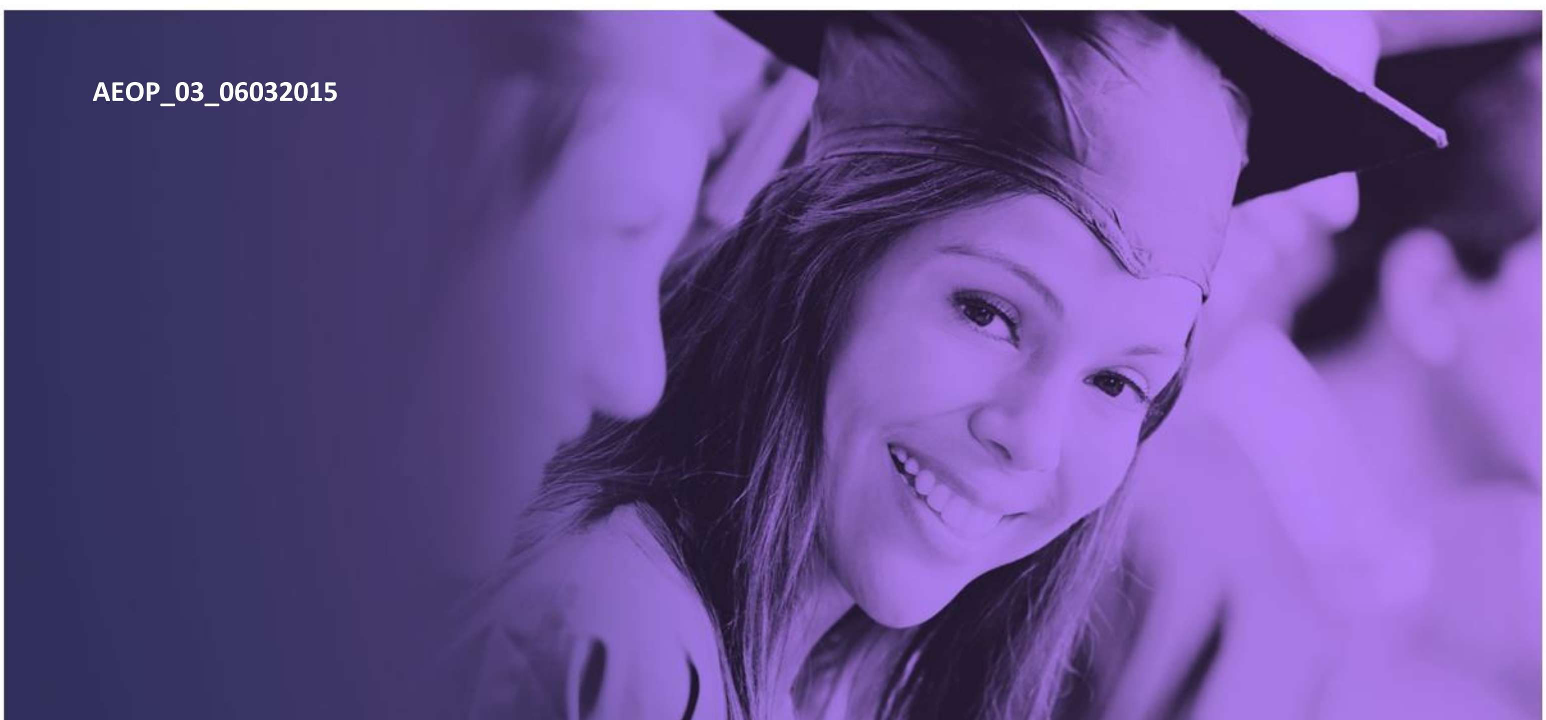
Army Educational Outreach Program

2014 Portfolio Evaluation Report



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Report AEOP_03_05152015 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by Virginia Tech in collaboration with Horizon Research, Inc. under award W911NF-10-2-0076.

