA state events, and one national event hosted in conjunction with the TSA national conference.
Participant Population	5th–8th grade students
Number of Applicants	636
Number of Students	636
Placement Rate	N/A (all students who registered were participants)
Number of Adults (Mentors and Volunteers – incl. Teachers and Army S&Es)	168
Number of Army S&Es	26
Number of Army Research Centers and Laboratories	3
Number of K-12 Schools	266
Number of K-12 Schools – Title I	94
Number of Other Collaborating Organizations	0
Total Cost	$123,371.86
Scholarships/Awards Cost	$15,072.52

Stipend Cost	$500.00*

*Stipend was provided to the guest speaker at the national conference.

Summary of Findings

The FY15 evaluation of JSS collected data about participants; their 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.

2015 JSS Evaluation Findings	
Participant Profiles	
JSS experienced a decline in applications and youth/adult participants in FY15. JSS served relatively small percentages of students from historically underrepresented and underserved populations; there is room for growth in this area as well as a need for consistent collection of enrollment demographic data.	The overall number of applications for and participants in JSS for FY15 decreased 29% from FY14. The number of adults who supported the JSS program declined 51% from FY14. Interestingly, the number of participating K12 schools grew 74% (266) in FY15 compared to FY14. Additionally, 68% of participating schools were Title I.
	Only 27% of JSS student participants in FY 15 were female —a population that is historically underrepresented and underserved in STEM fields, which is particularly so in the physical sciences. JSS had limited success in engaging students from historically underrepresented and underserved races/ethnicities. Enrollment data indicate that in FY15 only 7% of participants identified themselves as Black or African American and 9% as Hispanic or Latino. This may be due to the fact that only TSA chapter members and their students are permitted to participate in JSS and the overall TSA population may be limited in diversity.
	There is evidence that JSS's success in reaching low-income students was limited. Only 20% of enrolled participants identified themselves as qualifying for free or reduced-price lunch (FRL), a commonly used indicator of family income. It is noteworthy, however, that 16% of participants chose not to report their FRL status.
	No enrollment demographic data is available for FY14, therefore it is not possible to compare FY15 student demographic data with the prior year's data to track emerging trends in enrollment (data is available for FY14 questionnaire respondents, however since only 9% of students and 5% of mentors responded it cannot be assumed that these respondents are representative of participant demographics for the year). There is a need for consistent tracking of JSS participant demographics.

JSS participants have little experience with other AEOPs and only limited interest in participating in other AEOPs in the future.	Only a very small number of students reported having participated in other AEOPs in the past. In addition, the majority of students have not heard of AEOPs that they currently qualify for or that they may qualify for in high school. This is an area for potential growth for JSS. It is unclear how much TSA promotes non-TSA events/competitions to their membership.
Actionable Program Evaluation	
There is evidence that the national infrastructure for JSS benefits participants and enhances marketing efforts.	Nearly half (49%) of students questionnaire respondents reported learning about JSS from the TSA while over half (64%) of mentors reported learning about JSS from the TSA; this was by far the most common method of learning about JSS for both groups and indicates that TSA's infrastructure and outreach efforts are key to the continued success of JSS.
	Students and mentors reported high levels of satisfaction with TSA online resources, and the TSA website was cited by students as a major source of information about other AEOPs.
JSS students reported a variety of motivators for participating in the program.	Students were most frequently motivated to participate in JSS by an interest in STEM (19%), a desire to learn something new or interesting (16%), to have fun (16%), and because of teacher encouragement (14%).
JSS students reported engaging in meaningful STEM learning through team-based and hands-on activities.	Most students (53-64%) report communicating with other students about STEM and learning about new STEM topics on most days or every day of their JSS experience.
	Teamwork, participating in hands-on STEM activities, and coming up with creative explanations/solutions were key to students' work in JSS. Student respondents reported engaging in these practices most days or every day (74%, 72% and 59% respectively). Students engaged in a variety of other STEM practices on a frequent basis, including analyzing data or information (59%) and drawing conclusions from an investigation (55%).
	Mentors reported using a variety of strategies to help make learning activities to students relevant, support the needs of diverse learners, develop students' collaboration and interpersonal skills, and engage students in authentic STEM activities.
JSS involved more Army/DoD S&E's in the program in FY15. However, JSS has an opportunity to improve student and mentor awareness of other AEOPs and DoD STEM careers.	The number of Army/DoD S&E's grew to 26 in FY15 for JSS. Although 62% of students reported that participating in JSS impacted their awareness of other AEOPs, most students reported never hearing about any of the other AEOP initiatives. Only small proportions of mentors (10% or less) reported discussing specific programs with students although over half of mentors (52%) indicated that they discussed AEOP in general with their students.
	The majority of mentors (68%) found the TSA website to be a useful resource to expose students to DoD STEM careers. Student attitudes toward DoD researchers and research were positive, although 58% of students indicated learning about no DoD STEM careers during JSS. In comparison, 66% of students reported learning about at least one career in STEM more generally.
Students and mentors value the JSS experience.	Most students indicated being satisfied with their JSS experience. Learning about various topics, learning about STEM in general, and opportunities for teamwork were particular areas of satisfaction noted by students.

	Like students, nearly all responding mentors reported having a positive experience with JSS. Teamwork and the opportunity for hands-on learning were two of the most commonly mentioned benefits for students named by mentors.
Outcomes Evaluation	
JSS students reported gains in STEM knowledge and competencies.	Most students reported at least some gains in their STEM knowledge, including knowledge of how scientists and engineers work on real problems in STEM, an in-depth knowledge of a STEM topic, and knowledge of the research processes, ethics, and rules for conduct in STEM.
	Students also reported gains in their STEM competencies, including making a model of an object or system showing its parts and how they work, carrying out procedures for an experiment and recording data accurately, and communicating information about their design experiments and solutions in different ways.
JSS participants reported gains in 21st Century Skills.	Nearly all students reported gains in their 21st century skill. For instance, all students reported gains in making changes when things do not go as planned. A majority of students reported large or extreme gains in all categories of 21st Century Skills, including working well with students from all backgrounds, including others' perspectives when making decisions, and communicating effectively with others.
JSS participants reported gains in their identity in STEM and in their interest in engaging in STEM in the future.	The majority of students reported gains in areas related to their STEM identity, defined as confidence in one's ability to succeed in STEM. Over half reported large or extreme gains in areas such as interest in a new STEM topic (59%), feeling prepared for more challenging STEM activities (59%), and thinking creatively about a STEM project or activity (57%).
	Students also reported gains in the likelihood that they would engage in STEM activities outside of school. For instance, 72% indicated that as a result of JSS they were more likely to tinker with a mechanical or electrical device, 69% that they were more likely to take an elective STEM class, and 58% that they were more likely to participate in a STEM camp, club, or competitions.
Students had higher education aspirations after participating in JSS, although their career aspirations showed little change.	After participating in JSS, there was an increase in the number of students aspiring to continuing their education after college (57% as compared with 45% reporting this as their aspiration before JSS participation).
	Students reported similar career aspirations before and after participating in JSS, although more students aspired to a career as an engineer or architect after participation in JSS (31% before versus 40% after). Overall, there was not a statistically significant difference in career aspirations from before JSS to after.
Although JSS students are largely unaware of AEOP initiatives, students showed some interest in future AEOP opportunities.	In spite of results that showed a majority of students were unaware of most other AEOP initiatives, 62% of students indicated that JSS impacted their awareness of other AEOPs. Students had at least a little interest in participating in all other AEOPs for which they are currently eligible or will be eligible in high school, including GEMS (49%), eCYBERMISSION (39%), and SEAP (31%).

Recommendations

Evaluation findings indicate that FY15 some success overall for the JSS program. Notable successes for the year include high levels of mentor and student satisfaction with the program, evidence of an expanding national infrastructure to support JSS activities, and satisfaction with TSA resources. Both students and mentors reported gains in students' STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the JSS experience.