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Contents

Executive Summary

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K–college programs and expose 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 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 2014, the AEOP had 51,772 unique program participants, 41,802 were youth program participants and 9,970 were adult participants which included Army Scientists and Engineers (S&Es) in various roles, such as mentors, judges, and presenters. Of the total participants in 2014, 982 students and 71 teachers were from 47 DoDEA schools from the Pacific, Europe and the U.S. The number of unique youth program participants in 2014 were slightly more compared to 2013 (41,475). Despite the West Point Bridge Design Competition no longer being a program under the AEOP in 2014, AEOP still served a growing number of students.

2014 AEOP Participation Numbers			
		Youth	**Adults**
CII	Camp Invention Initiative (Not included in 2014 program evaluations)	860	163
CQL	College Qualified Leaders	307	288
eCM	eCYBERMISSION	29,682	4,582
GEMS	Gains in the Education of Mathematics & Science	2,095	390
HSAP	High School Apprenticeship Program	10	7
JSHS	Junior Science & Humanities Symposium	7,409	3,846
JSS	Junior Solar Sprint	891	341
REAP	Research & Engineering Apprenticeship Program	117	74
SEAP	Science & Engineering Apprentice Program	92	86
UNITE	UNITE	280	162
URAP	Undergraduate Research Apprenticeship Program	59	31
	Total 2014 AEOP Participants	**41,802**	**9,970**

In 2014, the AEOP involved participants from 2,918 K-12 schools, including more than 798 Title I schools. The portfolio of programs also involved 412 colleges/universities, including at least 54 HBCUs/MSIs. AEOP's Camp Invention Initiative was not part of the program evaluations in 2014, but will be considered for evaluations in future programming. The AEOP had 145 separate engagements with Army and DoD research and development laboratories or Army organizations and worked with 34 Army-funded laboratories at colleges/universities. Approximately 1,216 Army and DoD S&Es participated in the 2014 AEOP. More than 982 students and 71 teachers from 47 DoDEA schools in the Pacific, Europe and the U.S. participated in the AEOP through the GEMS, eCM and JSHS programs. Additionally, through the AEOP competition programs (eCYBERMISSION, JSHS, JSS) and UNITE, the AEOP engaged and collaborated with 224 organizations external to schools and the Army and DoD laboratories (e.g. professional STEM organizations, businesses, Technology Student Association state delegations, etc.).

Number of 2014 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 Organizations	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[††]	104	13	10[†]	NA[††]	288	NA[††]
eCM	671	340	98	___[§]	38	NA[††]	266	65
GEMS	755	126	28	3	13[†]	NA[††]	246	NA[††]
HSAP	10	___[§]	7 [†]	3[†]	NA[††]	7	NA[††]	NA[††]
JSHS	1,100	137	102	___[§]	57	NA[††]	300	120
JSS	71	31	NA[††]	NA[††]	3[†]	NA[††]	10	21
REAP	117	97	36[†]	18[†]	NA[††]	NA[††]	NA[††]	NA[††]
SEAP	58	___[§]	NA[††]	NA[††]	9[†]	NA[††]	86	NA[††]
UNITE	121	53[‡]	10[†]	7[†]	12	NA[††]	20	18
URAP	NA[††]	NA[††]	27[†]	10[†]	NA[††]	27	NA[††]	NA[††]
Total Sites	**2,918**	**798[‡]**	**412**	**54**	**145**	**34**	**1,216**	**224**

[†] *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.*
[§] *Data not available.*
[††] *Does not apply.*
** Camp Invention Initiative (CII) was not part of program evaluations in 2014.*

The costs for the individual 2014 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 $2,823 (SEAP) to $3,824 (URAP). CQL is the most expensive of the apprenticeship programs at an average cost of $11,933 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 2014 AEOP competitions ranged from $105 (eCM) to $265 (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 $475 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 $1,286 per student.

2014 AEOP Costs		
	Program Cost	**Cost Per Student Participant**
CII	$193,500	$225
CQL	$3,663,463	$11,933
eCM	$3,127,314	$105
GEMS	$994,139	$475
HSAP	$38,239	$3,824
JSHS	$1,962,881	$265
JSS	$145,535	$163
REAP	$347,392	$2,969
SEAP	$259,719	$2,823
UNITE	$359,940	$1,286
URAP	$210,185	$3,562

The 2014 AEOP portfolio was evaluated by Virginia Tech, the Lead Organization (LO) of the AEOP CA. With the support of the AEOP CA Consortium Members, Individual Program Administrators (IPAs), and Government POCs, Virginia Tech conducted evaluation studies for the CQL, GEMS, HSAP, JSHS, JSS, REAP, SEAP, UNITE, and URAP programs, with data analysis and reporting completed in collaboration with Horizon Research, Inc. David Heil & Associates conducted the evaluation study of eCM. The AEOP program evaluations utilized participant questionnaires, as well as focus groups or interviews with participants and adults who led educational activities or supervised research projects (herein called mentors).

This report summarizes the 2014 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

In 2014, each AEOP evaluation study collected data about participants, their perceptions of program processes, resources, and activities. Additionally, each study collected 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 following table.

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: The AEOP provided outreach to 41,802, students through its comprehensive portfolio of programs. 37,982 students participated in AEOP competitions (eCM, JSHS and JSHS). The AEOP provided 585 STEM apprenticeships (CQL, HSAP, REAP, SEAP, and URAP) and 2,375 students participated in hands-on summer STEM enrichment activities (GEMS and UNITE). However, there is a considerable unmet need with over 8,500 applicants who were not accepted into the programs. • Finding #2: The AEOP provided outreach to many students from underserved and under-represented groups with some programs being more effective at serving these groups than others. While 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. In 2014, more than 95% of the students in REAP and UNITE were from groups that are historically underserved and under-represented in STEM. In addition, 4 of the 11 AEOP elements increased the proportion of students they served from these groups. The other programs had mixed results in this regard and may want to improve outreach to specific underserved and under-represented groups. • Finding #3: In 2014 as in 2013, 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 2013, students participating in the AEOP programs in 2014 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 continues to expand the number of students who are engaged in and exposed to DoD research. Students reported positive attitudes toward DoD STEM research and researchers, which can be attributed to their AEOP experience.

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 #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., CQL and GEMS) at doing so than others (e.g., REAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities are 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. Some programs reported that they encountered barriers when they attempted to engage Army personnel to participate in program activities. • Finding #7: The AEOP programs served both 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 their interest in pursuing DoD STEM careers as a result of participation in AEOP (e.g., GEMS, CQL, HSAP, and JSHS-N). As compared to AEOP apprentices in 2013, there was at least a 20% increase in interest in pursuing DoD STEM careers across the 2014 apprentice programs.
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	• Finding #1: AEOP mentors used a large number, and wide variety, 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. However, mentors tended to use fewer strategies for supporting mentees' educational and career pathways, which may help explain the relatively low numbers of mentees reporting learning about multiple STEM careers during their experience. • 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: 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 the future, evaluators and program administrators will benefit from efforts to improve response rates to evaluation assessments including earlier planning and incentives for participation. Additionally, the continued refinement of questionnaires to enhance reliability, validity, and alignment with federal reporting standards will ensure quality assessment of AEOP programs in the future.

Priority 3: Sustainable Infrastructure *Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.*	• Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in 2013, the 2014 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.

What AEOP participants are saying...