While these successes are commendable, there are some areas that remain with potential for growth and/or improvement. Specifically, the JSS program experienced significant decline in number of participants and overall lack of diversity in participant demographics. The membership model associated with TSA chapters being the sole source of recruitment may be limiting the ability of JSS to grow and reach the desired target populations. 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. The AEOP goal of broadening the talent pool in STEM fields continues to be a challenge for JSS. The recommendations made in the 2013 and 2014 JSS evaluation reports for the program to consider doing more to engage and interest students from schools serving historically underrepresented and underserved groups is therefore repeated. However, it is unclear if TSA has the capacity to do this within their current chapter membership. Additionally, the program may wish to consider ways to revise its outreach and marketing strategies to reach and appeal to female students and other groups underrepresented in STEM careers. It is recommended that TSA coordinate regional promotional activities associated with Army JSS Host Sites with POCs at Army research centers and labs.

2. It should be noted that the lack of demographic data for 2014 JSS enrollment prevented identifying any growth that occurred in this area over the past year. The universal use of CVENT for participant enrollment going forward should permit for enhanced data collection and the ability to more effectively track enrollment trends. The evaluation team would also like for TSA to provide overall demographics for their TSA chapter membership nationally to have a better understanding of how reflective the JSS participation is of the overall potential recruitment base within the TSA chapters.

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

1. Responding mentors reported an overall high level of satisfaction with resources, including TSA website resources, TSA instructional materials, and materials. Although the program met and exceeded its goal of distributing 240 car kits (a total of 300 PITSCO car kits were distributed in FY15), there was no funding for JSS-in-a-box kits or for instructional videos and webinars. It is noteworthy that over 50% of students reported dissatisfaction with (10%) or lack of experience with (44%) JSS video tutorials. When asked about resource improvements, 18% of students

specifically suggested providing videos or examples, indicating that these resources would be welcome instructional supports. In light of this, the program should continue to pursue opportunities to create video content to support teachers and students.

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

1. The JSS program objective of creating a national infrastructure to support local, regional, and national events and increase participation in JSS was supported by a number of program activities. Student comments about frustration with the event registration process (in particular the requirement to register in two separate places for events) should be taken into consideration as the program continues to build this infrastructure. The evaluation team would like to explore the ability of AEOP to import the current JSS registrations from the TSA system into CVENT. JSS should follow up with the AEOP CAM office to explore this as soon as possible.

2. In order to create a robust pipeline of AEOP programs in which students' progress from other AEOPs into JSS and beyond, the program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. 2015 saw a slight increase in the number of mentors who recommended AEOPs to students that align with students' educational goals (43% versus 33% in 2014), however few mentors discussed specific AEOPs with students. The recommendation made in 2013 and 2014 to devise strategies to increase students' exposure to other AEOP opportunities will therefore be repeated. In particular, the program may want to work with each site to ensure that all students have access to structured opportunities that both describe the other AEOPs and provide information to students on how they can apply to them. Since teachers provide much of the program information students receive during JSS, efforts should be made to ensure that teachers are informed about the range of AEOPs. Other means of educating students about AEOPs should be combined with teacher information, especially given the very real consideration of teacher time constraints in working with students. Given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with information and facilitate their enrollment in other AEOPs.

3. The JSS program's participation in evaluation activities continues to be a source of concern. Although the response rates were slightly higher for FY15 than for FY14 (14% versus 9% for students and 8% versus 5% for mentors), the low response rates for both the student and mentor questionnaires raise questions about the representativeness of the results. The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities to be conducted on-site directly following the actual race. In addition, the evaluation instruments may need to be streamlined and revised with age-appropriate language to reduce the time commitment of respondents.

Appendix H: 2015 Research & Engineering Apprenticeship Program (REAP) Evaluation Executive Summary

REAP is a summer internship 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 FY15 REAP program. Virginia Tech, in collaboration with ASEE, collected the FY2015 evaluation data for the REAP program. Purdue University, the new evaluation lead, prepared the FY 2015 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 FY15, there were 101 REAP apprentices at 37 different colleges and universities. This was a decrease in participation of 14% from FY14 enrollment (117). In FY14 there were 117 apprentices to 74 mentors, and for the FY15 year, the ratio is approximately equal. The FY15 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 FY15 annual program report compiled by the Academy of Applied Science (AAS).

2015 REAP Fast Facts	
Major Participant Group	Rising 10th, 11th, and 12th grade high school students, rising first-year college students
Number of applications (Cvent)	270
Number of applicants (applied directly to Universities)	268
Apprentices	101: 78 REAP; 23 REAP/Unite (decrease of 14% from FY14)
Placement rate	37%
Placement Rate using all applicants/Univ and AEOP (total 556)	18%
Mentors	68
Sites	37
Total Cost	$349,690
Total Stipends (apprentices & mentors)	$200,699
Cost Per Student Participant	$3,462.28

Summary of Findings

The FY15 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.

2015 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, 61% of participants in FY15 were female, a population that is historically underrepresented in engineering fields. There was a slight decrease in participants (14%) and mentors (8%) in FY15 compared to FY14.
	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 (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). In fact, 34% of apprentices identify as Black or African American, 23% as Hispanic or Latino, and 61% as female. Further, 91% of the participating apprentices attend Title I schools (students from Title I schools typically come from underrepresented and underserved populations).
	Most apprentices reported attendance at public schools (91%) and schools in suburban settings (56%). However, a third of students came from schools in urban areas (35%), which tend to have higher numbers or proportions of underrepresented and underserved groups.
	REAP continued to implement the bridge with Unite, another AEOP program that serves students from underrepresented and underserved groups. In 2015, 24 alumni of Unite participated in REAP apprenticeships.
The diversity of the mentors continues to grow.	FY15 mentors were remained predominantly male (76%) and White (38%). This did represent a decrease in the percentage of White mentors overall.
	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.
Apprentices demonstrated a greater interest in pursuing a career in a STEM-related field after participating in REAP.	97% of the 85 apprentice respondents indicated their intent to pursue a career in a STEM-related field. More respondents intended to pursue careers in Medicine/Health (32%) than any other field, with Engineering (27%) and Physical Science (8%) being the next most frequently reported fields.

Actionable Program Evaluation	
REAP marketing and recruitment was focused at the local level.	Mentors reported using connections with local school teachers (44%) to recruit participants, as well as school based communications (31%), and communications by universities and faculty (24%). Applications solicited by the AAS and general AEOP marketing were also used to recruit apprentices (51%).
	Apprentices most frequently learned about REAP from teachers and professors (56%), school newsletters, emails, or websites (20%), from a REAP mentor (15%), or from the AEOP website (15%).
	Mentors learned about REAP from the AAS website (33%), from a superior (29%), such as a Department Chair, Center Director, or Dean, and 24% from a past REAP participant.
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.	Many apprentices received encouragement to participate from others, including friends, family members, and school staff, often who have current or past connections to the REAP program. Apprentices who participate in REAP report having clear understandings of the knowledge and skills it takes to succeed in a STEM career.
REAP apprentices engage in meaningful STEM learning through team-based and hands-on activities.	Most apprentices (84-97%) reported learning about new STEM topics, communicating with other students about STEM, and interacting with STEM professionals.
	Apprentices had many opportunities to engage in a variety of STEM practices during their REAP experience. For example, 81% participating in hands-on activities, 82% working as part of a team, 80% analyzing or interpreting data or information, and 73% drawing conclusions from an investigation on most days or every day.
	Apprentices reported greater opportunities to learn about STEM and greater engagement in STEM practices in their REAP experience than they typically have in school.
	Many mentors reported using strategies to help make learning activities to students relevant, support the needs of diverse learners, develop students' collaboration and interpersonal skills, and engage students in "authentic" STEM activities.
REAP promotes STEM research and careers but can continue to improve mentors' awareness of and resources for promoting AEOP opportunities and DoD STEM careers.	Mentors reported limited awareness of or past participation in an AEOP initiative beyond REAP. Twenty-four percent of responding mentors had past experience with REAP but with the exception of Unite, 90% of responding mentors indicated they had not participated in the other AEOP programs. Nearly half of the responding mentors had participated in Unite (49%). In addition, most apprentices reported an increase in awareness of other AEOPs, and only 17% of the apprentices reported that their mentors never recommended any AEOP programs, down from 68% in 2014.
	Mentors reported sharing information with apprentices about STEM majors and careers (75% of apprentices reported learning about three or more STEM careers), but few of those were DoD STEM careers. Some mentors stated that they were unaware of DoD STEM careers, and 45% of apprentices reported that their mentors never discussed STEM career opportunities with the DoD (down from 68% in 2014).