*"My [**CQL**] mentors were very helpful, and I learned so much from them in the one-on-one setting that I got to work in. The hands-on experience was incredible. I got to use equipment that I could only look at in catalogs before my internship...I am very thankful for this internship and I feel like it has contributed a lot to my overall engineering education."* – CQL Apprentice

*"My [**CQL**] student was great to work with and I look forward to the opportunity to work with him again possibly in the future. I enjoy working with the students and giving them an opportunity to gain real work experience prior to graduation. It is what steered me into research while I was attending undergraduate school. I will continue to mentor students as long as possible as I feel it's an invaluable tool in promoting STEM."* – CQL Mentor

*"I decided to participate in **eCYBERMISSION** because it helps the military and the world."* -eCYBERMISSION Student

*"I now want to have a career in biomedical engineering, thanks to the **GEMS** program. I also feel more comfortable being a woman going into an engineering field, and not scared to be the only one, but proud :) Thanks for this amazing opportunity!!!!"* – GEMS Student

*"I really enjoyed working with the **GEMS** program. It was not only a great opportunity for me to learn about the topics and about myself but also gave the students a great opportunity to learn, have fun and make connections in science."* **–** GEMS Mentor

*"Above all, I am really enthusiastic knowing that the work I'm doing could contribute to real life situations. It feels great knowing that the research that I'm working on could help people in the world. While I continue to have a never ending passion for STEM learning, **HSAP** has made me grow more interested in STEM learning."* – HSAP Apprentice

*[T]he students in the high school, they're doing work that's different from the research program we're doing in the university. We [**HSAP**] give them more freedom and more independent thinking. That allows them to put more of their own thoughts into the research problem. This is quite challenging for them, and quite different from their experience in high school.* – HSAP Mentor

*"[***JSHS***] gave me confidence in public speaking. I learned so much from other's research and met amazing new people from all across the country. I learned the technical aspects of presenting research, writing technical papers and effectively communicating my research to the public."* – JSHS Student

*"**JSHS** is one of the greatest programs available for bringing youth together and allowing them to work side by side with the foremost people in science, engineering and research. The exposure to STEM through **JSHS** is invaluable to increasing students' desires to follow career pathways."* – JSHS Mentor

*"**JSS** was a fun and educational experience. I enjoyed engineering an effective car, modeling it, and creating it. I would recommend this program. "* – JSS Student

*"I think [**JSS**] helps the children learn teamwork and helps them to use their brain cells a little bit, instead of focusing on an iPad, or iPod, or cell phone. I think it brings out their creativity and origination as well, because they are creating their own masterpiece and when it works they can see what they can do."* – JSS Mentor

"*Overall, I was very satisfied with the **REAP** experience. I was exposed first hand to a lab environment, and was able to conduct my very own research with help from others in my lab. Research had always been a field that I'd been interested in, and this was a fantastic opportunity to explore it firsthand. I gained vast amounts of scientific knowledge, as well as the ability to present scientific results to others through papers and presentations. Everyone was friendly and eager to help, and that comfortable lab environment was one of the most important factors that contributed to my success."* - REAP Apprentice.

*"I think the **REAP** program is very essential in providing high school students a scientific experience that's more realistic…being able to work in a scientist or engineering lab or place of work, it just provides a great opportunity for that student to really get a true taste of what science is all about."* – REAP Mentor

*"**SEAP** has been the deciding factor in what I want to do in college and what kind of career I want to pursue after my education. Working in a real lab removed all of my uncertainties of what research is like. I know that I can do work in research that will directly benefit the well-being of countless people. I also better understand the responsibilities a scientist has such as the importance of publishing research and requesting funding. All of these things I learned from work in the lab as well as talking with other scientists and my mentor. **SEAP** has been the greatest experience of my educational career thus far. I hope that AEOP can continue their work in finding students like me who want nothing more than to experience work in a STEM field while also serving their country."* – SEAP Apprentice

*"I have been mentor or **SEAP** coordinator for [many] years; it is a great program!! I have had kids go on to science/medicine careers both in DoD and without. I am very proud of all their achievements and the fact that our lab contributed in some way to their success."* – SEAP Mentor

*"Overall, I really enjoyed the **UNITE** program. I loved the classes and fun, educational field trips that deal with science, technology, engineering, and mathematics careers. I also liked the other scholars in the program, my classmates. It was very interesting being around intelligent people like me. One of my favorite activities of the program was the opportunity to do engineering projects, such as building earthquake towers and roller coasters made out of paper, dealing with physics. I really enjoyed the program and I can't wait to come back next year."* – UNITE Student

"I think the benefit that the students get from **UNITE** *is very good and very dear. They have the ability to know what is going on outside of their school. They know exactly that there are a lot of specialties, more than they can get inside the high school like physics or math or any kind of computer science they take in the high school, they meet a lot of people from a lot of different majors, like computer science, like robotics, like math, like space centers."* – UNITE Mentor

*"***URAP** *provided me with the opportunity to work in a real research environment. I was able to interact with graduate students, faculty, and other* **URAP** *participants to learn more about what it means to do research. Because of* **URAP***, I intend to pursue a graduate degree in engineering."* – URAP Apprentice

"I am very satisfied with my experience with the **URAP** *program. The students I have been able to mentor as a result of their participation in* **URAP** *have made meaningful contributions to [our] research and will be encouraged to remain in the research group as undergraduate or graduate research assistants."* – URAP Mentor

Recommendations

1. **Expanding AEOP.** As in previous years, there were many more applicants for the AEOP programs than students enrolled in the programs—over 8,500 students applied, but did not enroll in an AEOP. Although some programs are open to as many students who want to participate (eCM), others are limited by funding (REAP and UNITE), space/capacity (GEMS, JSHS and JSS), the number of sites willing to partner for the program (GEMS, SEAP, CQL, HSAP, URAP), or, in the case of the apprenticeship programs, the number of mentors willing to take on apprentices (SEAP, CQL, HSAP, and URAP).

   To encourage greater participation and maximize the impact of the AEOP, pipelines were created for students to progress through programs (GEMS-SEAP-CQL, UNITE-REAP). However, the latter programs in these pipelines could not serve many of the students in the initial programs if they chose to continue. For example, in 2014 GEMS served 2,095 students, while SEAP served 92 (from 810 applicants) and CQL 307 (from 550 applicants). Similarly, UNITE enrolled 280 students, but REAP involved only 117 (426 applied).

   Increasing the marketing of the competition programs would likely help boost enrollment in those programs with minimal additional costs. However, increasing enrollment in other AEOP programs (e.g., CII, GEMS, UNITE) would take additional financial resources to recruit additional sites and build an infrastructure to serve greater numbers of students. Increasing the number of students participating in apprenticeship programs would require greater efforts to recruit mentors, as well as possibly providing funds to cover the resources (both time and materials) needed for a successful apprenticeship.

2. **Broadening Participation of Underserved and Under-represented Populations.** AEOP objectives include expanding participation of historically under-represented and underserved populations. Although AEOP elements conduct program-level marketing that targets those populations, evaluation data suggest that site-level marketing, recruiting, and selection processes have greater influence than national-level marketing in determining

participants. Data also suggest that, although some programs have had success in recruiting under-represented and underserved participants to AEOP, there is still substantial room for improvement in this area. For example, in 2014 GEMS, HSAP, JSHS, REAP, SEAP, UNITE, and URAP each increased the proportion of racial/ethnic minorities participating compared to 2013. Similarly, eCM, HSAP, JSHS, SEAP, UNITE, and URAP each had more females participating in 2014. However, CQL and eCM experienced a decrease in racial/ethnic minorities participating, and CQL, GEMS, and REAP each had smaller proportions of females enrolled.

While the AEOP envisions higher participation of under-represented and underserved students across all of its efforts, it should be noted that the AEOP is growing its under-represented/underserved participation from its efforts in grades k through 8 (e.g., CII, JSS, and GEMS).