The REAP experience is greatly valued by apprentices and mentors.	Apprentices indicated satisfaction with the REAP research experience overall. Open-ended responses about the overall experience highlighted apprentices' opportunity to do hands-on research and learn about STEM content and research. Apprentices also commented on how REAP provided opportunities they do not get in school and would not otherwise have.
	A majority of responding mentors reported positive experiences. Further, many commented on the benefits the program provides apprentices, including hands-on research experience and increases in STEM content knowledge.
Outcomes Evaluation	
REAP apprentices reported gains in STEM knowledge and competencies.	Apprentices reported large or extreme gains on their knowledge of how professionals work on real problems in STEM, what everyday research work is like in STEM, a STEM topic or field in depth, the research processes, ethics, and rules for conduct in STEM, and research conducted in a STEM topic or field. These impacts were identified across all apprentice groups.
	Apprentices reported impacts on their abilities to do STEM, including such things as reading technical or scientific texts to learn about the natural or designed worlds, designing and carrying out procedures for investigations, asking questions to understand data, and deciding what kind of data to collect to answer a question.
REAP apprentices' reported gains in 21st Century Skills.	Apprentices reported large or extreme gains on their patience for the slow pace of research, making changes when things do not go as planned, and sticking with a task until it is complete.
REAP apprentices reported increased confidence and identity in STEM, as well as increased interest in future STEM engagement.	Apprentices reported a large or extreme gain on their preparedness for new STEM activities (78%), their confidence in trying out new ideas or procedures (77%), desire to build relationships with mentors (87%), and connecting a STEM topic to their personal interests (78%). In addition, 82% reported an increase in their sense of accomplishing something in STEM, and 68% reported deciding on a path to pursue a STEM career.
	A majority of apprentices indicated that as a result of REAP, they were more likely to work on a STEM project in a university or professional setting; participate in a STEM club, student organization, or professional organization; work on solving mathematical or scientific puzzles; or help with a community service project related to STEM.
REAP apprentices reported increased higher education aspirations and interest in pursuing STEM careers.	After participating in REAP, apprentices indicated being more likely to go further in their schooling than they would have before REAP, with the greatest change being in the proportion of apprentices who expected to continue their education beyond a Bachelor's degree (81% before REAP, 92% after) and get a Ph.D. (15% before and 24% after).
	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.
A substantial portion of apprentices expressed interest in future AEOP	At the end of their apprenticeship, many apprentices reported that they had never heard of any of the AEOPs except for REAP (77-99% of apprentices, depending on the program). However, after participating in REAP, a large proportion of apprentices

opportunities. However, many REAP apprentices and mentors were largely unaware of other AEOP initiatives.	were somewhat to very interested in participating in other AEOP initiatives in the future (83% of apprentices). This ongoing trend continues to occur despite communication efforts to apprentices, mentors and directors such as sending apprentices AEOP materials, a welcome letter, brochures, suggestions to review the AEOP website, and additional materials to take back to schools.
REAP apprentice reported awareness and appreciation of DoD STEM research and careers increased. REAP apprentices also expressed interest in pursuing a STEM career with the DoD.	A majority of apprentices reported that they had a greater interest (84%) and awareness (69%) of DoD STEM research and careers. Apprentices cited their participation in REAP (52%), their REAP mentor (45%), and the AEOP instructional supplies (42%) as having the most impact on their awareness of DoD STEM careers.
Participation in evaluation surveys have increased, providing more complete information about REAP outcomes	A recommendation from the 2014 Evaluation Report included the need for increased participation in REAP evaluation efforts. The REAP program had an 84% return rate for apprentice surveys and a 74% return rate for mentor surveys. FY 15 had a 36% increase in apprentice surveys and a 21% increase in mentor survey responses from FY 14.

Recommendations

Evaluation findings indicate that FY15 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. There has also been an increase in the number of African American mentors from 2014, providing more exposure to role models from historically underserved and underrepresented in STEM careers. 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.

A second area of strength for REAP was the growth in number of apprentices who intended to pursue a STEM career after participation in the program. REAP apprentices who did not intend to pursue a career in STEM before participating clearly change their mind to pursue a STEM career after the REAP experience. This positive momentum in diversity the STEM pipeline presents an opportunity to inform apprentices of tangible career goals in Army/DoD STEM careers.

A third 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 encouraged.

One example of a positive trend is the Unite/REAP partnership. 24 students from Unite received REAP apprenticeships in 2015, up from 18 in 2014.

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 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. 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.

2. 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. Some of the mentors also said that the apprenticeship experience should be lengthened. Suggestions were made by both mentors and apprentices to extend the apprenticeship into the school year and/or to continue working with the same project for at least two summers. Another option for intensified mentorship is to train mentors in the key elements of a cognitive apprenticeship model: introductory tasks that are familiar to students, breakdown of the problem, and introduction of precise rules that are used by scientists/engineers (Brown, Collins & Duguid, 1989). Mentors mentioned in the interviews that working with high school students is a different situation than working with undergraduates, and needed some training in working with younger students.

3. Efforts should be made to help mentors and apprentices become more aware of DoD STEM research and careers. Forty-five percent of apprentices reported not learning about any DoD STEM careers during their REAP experience. Comments from mentors in the focus group and open-ended questionnaire items suggest that they are not familiar with DoD STEM careers and did not spend very much time discussing DoD STEM careers with apprentices. 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.

4. 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. One mentor mentioned that the magnitude of the stipend was below the minimum wage for the state in which the

REAP program was located, and elaborated that paying such a low amount was actually against the state law. If REAP intends to encourage awareness of Army/DoD STEM careers, the compensation should be aligned to the compensation of the career in which the apprentice is participating. The program is encouraged to revisit the funding structure to address the small stipend to the students. SEAP students receive on average $1400/month of their apprenticeship, using a stipend scale based on education and experience. Perhaps AAS could look into a similar approach to student stipends.

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

1. 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).

2. 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. Only 54% of mentors recommended other AEOPs to apprentices. For example, mentors mentioned that they were vaguely aware of other programs and provided some accurate descriptions of the programs. 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.

3. Exposure to DoD STEM careers and research are also areas targeted for improvement for REAP. Some strategies that the program may consider are having webinars for students, creating DoD STEM career information and materials, and recruiting speakers in different STEM disciplines to enhance the program. Currently the program is exploring the possibility of all students talking with each other through a webinar format. The program should also provide mentors with materials (website links, printed materials) that can be easily shared with interested apprentices. AAS is encouraged to find a way to provide a forum for REAP PIs and mentors to share best practices and experiences with other AEOPs and DoD careers/research. The AEOP CAM or Consortium Lead could develop and make available Power Point slides promoting both AEOP and DoD STEM careers and research.

Appendix I: 2015 Science & Engineering Apprenticeship Program (SEAP) Evaluation Executive Summary

The Science & Engineering Apprenticeship Program (SEAP), managed by the American Society for Engineering Education (ASEE) in 2015, is an Army Educational Outreach Program (AEOP) that matches talented high school students (herein referred to as apprentices) with practicing Army Scientists and Engineers (Army S&Es, herein referred to as mentors), creating a direct apprentice-mentor relationship that provides apprentice training that is unparalleled at most high schools. SEAP apprentices receive firsthand research experience and exposure to Army research laboratories during their summer apprenticeships. The intent of the program is that apprentices will return in future summers and continue their association with their original laboratory and mentor and upon graduation from high school participate in the College Qualified Leaders (CQL) program or other AEOP or Army programs to continue their relationship with the laboratory. Through their SEAP experience, apprentices are exposed to the real world of research, gain valuable mentorship, and learn about education and career opportunities in STEM. SEAP apprentices learn how their research can benefit the Army as well as the civilian community.

In 2015, SEAP provided outreach to 92 apprentices, 73 adult mentors, and 43 Army S&Es at 9 Army laboratory sites (1 lab selected 0 apprentices) herein called SEAP sites. There was no change in the number of apprentices from 2014 to 2015.

This report documents the evaluation of the 2015 SEAP program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for SEAP included post-program questionnaires distributed to all apprentices and mentors, two interviews with apprentices, and an annual program report compiled by ASEE.

2015 SEAP Fast Facts	
Description	STEM Apprenticeship Program – Summer, at Army laboratories with Army S&E mentors
Participant Population	9th-12th grade students
Number of Applicants	633 individual applicants with 1198 applications to specific SEAP sites
Number of Students (Apprentices)	92
Placement Rate	15% or 8%
Number of Army S&E Mentors	116
Number of Army Research Laboratories	9
Number of K-12 Schools	63
Number of K-12 Schools – Title I	11
Number of DoDEA Students	0
Number of DoDEA Schools	0
Total Cost	$325,223.60
Stipend Cost (paid by participating labs)	$272,418.83

Administrative Cost to ASEE	$52,804.77
Cost Per Student Participant	$3,535.04

† There are more SEAP mentors than apprentices as some apprentices receive mentorship from more than one Army S&E.

The response rates for the post-program apprentice and mentor surveys were 64% and 18%, respectively. The margin of error for both surveys is larger than generally acceptable (7.9% at 95% confidence[20] for the apprentice survey and 21.7% at 95% confidence for the mentor survey), indicating that the samples may not be representative of their respective populations and caution is needed in interpreting the results.

Summary of Findings

The FY15 evaluation of SEAP collected data about participants; their 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.

2015 SEAP Evaluation Findings	
Participant Profiles	
SEAP continued to serve students from historically underrepresented and underserved populations, providing evidence that the program disseminated information about SEAP to a diverse audience.	The proportion of females - a population that is historically underrepresented in engineering fields - participating in SEAP increased from 40% in FY14 to 45% in FY15.
	SEAP continued to serve students from historically underrepresented and underserved race/ethnic groups at similar rates as in FY14. Of enrolled apprentices in FY15, 14% identified as Black or African American (13% in FY14) and 2% as Hispanic or Latino (1% in FY14). Although there was a small increase in the percentage of students identifying with these groups, this remains an area for potential growth.
SEAP experienced limited success in recruiting GEMS participants to SEAP.	Although no SEAP apprentices reported past participation in programs such as JSHS and JSS, 32% reported having participated in GEMS at least once. This is a slight increase over FY14 when 30% of SEAP participants reported being alumni of GEMS, but falls short of the goal for FY15 of 40% of SEAP participants being GEMS alumni. GEMS mentors (66%) in FY15 reported discussing SEAP with GEMS participants and 37% of GEMS participants indicated interest in participating in SEAP in the future.
SEAP did not reach its targeted number of program applicants.	The program fell short of its FY15 goal of 900 applicants and received fewer applications (22% decrease) in FY15 than in FY14 (633 versus 810).
Actionable Program Evaluation	

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

Pre-existing relationships continue to be a factor in SEAP recruitment, however website applications played an increased role in apprentice recruitment.	As in FY14, references from workplace colleagues and applications from the ASEE or AEOP websites were the most commonly reported methods of apprentice recruitment. However, in FY15, slightly more mentors reported that website applications were a key recruitment strategy (29% in FY15 versus 24% in FY14) and fewer reported personal references as a key strategy (33% in FY15 versus 41% in FY14).
	As in FY14, apprentices in FY15 most commonly learned about SEAP from personal relationships including family members (39%) and past participants of the program (36%). The AEOP website, however, was cited by only 25% of apprentices as a method of learning about SEAP.
SEAP apprentices continue to be motivated by a variety of factors, although apprentice stipends were a key motivator for participation.	A range of factors motivated apprentices to participate in SEAP. Apprentice stipends were a major motivator with 67% of respondents reporting that stipends "very much" motivated them to participate. Other factors included exploring a unique work environment (35%), SEAP mentors (27%), and learning in ways that are not possible in school (27%).
SEAP engaged apprentices in meaningful STEM learning.	Over 90% of apprentices reported interacting with scientists or engineers, applying STEM to real life situations, and learning about STEM topics new to them on most days or every day of their apprenticeship. Likewise, over half of apprentices reported communicating with other students about STEM, learning about careers that use STEM, and learning about new discoveries in STEM on most days or every day.
	Apprentices reported engaging in a variety of STEM practices during their SEAP experience. For example, a large majority of apprentices reported participating in hands-on STEM activities every day or most days (92%), analyzing data or information (91%), and using laboratory procedures and tools (81%).
	Apprentices reported markedly greater opportunities to learn about STEM and engage in STEM practices in SEAP as compared to their typical school experiences.
	All responding mentors reported using a variety of teaching and/or mentoring activities to meet students' needs. Mentors also used a variety of other strategies to support the diverse needs of their students as learners, including identifying student learning styles (79%) and directing students to other individuals or programs for additional support (79%). Similarly, mentors used a variety of strategies to support student collaboration and interpersonal skills. These strategies included having students listen to the ideas of others with an open mind (92%), having students explain difficult ideas to others (88%), and having students work on collaborative activities or projects (88%). Mentors also supported apprentices' engagement in authentic STEM activities using a variety of strategies including demonstrating laboratory/field techniques, procedures, and tools (92%), providing students with constructive feedback (92%), had having students work independently to improve their self-management abilities (92%).
SEAP promotes apprentice awareness of DoD STEM research and careers.	Apprentices reported overwhelmingly positive opinions about DoD researchers and research. For example, apprentices reported that they believe that DoD research is valuable to society (96%) and that DoD researchers advance science and

	engineering fields (94%).
	Nearly all apprentices (92%) reported learning about at least one DoD STEM career during their participation in SEAP. Apprentices found participation in SEAP and their mentors to be the most impactful resources in learning about DoD STEM careers while mentors reported that participation in SEAP and the SEAP program administrator or site coordinator were the most useful resources in their efforts to expose apprentices to DoD STEM careers.
SEAP has an opportunity to improve mentor and apprentice awareness of and marketing of other AEOP opportunities.	Most apprentices reported never hearing about or never participating in most AEOP programs beyond SEAP. One exception to this was the GEMS program; over a quarter of SEAP apprentices reported participating in GEMS at least once. Similarly, responding mentors generally had little awareness of or past participation in other AEOP programs, although a quarter reported participating in GEMS at least once in the past.
The SEAP experience is valued by apprentices and mentors.	The number of SEAP mentors increased by 18% in FY15 (compared to FY14). Apprentices and mentors were asked about their overall satisfaction with the SEAP program. Nearly all respondents had overall positive perceptions of the program. While 15% of apprentices reported being not at all satisfied with "other administrative tasks" associated with SEAP, this is an improvement over FY14 when 31% reported dissatisfaction with administrative aspects of the program. In responses to an open-ended item asking about their satisfaction with the SEAP program. The vast majority of apprentices (93%) reported being at least somewhat satisfied with instruction or mentorship during the program and 89% reported being at least somewhat satisfied with their working relationship with their group or team. Likewise, mentors reported being somewhat or very satisfied with program features such as communication with the SEAP site (88%), the research presentation process (83%) and research abstract requirements (82%).
Outcomes Evaluation	
SEAP apprentices reported gains in STEM knowledge and competencies.	A large majority of apprentices reported large or extreme gains in their STEM knowledge, including what everyday research work is like in STEM, how professionals work on real problems in STEM, and knowledge of a STEM topic or field, as a result of their SEAP participation.
	Apprentices reported large or extreme gains in a variety of STEM competencies as well, including carrying out procedures for an experiment and recording data accurately; designing procedures for an experiment appropriate for the question to be answered; identifying the limitations of methods and tools used for data collection; defining a problem that can be solved by developing a new or improved object, process, or system; and organizing data in charts or graphs to find patterns and relationships.
SEAP participants reported gains in 21st Century Skills.	Apprentices reported gains in their 21st century skills as a result of participating in SEAP. In particular, the majority of apprentices reported large or extreme gains in areas such as their ability to make changes when things do not go as planned, viewing failure as an opportunity to learn, learning to work independently, and communicating effectively with others.