Given this focus, AEOP programs may benefit from more guidance from Army leadership regarding program- and site-level priorities and processes for maximizing the inclusion and retention of under-represented and underserved students as appropriate for the individual programs. This guidance may include recommendations for promising marketing practices employed in the past targeted to specific locations that serve large proportions of students from these groups. In addition, given that many of the participants in the apprenticeship programs were recruited through personal connections with the mentors (e.g., via family, family friends, or school-based connections), the programs may want to focus on recruiting mentors from historically under-represented and underserved groups who may have connections with students of similar backgrounds. These mentors may also better understand the unique aspects of working with students from such groups, resulting in greater success for these students and the programs.

Similarly, the competition programs may want to seek out partnerships with minority-serving organizations in STEM such as the National Society of Black Engineers, Society of Women Engineers, American Indian Science and Engineering Society, and Society of Hispanic Professional Engineers. This approach would leverage groups who work with under-represented and underserved populations, taking advantage of an audience already interested in STEM. The AEOP should consider different types of partnerships such as having these groups use AEOP competitions as part of their curriculum, providing mini-grants to help increase participation in programs like eCM, or holding awards ceremonies for the AEOP at their annual meetings.

Another strategy would be to increase funding and/or the number of sites in programs that have proven successful at recruiting under-represented and underserved students. For example, UNITE received applications from 18 sites wanting to host the program, but awarded only 10. Similarly, REAP received applications from 82 sites, but awarded only 36.

The Army, program administrators, and sites need to also consider practical solutions to other challenges posed to the host-site or event locations, as proximity alone is likely to advantage some populations more than others (e.g. students with greater proximity, or students with means for longer-distance transportation or temporary relocation near the site). In-residence programs and/or travel accommodations (e.g., bus transportation from schools) may be needed to recruit and make participation feasible for underserved populations living at greater distances from the host or event sites. Beyond recruitment, additional support may be necessary to mitigate underserved students' resource and educational gaps (identified by participants, mentors, and event directors), to ensure their participation is both feasible and successful.

As the program works to expand the participation of historically under-represented and underserved populations, it will be important to monitor the demographic characteristics of the applicant pool to assess the extent to which recruiting and selection strategies are successful. The new centralized application system, which will collect student demographic information, will facilitate such data tracking. In addition, it will also be useful for individual programs to develop site-specific recruiting strategies and set goals in this area that can be examined at regular intervals for progress, adjusting strategies as needed.

Finally, Army leadership may want to consider funding a long-term study of its outreach efforts to under-represented and underserved populations, examining strategies that have and have not been successful in increasing participation of under-represented and underserved populations. Such as study might generate findings that could be important in making improvements to all AEOP programs in this area.

3. **Marketing of the AEOP Portfolio of Programs.** Across the AEOP, although participants reported somewhat limited awareness of other AEOP opportunities, a substantial proportion expressed interest in future participation. In many cases, participants were most interested in enrolling again in the same program. In addition, participants in the high school apprenticeship programs tended to be interested in the college apprenticeship programs. Given that participants were most likely to indicate learning about AEOP programs through their local site and/or their mentors, the AEOP program may want to invest additional effort in making sure local sites provide information about other AEOP programs to their participants. One possible strategy would be for program administrators to email students participating in other AEOPs who will be eligible to participate in their program in future years. Further, raising mentors' awareness of the various AEOP programs and asking them to talk with students/apprentices about the programs may result in even greater interest, and enrollment, in other AEOP programs. For example, it may be useful for program administrators and/or sites to institute a mentor orientation to familiarize mentors with other AEOP programs. Another possible strategy would be for the Army to leverage its existing university and industry partners, and promote AEOP through their network. The 2015 implementation of the new AEOP website and affiliated AEOP newsletter as well as the collection of participant email addresses assembled through the new centralized AEOP registration system may also allow for an increase in direct marketing of AEOP portfolio opportunities to participants, alumni, applicants, and interested community members.