SEAP participants reported increased confidence and identity in STEM.	Apprentices reported gains in their confidence and STEM identity, including large or extreme gains in areas such as a sense of accomplishing something in STEM, confidence to try out new ideas or procedures on their own in a STEM project, and deciding on a path to pursue a STEM career.
SEAP participants reported increased interest in future STEM engagement.	Apprentices reported that after participating in SEAP they were more likely to engage in STEM activities outside of school. A majority of apprentices indicated that they were more likely to engage in activities such as working on a STEM project or experiment in a university of professional setting, mentor or teach other students about STEM, and talk with friends and family about STEM.
SEAP participants reported aspiring to advanced degrees and STEM careers with little overall change in education or career aspirations after participating in the program.	Most apprentices indicated wishing to pursue an advanced degree both before and after SEAP, although somewhat more students expressed interest in a degree in a medical field after SEAP participation.
	Most apprentices expressed interest in STEM-related careers both before and after participating in SEAP.
SEAP participants show interest in future AEOP opportunities.	A majority of apprentices indicated being "very much" interested in participating in SEAP again (67%) and in CQL (51%). Another 41% were very interested in SMART, and about a quarter of participants expressed a high level of interest in both URAP and the GEMS Near Peer Mentor Program.

Recommendations

Evaluation findings indicate that FY15 was a successful year overall for the SEAP program. Notable successes for the year include an increase in the percentage of female participants over FY14, evidence of increased use of the ASEE and AEOP websites, and evidence of a growing AEOP pipeline with 32% of SEAP apprentices reporting that they were alumnae of GEMS, and 82% of apprentices indicating that they are familiar with CQL. Apprentices and mentors continue to report high levels of satisfaction with the program and with mentor-apprentice relationships. Both groups likewise report strong apprentice gains in STEM knowledge and competencies as a result of the SEAP experience.

While these successes 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. The AEOP goal of attracting students from groups historically underrepresented and underserved in STEM has been met with limited success in SEAP. Most apprentices reported learning about SEAP through personal connections, suggesting that the pool of SEAP applicants has not broadened considerably over previous years. This is borne out by enrollment statistics showing little increase in the numbers of students identifying as Black or African American and Hispanic or Latino. The lack of growth in SEAP apprentices from groups historically underrepresented and underserved groups is influenced by various factors including the recruitment and selection process and the marketing of SEAP to target groups. The program may want to consider additional/alternate means of broadening

the pool of applicants and devising strategies for recruiting and selecting apprentices and mentors to ensure that SEAP includes diverse groups of highly talented participants. For example, the IPA may choose to place a cap on the number of students accepted in the program who are related to lab personnel; once this cap is reached, mentors would then need to select students based upon their qualifications and aptitude rather than relationships.

2. The percentage of applicants who are recruited outside of existing connections with Army Labs needs to be increased. The AEOP wants to ensure the programs (including SEAP) have a fair and competitive selection process. If only 29% of mentors are using the online application to select participants, the selection process can and should be improved substantially. It is recommended that SEAP mentors utilize the online application as the primary means of selecting participants to insure the selection process is fair and competitive in the future.

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

1. There is a continued need for SEAP to grow the number of participating mentors in the program. Even with a reduced number of apprentice applications in FY15 as compared to FY 14 (633 versus 810), there is substantial unmet need in terms of mentor capacity with only 92 students (15% of applicants) being placed. In order to expand the program beyond its current size, the program will need to actively recruit additional Army S&Es to serve as mentors. These recruiting efforts may focus on communicating the value of the AEOP pipeline to potential mentors by highlighting success stories of apprentices who proceeded through SEAP into other AEOP programs and into successful STEM careers. It may be necessary to examine the procedures and resources used to recruit SEAP mentors and identify factors that motivate and discourage Army S&Es from assuming this role.

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

1. The effectiveness of SEAP program administration continues to be a concern. Although the level of satisfaction with administrative tasks was higher in FY15 than in FY14, apprentice and mentor responses indicate that there is yet room for improvement. While apprentices and mentors were positive overall about their SEAP experiences, concern was expressed regarding in-processing procedures such as receiving computer access and communication between SEAP organizers and apprentices. Additionally, some apprentices reported finding the application process confusing and identified this as an area for potential improvement. As the Academy of Applied Science assumes the administration of SEAP, it should be mindful of these issues and leverage its past experience with administering apprenticeship programs to streamline processes and improve communication with apprentices. It is recommended that AAS implement separate SEAP/CQL applications for each lab.

2. There is continued room for improvement in marketing of other AEOPs within the SEAP program. As a starting point for SEAP there could be much more effort in promoting other AEOP programs (e.g., welcome packet with information on applicable AEOP programs). Further, to create a robust pipeline of AEOP programs in which students progress from other AEOPs into SEAP and beyond, the program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. Given the FY15 objective of encouraging more

GEMS alumni to participate in SEAP, program administrators may with to work closely with the GEMS program to devise ways of disseminating SEAP information to GEMS participants and alumni. It is notable that 50% of mentors reported explicitly discussing CQL with their apprentices. At the same time, however, less than half discussed SMART (38%) and GEMS (33%), and only 9% discussed GEMS Near Peer Mentors with their apprentices. Since mentors provide much of the information apprentices receive during SEAP, efforts should be made to ensure that mentors are informed about the range of AEOPs. Other means of educating apprentices about AEOPs should be combined with mentor information, especially given the very real consideration of mentor time constraints in working with apprentices. This could include incorporating AEOP information into orientation materials and alumni communications. Given the limited use of AEOP website, print materials, and social media, the program should consider how these materials could be more effectively utilized to provide students with targeted program information.

3. The SEAP programs' participation in the overall AEOP evaluation has been less than desired. The continued low response rates for both apprentice and mentor questionnaires (50% and 21%) raise questions about the representativeness of the results. It is recommended that SEAP/AAS continue to emphasize the importance of these evaluations with individual program sites and communicating expectations for evaluation activities to take place on-site during the program. Finally, there is a need for increased Army leadership support for evaluation participation at the Army labs.

Appendix J: 2015 Unite Evaluation Executive Summary

Unite managed by the Technology Student Association (TSA), is an AEOP pre-collegiate program for talented high school students from groups historically underrepresented and underserved in science, technology, engineering, and mathematics (STEM). Unite encourages and helps prepare high school students to pursue a college education and career in engineering and other STEM-related fields. In a four to six-week summer program at a partner university, Unite provides academic and social support to participants so that they have the ability and confidence to become successful engineers.

This report documents the evaluation of the FY15 Unite program. Virginia Tech, in collaboration with TSA, collected the FY2015 evaluation data for the Unite program. Purdue University, the new evaluation lead, prepared the FY2015 evaluation reports, which addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for Unite included questionnaires for students and mentors, 12 interviews with students and 15 with mentors, and an annual program report compiled by TSA. Unite sites included Alabama State University (ASU), University of Colorado, Colorado Springs (UCCS), Florida International University (FIU), Savannah State University (SSU), Xavier University of New Orleans (XULA), Jackson State University (JSU), New Jersey Institute of Technology (NJIT), University of New Mexico (UNM), University of Pennsylvania (UPENN), and South Dakota School of Mines and Technology (SDSMT).

2015 Unite Fast Facts	
Description	STEM Enrichment Activity: Pre-collegiate, engineering summer program at university host sites, targeting students from groups historically underserved and under-represented in STEM
Participant Population	Primarily rising 11th grade students from groups historically underserved and under-represented in STEM
Number of Applicants	491
Number of Students	200
Placement Rate	41%
Number of Adults	112
Number of Army S&Es	9
Number of Army Agencies	6
Number of K-12 Teachers	51
Number of K-12 Schools	129
Number of K-12 Schools – Title I	36‡
Number of College/Universities	10
Number of HBCU/MSIs	7
Total Cost	$ 323,632
Stipend Cost	$86,300
Cost Per Student Participant	$1,619

‡ *Data from Unite reflects the number of participants from Title I schools rather than the number of Title I schools.*

Summary of Findings

The FY15 evaluation of Unite collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to AEOP's and Unite's objectives and intended outcomes. A summary of findings is provided in the following table.

2015 Unite Evaluation Findings	
Participant Profiles	
Unite experienced growth in program interest and participation from most underrepresented groups, but fewer females and students from K-12 Title I schools were represented.	Unite was successful in achieving a 12% increase in applicants to the program in FY15. Enrollment data indicate that the overall enrollment increased 6% (FY15 200 participants; FY14 189 participants). However, the number of participating K-12 Title I schools decreased by 32% and the participation of females decreased in FY15 (45%) from FY14 (65%).
	In FY15, Unite enrollment included students from historically underrepresented and underserved minority race/ethnicity and low-income groups. Records indicate that a majority (39%) of students who indicated a race/ethnic category identified as Black or African American, and 14% as Hispanic or Latino/a. A majority of students responding to the evaluation questionnaire reported qualifying for free or reduced-price lunch (51%). Attracting a majority of students from historically underrepresented and underserved groups and free or reduced price lunch qualifiers as Unite students were also evident in 2014, demonstrating a consistent pattern, though percentages for each group decreased in FY15.
	Unite served students from school contexts that tend to have a higher number or proportions of underserved groups. Most student questionnaire respondents attended public schools (78%) and schools in urban settings (44%) or frontier/tribal schools (8%).
Demographic characteristics of Unite mentors reflect the diversity of the student participants.	STEM mentors, including university faculty, high school and university students, local teachers, and industry STEM professionals consisted of 44% females. Although 55% of Unite mentors chose not to report race/ethnic identity, a majority (31%) of the responding mentors identified as Black or African American.
Actionable Program Evaluation	
Unite is successfully reaching out to schools and teachers serving historically underrepresented and underserved groups, but more could be done with digital communication.	A multi-pronged effort to market programs to and recruit students from schools and school networks identified as serving large populations of traditionally underrepresented and underserved students was successful in attracting and accepting positions as participants and mentors. Personal contacts and websites were the most frequently reported forms of information to learn about Unite. However, efforts such as university websites and social media (Facebook) were least frequently mentioned as sources of learning about Unite.
	Students most frequently learned about the local Unite program from past participants (18%), or mentors from the Unite program (16%). Only 3% of students reported learning about Unite from social media. Likewise, mentors reported learning about Unite from past participants (64%) and 0% of mentors learned about Unite from social media.

Students are motivated to learn more about STEM through Unite programs.	Students were most frequently motivated to participate in Unite by the desire to learn something new or interesting (49%) and because of their interest in STEM (62%).
Unite successfully engages students in team-based, hands-on STEM learning that is meaningful.	80% of responding students indicated working as part of a team on most days or every day, 71% reported participating in hands-on activities and 69% reported analyzing data or information on most or every day.
	In addition, students indicated being integrally involved the work of STEM on most days or every day, including posing questions to investigate (68%), coming up with creative explanations or solutions (65%), using laboratory procedures and tools (62%), drawing conclusions (62%), designing investigations (57%), and carrying out investigations (60%). The amount of student engagement in STEM practices in Unite has remained consistently high in all items as compared to 2014
	Students reported greater opportunities to learn about STEM and greater engagement in STEM practices in their Unite experience than they typically have in school.
	The majority of mentors reported that students engaged in STEM activities that were meaningful and authentic, indicating that perceptions of the usefulness of activities for students and mentors were aligned.
Unite promotes overall STEM research and careers but can improve marketing of other AEOP opportunities.	Unite sites offered a variety of activities for promoting STEM careers, including interactive expert panels, off- and on-campus STEM expos, and field trips to Army, university, and other research labs and facilities. In open-ended question responses, Unite students mentioned these activities as the most impactful.
	Similar to findings of the FY14 Unite evaluation, 80% of Unite students are unaware of other AEOP programs when they register for Unite. Further, most mentors had no awareness of or past participation in an AEOP initiative beyond Unite. As was the case in FY14, mentors report that they mention apprenticeship opportunities, but do not discuss specific programs in AEOP.
	Participation in Unite (68%), invited speakers or career events (58%), and students' mentors (60%) were most often reported as being somewhat or very much responsible for student awareness of DoD STEM careers. The 2015 percentages were similar to the trends found in 2014.
The Unite experience is greatly valued by students and mentors.	Mentors and students were very satisfied with the Unite program. The categories that were most mentioned were field trips or laboratory tours, physical location of Unite activities, communication with the Unite site coordinators, invited speakers or career events, and instruction or mentorship.
	The majority of responding mentors indicated having a positive experience with Unite. Mentors commented that the program provides students a way to deepen their knowledge about STEM and gain insight into a college experience.
Outcomes Evaluation	
Unite increased students' STEM knowledge and competencies, particularly in groups traditionally underserved and	Unite students reported large or extreme gains on their knowledge of how professionals work on real problems in STEM, what everyday research work is like in STEM, a STEM topic or field in depth, the research processes, ethics, and rules for conduct in STEM, and research conducted in a STEM topic or field. Students who qualified for free and reduced lunch reported higher gains in STEM knowledge

underrepresented in STEM.	compared to students who did not qualify for free and reduced lunch programs.
	Although a vast majority of students reported that Unite contributed to gains in knowledge about science and engineering practices, students who qualified for free and reduced lunch reported higher gains in science and engineering practices compared to students who did not qualify for free and reduced lunch programs.
Unite increased participating students' 21st Century Skills.	Over 75% of the students reported extreme or large gains in all of the 21st Century Skills. Low-SES students reported higher gains on 21st Century Skills Gains compared to students with higher-SES due to the Unite program.
The number of Unite mentors and participating Army agencies decreased in FY15. However, Unite mentors were skilled in supporting students traditionally underserved or underrepresented in STEM.	The number of Unite mentors and participating Army agencies both decreased by 55% in FY15 compared to FY14. 100% of mentors reported treating all students the same way, regardless of gender or race/ethnicity, and 97% indicated using diverse teaching/mentoring activities. Many mentors provided extra readings for students who lacked essential background knowledge and skills (85%), helped students find additional support if needed (79%), tried to find out about student learning styles (76%), and integrated ideas from education literature to teach/mentor students from groups underrepresented in STEM.
Unite succeeded in raising students education aspirations, and students shifted their career aspirations toward STEM after their Unite experience.	After participating in Unite, students indicated being more likely to go further in their schooling than they would have before Unite, with the greatest change being in the proportion of students who expected to continue their education beyond a Bachelor's degree (48% before Unite, 73% after).
	Students 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. More students shifted away from medical careers toward engineering and computer science careers after Unite.
Unite students show substantial interest in future AEOP opportunities, but are largely unaware of the specifics of joining other AEOP programs.	The majority of students indicated wanting to participate in another AEOP program after Unite, however 20% indicated they had not heard of other AEOP programs even after the Unite experience. Only 61% of mentors recommended other AEOP programs to students.
Unite continues to successfully raise awareness of STEM research and careers overall, and DoD STEM research and careers specifically.	99% of students indicated they were aware of STEM careers because of Unite, and 86% reported learning about STEM DoD careers in Unite. Further, more mentors discussed STEM careers within the DOD or government in 2015 than in 2014 (57% in 2014, 62% in 2015). However, the number of participating Army S&E's decreased by 55% in FY15.
Unite provides STEM experiences for students that are not typically experienced in school.	To examine how the Unite experience compares to their typical school experience, students were asked how often they engaged in the same activities in school. Scores were significantly higher on the "in Unite" versions of both composites than on the in school versions. These data indicate that Unite provides students with more intensive STEM learning experiences than they would typically receive in school.

Recommendations

Evaluation findings indicate that FY15 was a successful year for the Unite program. Unite has had consistent success attracting both students and mentors from traditionally underrepresented and underserved groups. This success may be attributed to Unite's program focus being only on including underrepresented and underserved participants[21]. Unite has experienced success in recruiting diverse STEM mentors and have had women, Black or African American, and Hispanic and Latino/a students and mentors in FY14 and FY15. Students and mentors overwhelmingly reported their satisfaction with the Unite experience. In particular, Unite has shown to increase student STEM experiences, science and engineering practices and has promoted awareness of STEM careers with the students. The mentors have reported they have used effective instructional techniques that students report are engaging. The Unite program succeeded in increasing STEM knowledge and skills of students, increasing mentor and student diversity, encouraged students to pursue additional post-graduate studies, and providing an authentic hands-on experience for students.

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

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

1. AEOP objectives include expanding participation of historically underrepresented and underserved populations. In 2014 and 2015, Unite has engaged a majority of female, Black or African American, and Hispanic or Latino/a students and mentors, which is a positive trend. Future marketing efforts could focus on the need for a more diverse pool of STEM professionals, and take the opportunity to showcase the diversity of mentors in electronic and printed materials.