4. **Raising Awareness of Army/DoD STEM Careers.** Across the AEOP, large proportions of participants reported opportunities to learn about STEM research and careers, including Army/DoD STEM research and careers, during program activities. Direct engagement with Army and DoD STEM researchers and/or facilities during program activities is the most promising practice, and likely impacts not only awareness but also interest. However, some

programs have been more effective at raising awareness of STEM careers than others, particularly careers within the Army/DoD. Similar to last year, many mentors involved in programs not located at Army installations reported a lack of awareness of STEM careers in the DoD. Thus, the AEOP may want to work with the administrators of these programs on strategies for increasing the emphasis given to Army/DoD STEM careers. One of these strategies should likely focus on educating mentors both about Army/DoD STEM careers and how to effectively engage participants in learning opportunities about Army/DoD STEM careers.

As was suggested last year, a centralized effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es may be useful for achieving this goal. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or participant to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[1] The National Institutes of Health-funded *Building Bridges: Health Science Education in Native American Communities* annually evolving Community Poster Project (http://www.unmc.edu/mmi/education/sepa/role-model-posters.html) provides a promising model for encouraging underserved populations in considering STEM careers.

Given the importance of raising student awareness of DoD/STEM careers, it might be productive to have program administrators develop specific plans for increasing this focus in their program, including developing specific measurable goals. Specifying, short- and long-term goals along with developing strategies for achieving them will allow for better monitoring of this goal of the AEOP.

5. **Aligning with NGSS.** While AEOP mainly operates under informal STEM education, some of AEOP's competitions and STEM enrichment activities may benefit from alignment of educational resources with the *Next Generation Science Standards* (NGSS), attending both to AEOP objectives and the national call for shared standards across formal and informal education settings. Creating a central repository of high-quality, standards-aligned resources, along with documentation of how to use those resources effectively, may greatly enhance the quality and effectiveness of the AEOP experience for large numbers of students and teachers. However, care will need to be taken to help ensure that these resources truly align with the three-dimensional nature of the NGSS (i.e., disciplinary core ideas, science and engineering practices, and cross-cutting concepts) rather than being superficial connections. The recently released EQuIP rubric (available at http://www.nextgenscience.org/resources) may be useful for helping evaluate and improve the alignment of such resources. Having such a repository of materials may also be useful in marketing and serve to expand recruitment, as participating sites and mentors would have access to high-quality, ready-made materials.

[1] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

6. **Improving Response Rates to Program Evaluation Surveys.** The standardization and rigor of the evaluation continued to improve in 2014; however, response rates for the apprentice/student and mentor questionnaires were poor in most AEOP programs—just over 5,000 youth and adult participants responded to a questionnaire out of over 50,000 who were involved in the AEOP (a somewhat worse participation rate than in 2013). Although all programs were asked to administer a mentor questionnaire in 2014, resulting in more mentor data than in the past, the low response rates among students and mentors raise concerns about the representativeness of the data. As the evaluation system continues to be refined, consideration should be given to how to improve response rates. One possible strategy is to have individual programs and sites better advertise the importance of participating in the evaluation. Another is to consider reducing the response burden, as the estimated time for completing a questionnaire is 45 minutes. Although triangulation of data is an important aspect of an evaluation, the program should carefully consider which elements of the data collection system are important to triangulate and which may be unnecessary. In addition, items that are collected in 2015 through the new, centralized registration and those that may provide difficult-to-interpret data should be considered for removal. It is critical to the AEOP evaluations effort that IPAs, Government POCs, local program coordinators and/or regional directors as well as senior leaders at Army laboratories and/or partner universities are synchronized to ensure integrated program planning, execution and messaging.

Introduction

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K-college programs and expose them to Department of Defense (DoD) STEM careers. The consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), supports the AEOP in this mission by engaging non-profit, industry, and academic partners with aligned interests, 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 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.