2. Student and mentor recruitment for Unite is largely accomplished with personal interactions, either by knowing a professor or peer who attended Unite previously. Only a few respondents mentioned the AEOP website as their initial source of information about Unite, and only 1% of students and no mentors mentioned social media as a source. As a result, the ability of Unite to recruit underserved or underrepresented populations of students depends upon the diversity of the schools in which recruitment takes place. Thus, the program may want to emphasize recruiting a more diverse pool of mentors and students by considering social media communication plans. Social media has the potential to reach more students and mentors than personal connections.

3. Unite is very effective in giving students authentic opportunities to engage in STEM knowledge and skills, and for mentors to build the next generation of STEM professionals. Nearly all mentors reported asking students to relate outside events or activities to topics covered in the program and giving students real-life problems, and a vast majority helped students see how STEM can affect them or their communities. Almost all mentors tried to learn about the students and their interests at the beginning of the program. However, one area that was weak in terms of mentor-student interactions was the mentors selecting readings or activities the related to students'

[21] Underserved populations are inclusive of low-income students, students belonging to race and ethnic minorities that are historically underrepresented in STEM (e.g., Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders), students with disabilities, students with English as a second language, first generation college students, students in rural and frontier schools, and females in certain STEM fields (e.g., physical science, computer science, mathematics, or engineering).

backgrounds, and mentors highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM. Given that Unite is doing a good job recruiting minority populations in STEM, the program is encouraged to systematically incorporate materials for the mentors to share successes of minority populations in STEM.

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

1. Few mentors were aware of specific AEOP programs and even fewer mentors explicitly discussed other AEOP opportunities with their students. This lack of awareness is a barrier in communicating about other AEOP opportunities. In an effort to increase and standardize the information provided to students, it would be beneficial to create a resource that profiles AEOP programs and the relationship they have to ongoing education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about AEOP programs and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific AEOP opportunities. The application to be a mentor could ask for their plan to explicitly discuss these resources thus expanding the network of ongoing opportunities for the students. This is particularly important for Unite since it engages students before students make decisions about college and career.

2. Unite program administrators may also want to build in systematic opportunities to provide this information to their students about DoD STEM research and careers. The field trips informed students about science and engineering opportunities with the Army, but because of the variety of locations of Unite programs, the field trips are not consistent from site to site. In an effort to increase and standardize the information provided to students, it would be beneficial to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army careers. Further, efforts should be focused on growing the participation of more Army S&E's in the Unite program. Engaging more S&E's will provide more opportunities for participants to interact with real-world Army/DoD role models. These suggested resources could not only start the conversation about Army STEM careers and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific Army/DoD STEM research and careers.

3. Efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the mentor questionnaires raise questions about the representativeness of the results. Low response rates were a concern during the 2013, 2014 and 2015 questionnaire administration, and this indicates an ongoing problem for survey response rates. Improved communication with the individual program sites about expectations for the Unite evaluation study may help. In addition, the evaluation instruments may need to be streamlined as the questionnaires are quite lengthy (estimated response time 45 minutes) and response fatigue can affect participation.

Appendix K: 2015 Undergraduate Research Apprenticeship Program (URAP) Evaluation Executive Summary

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

Apprentices receive an educational stipend equivalent to $10 per hour and are allowed to work up to 300 hours total. The apprentices contribute to the research of the laboratory while learning research techniques in the process. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the program, the apprentices prepare abstracts for submission to the US Army Research Office Youth Science programs office.

This report, prepared by the consortium evaluation team with based in part on data from the U.S. Army Research Office, documents the administration of 2015 URAP. The intent is to provide key data points from 2015 URAP as well as a contextualized understanding of administration decisions and program achievements.

In 2015, URAP provided outreach to 48 apprentices and 40 mentors at 36 Army-sponsored university/college laboratory sites. Participant enrollment in URAP decreased 18.5% in FY15. However, there was a 29% increase in mentors (31) from FY14. There were nine more Army-sponsored university/college laboratory sites in FY15 than in FY14. This report documents the evaluation of the 2015 URAP program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for URAP included: in-person interviews with apprentices and mentors conducted online or over the telephone and online post-program questionnaires distributed to all apprentices and mentors.

2015 URAP Fast Facts	
Description	STEM Apprenticeship Program – Summer, in Army-funded labs at colleges/universities nationwide, with college/university S&E mentors
Participant Population	College undergraduate students
Number of Applicants	104
Number of Students (Apprentices)	48
Placement Rate	46%
Number of Adults (Mentors)	40
Number of Army-Funded College/University Laboratories	36
Number of HBCU/MSIs	7
Total Cost	$173,909.50
Admin/Overhead Costs (Host Sites)	$27,373.50

Total Stipends	$146,536.00
Cost Per Student Participant	$3,700.20

Summary of Findings

The 2015 evaluation of URAP collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the following table.

2015 URAP Evaluation Findings	
Participant Profiles	
URAP continues to be a popular and selective program	Over 100 applications were received for the URAP program (an increase of 13% from FY14). Of the 104 applications for apprenticeships, only 48 students were selected, yielding an acceptance rate of 46%, which is competitive. The placement rate for FY15 decreased 20% from FY14. 22 URAP sites were also sites for the HSAP program.
Although URAP has increased numbers of Hispanic or Latino/a apprentices, outreach efforts are not motivating other historically underrepresented populations to apply.	More female and Hispanic or Latino/a apprentices participated in 2015 than in 2014. In 2014 there were 28% females and 3% Latino/a apprentices, and in 2015 this increased to 35% females and 11% Latino/a apprentices.
	Black or African American apprentice attendance was similar to 2014 at 13%, and URAP has low proportions of apprentices identify as Native American or Alaskan Native (0%), and Native Hawaiian (0%). Twenty-one percent of the apprentices identify as Asian.
URAP has had some success in recruiting diverse STEM mentors.	The number of overall mentors increased 22% in FY15. Although white mentors increase from 38% in 2014 to 54% in 2015, URAP gained 7% more Black or African American mentors.
Actionable Program Evaluation	
URAP apprentices and mentors marketed almost exclusively by the universities or colleges that host URAP	ARO continued to market and recruit URAP mentors from university or college laboratories that conduct Army-sponsored research. Subsequently, university or college researchers marketed and recruited URAP apprentices using university or college channels.
	There are a variety of ways that apprentices learned about URAP including: through local connections (university personnel, advertisements, classes), or other acquaintances associated with URAP site. Several apprentices reported previous connections with their mentor prior to URAP. One of the primary objectives for the URAP program is to expose new students to research opportunities. However, mentors benefit from having some continuity with apprentices as returning apprentices are able to contribute more to the lab's work. Thus, since this

	recommendation was also made in FY14, the program should continue to try to find the right balance between recruiting new participants and retaining existing students while affirming that each selected apprentice is an appropriate candidate overall.
The 2015 URAP apprentices had few prior experiences with URAP or any other AEOP program.	In 2013 and 2014, many apprentices and mentors had existing associations prior to URAP. Only a few 2015 URAP apprentices had prior experiences with AEOP programs. This could suggest an opportunity to continue this relationship through subsequent years and make the current URAP apprentices aware of the opportunity to reapply. URAP should investigate the application/selection process to ensure it is meeting the goal of involving new students in URAP.
URAP further engages apprentices who come to the experience with high interest in STEM through hands-on activities that are meaningful.	Apprentices reported that they were motivated to participate in URAP by their interests in STEM (47%) and the desire to expand laboratory or research skills (47%).
	Most apprentices (90%) had opportunities to engage in a variety of STEM practices during their URAP experience such as interacting with scientists and engineers and communicating with other students about STEM.
	Most apprentices (70-93%) report participating in hands-on activities, using laboratory procedures and tools, analyzing data, working as a team, and coming up with creative solutions on most days or every day of their URAP experience.
	Apprentices reported increased opportunities to learn about STEM and higher engagement in STEM practices during their URAP experience than compared with their daily school activities.
	Mentors reported making learning activities relevant to apprentices, supporting the needs of diverse learners, developing apprentices' collaboration and interpersonal skills, and engage apprentices in "authentic" STEM activities.
URAP can improve the communication of STEM careers to the apprentices and marketing of other AEOP opportunities.	Although approximately 90% of apprentices reported engaging in a variety of STEM practices, only 41% reported learning about different careers that use STEM. Many apprentices (63%) reported that they had not learned about any DoD STEM jobs/careers during the program, although 11% indicated that they learned about 5 or more DoD STEM jobs/careers during URAP. These data are similar to the data reported in 2014.
	The majority of mentors had no awareness of or past participation in an AEOP initiative beyond URAP and had not heard of other AEOPs. Mentors were aware of the existence of other AEOP programs but were unable to name any of them in interviews. No strategies for addressing this were discussed in the FY15 URAP Annual Report.
URAP offers meaningful experiences to both apprentices and mentors.	100% of apprentices reported satisfaction with their URAP experience. Among the most appreciated experiences were: opportunities to learn about STEM fields and careers, and opportunities for engaging in STEM learning outside of the classroom.
	Most responding mentors reported a positive and meaningful experience as well and expressed interest in working with URAP again.

Outcomes Evaluation	
URAP positively impacted apprentices' STEM knowledge and competencies, and 21st Century Skills.	Positive impacts on STEM knowledge, competencies, and 21st century skills were reported by participants including: large or extreme gains in knowledge of how professionals work on real problems in STEM; what everyday research work is like in STEM; a STEM topic or field in depth; the research processes, ethics, and rules for conduct in STEM; and research conducted in a STEM topic or field. These impacts were ubiquitous across all apprentice groups.
	Apprentices also reported impacts on their abilities to do STEM, including such things as applying knowledge, logic, and creativity to propose solutions that can be tested; making a model that represents the key features or functions of a solution to a problem; communicating information about their design processes and/or solutions in different formats; supporting a proposed explanation with data from investigations; and using mathematics to analyze numeric data.
	Apprentices reported large or extreme gains in their ability to have patience for the slow pace of research, sticking with a task until it is complete, making changes when things do not go as planned, learning to work independently, setting goals and reflecting on performance, building relationships with professionals in a field, and having a sense of being part of a learning community.
URAP helped apprentices' create a stronger STEM identify and gain confidence in learning and doing STEM.	Apprentices reported a large or extreme gain in feeling responsible for a STEM project or activity, confidence to do well in future STEM courses, ability to build academic or professional credentials in STEM, preparedness for more challenging STEM activities, feeling like a STEM professional, feeling like part of a STEM community, and trying out new ideas or procedures on their own in a STEM project.
	Apprentices reported a high likelihood that they would engage in additional STEM activities outside of school. A majority of apprentices indicated that as a result of URAP, they were more likely to work on a STEM project or experiment in a university or professional setting, to talk with friends or family about STEM, and to help with a community service project related to STEM.
URAP raised apprentices' education aspirations, and shifted their career aspirations toward a variety of STEM careers.	Apprentices indicated being more likely to go further in their schooling than they would have before URAP, with the greatest change being in the proportion of apprentices who expected to continue their education to a Ph.D. (30% before URAP, 48% after).
	Apprentices were asked to indicate what kind of work they expected to be doing at age 30. Although many of the students wanted to participate in STEM careers before URAP, some of the apprentices shifted their interest away from medicine to computer science.

URAP apprentices and mentors are largely unaware of AEOP initiatives, and mentors often do not explicitly discuss other AEOPs with apprentices.	Only two of the mentors indicated that they explicitly discussed any specific AEOP programs with the apprentices. The interviews confirmed the survey data, and mentors explained that they were aware of other programs but were not aware of the specifics. URAP should work to communicate information about AEOP opportunities (e.g., webinars, packets, etc.)

Recommendations

Evaluation finding indicate that FY15 was a successful year for the URAP program. URAP had a very competitive 48% acceptance rate of the apprentice applicants, which indicates there is great interest in this program. From the high quality applicants (mentors and apprentices), there were 40 mentors and 48 apprentices selected. URAP has experienced success in recruiting diverse STEM mentors and have had increased numbers of women and Hispanic and Latino/a apprentices in FY15. Mentors overwhelmingly reported their satisfaction with the apprentices and apprentices reported their satisfaction with their mentor and with the URAP experience. Mentors indicated they use innovative and research-based strategies to engage apprentices in STEM activities, and the apprentices similarly report increased ability to engage in STEM activities and have STEM habits of mind, due to the URAP experience. Apprentice educational aspirations were reportedly increased due to the URAP experience, most notably in an 18% increase of apprentices wanting to pursue a Ph.D. after the URAP experience. Additionally, engaging in more hands-on STEM experiences motivated the apprentices, which was delivered by their URAP experience. The URAP program succeeded in increasing STEM knowledge and habits of mind of apprentices, increasing mentor and apprentice diversity, and providing an authentic hands-on experience for apprentices that was a professional development experience for mentors.

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

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

1. AEOP objectives include expanding participation of historically underrepresented and underserved populations. URAP has made some progress in this area, as it was noted as an area for improvement in the FY14 evaluation report. Between 2014 and 2015, URAP has engaged more female and more Hispanic or Latino/a mentors, which is a positive trend. Future marketing efforts could focus on the need for a more diverse pool of STEM professionals, and take the opportunity to showcase the diversity of mentors in electronic and printed materials.

2. A second area that was noted for improvement in FY14 was the need to focus more on recruiting students from underrepresented populations. Similar to past years, in URAP, recruitment of apprentices is largely accomplished with personal interactions, either by knowing a professor or peer who attended URAP previously, using professional or academic connections, or mechanisms available to the university or college site. As a result, the ability of URAP to recruit underserved or underrepresented populations of students depends upon the diversity of the universities or colleges in which recruitment takes place. Additionally, the Army and ARO may need to consider practical solutions to the challenge posed by URAP locations, as the student population of some universities and colleges is likely to advantage some groups of students more than others, particularly in

STEM fields. Thus, the program may want to emphasize recruiting a more diverse pool of mentors and apprentices, perhaps specifically targeting Historically Black Colleges and Universities and other Minority Serving Institutions. A focused and strategic plan to engage a more diverse pool of mentors could ultimately engage a more diverse pool of apprentices.

3. URAP is very effective in giving apprentices authentic opportunities to engage in STEM professional activities, and for mentors to build the next generation of STEM professionals. Given the goal of exposing apprentices to Army/DoD STEM research and careers, the program may want to build in systematic opportunities to provide this information to their apprentices. More than half of apprentices who completed the survey reported that they did not learn about any DoD STEM jobs/careers during URAP. Perhaps more importantly, only a few mentors were aware of specific Army/DoD STEM research and careers and even fewer mentors explicitly discussed this with their apprentices. This was an area noted by the FY14 evaluation report as a need for additional focus that has not improved much in FY15. In an effort to increase and standardize the information provided to apprentices, it would be beneficial to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about Army STEM careers and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific Army/DoD STEM research and careers. The application to be a URAP site or a mentor could ask for their plan to explicitly discuss these resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines), thus developing a network of ongoing opportunities for the apprentices.

4. Perhaps more importantly, as in FY14 evaluation findings, only a few mentors were aware of specific AEOP programs and even fewer mentors explicitly discussed other AEOP opportunities with their apprentices. This lack of awareness is a barrier in communicating about other AEOP opportunities. In an effort to increase and standardize the information provided to apprentices, it would be beneficial to create a resource that profiles AEOP opportunities and the relationship they have to ongoing education, on-the-job training, and related research activities of Army careers. Such a resource could not only start the conversation about AEOP programs and motivate further exploration beyond the resource itself, but could be used to train the mentors to learn more about specific AEOP opportunities. The application to be a URAP site or a mentor could ask for their plan to explicitly discuss these resources thus expanding the network of ongoing opportunities for the apprentices.

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

1. Efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the apprentice and mentor questionnaires raise questions about the representativeness of the results. Low response rates were also a concern during the 2013, 2014 and 2015 questionnaire administration. Improved communication with the individual program sites about expectations for the URAP evaluation study may help. In addition, the evaluation instruments may need to be streamlined as the questionnaires are quite lengthy

(estimated response time 45 minutes[22]) and response burden can affect participation. It is recommended that program sites provide time on-site for participants to complete the AEOP evaluation survey.

[22] Berry, S. (2013). How to estimate questionnaire administration time before pretesting: An interactive spreadsheet approach. *Survey Practice, 2*(3). Retrieved from http://www.surveypractice.org/index.php/SurveyPractice/article/view/166. Date accessed: 13 Mar. 2015.