2014 Portfolio Overview

Details of the 2014 portfolio of AEOP initiatives is outlined in Table 1 below. The table includes the number of 2014 applicants and participants organized by program as well as numbers of Army and DoD S&Es, participating K-12 schools and colleges/universities, and collaborating organizations including Army and DoD laboratories. For ease of comparison, Table 2 summarizes the number of youth and adult participants by program. Table 3 similarly summarizes numbers collaborating schools, both K-12 and college/universities, as well as Army and DoD laboratories and S&Es. Table 4 provides a comparison of AEOP element cost.

There were 41,802 youth participants in 2014 AEOP activities. The AEOP portfolio also involved 9,970 adults, including 1,216 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).

Table 1. 2014 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.
No. of Students	860
No. of Teachers & Leadership Interns	163

No. of Sites	15
No. of Army Research Laboratories	3
Total Cost	$193,500
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
No. of Applicants	550
No. of Students (Apprentices)	307
Placement Rate	56%
No. of Adults (Mentors)	288
No. of Army S&Es	288
No. of Army Research Laboratories	10†
No. of Colleges/Universities	104
No. of HBCU/MIs	13
Total Cost	$3,663,463
Stipend Cost (Paid by participating Army laboratories)	$3,534,144
Administrative Cost to ASEE	$129,319
Cost Per Student Participant	$11,933
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
No. of Applicants/Students	29,682 registered and 15,859 completed mission folders (of whom 71 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	53%
No. of Adults (Team Advisors and Volunteers – incl. S&Es and Teachers)	4,582
No. of Team Advisors (Predominantly math and science teachers)	1,828
No. Volunteers (Ambassadors, CyberGuides, Virtual Judges)	2,754
No. of Army S&Es	266
No. of Army/DoD Research Laboratories	38
No. of K-12 Teachers (incl. pre-service)	2,357
No. of K-12 Schools	671

No. of K-12 Schools – Title I	340
No. of Colleges/Universities	98
No. of DoDEA Students	827
No. of DoDEA Teachers	46
No. of Other Collaborating Organizations	65
Total Cost	$3,127,314
Mini-grant Costs	$200,074
Scholarships/Awards Cost	$452,685
STEM Research Kits Cost	$160,174
Cost of National Event (NJ&EE)	$299,336
Administrative Cost to NSTA	$2,015,045
Cost Per Student Participant	$105
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)
No. of Applicants	3,343
No. of Students	2,095
Placement Rate	63%
No. of Adults	390
No. of Near-Peer Mentors	92
No. of Resource Teachers	52
No. of Army S&Es	246
No. of Army Research Laboratories	13[†]
No. of K-12 Teachers	52
No. of K-12 Schools	755
No. of K-12 Schools – Title I	126
No. of Colleges/Universities	28
No. of HBCU/MSIs	3
No. of DoDEA Students	15
No. of DoDEA Teachers	1
Total Cost	$994,139
Stipend Cost	$727,676
Supplies & Equipment (GEMS Sites)	$116,999
Administrative Cost to ASEE	$149,464
Cost Per Student Participant	$475
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
No. of Applicants	84

No. of Students (Apprentices)	10
Placement Rate	12%
No. of Adults (Mentors)	7
No. of College/University S&Es	7
No. of K-12 Schools	10
No. of K-12 Schools – Title I	N/A
No. of Army-Funded College/University Laboratories	7
No. of College/Universities	7[†]
No. of HBCU/MSIs	3[†]
Total Cost	$38,239
Admin/Overhead Costs (Host Sites)	$5,132
Stipend Cost (Paid by AEOP and ARO)	$33,107
Cost Per Student Participant	$3,824
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
No. of Applicants	13,373
No. of Students	7,409 Regional Participants (of whom 220 were selected to attend the National JSHS Symposium)
Placement Rate	55%
No. of Adults (Mentors, Regional Directors, Volunteers – incl. Teachers and S&Es)	3,846
No. of Army and DoD S&Es	300
No. of Army/DoD Research Laboratories	57
No. of K-12 Teachers	1,046
No. of K-12 Schools	1,100
No. of K-12 Schools – Title I	137
No. College/University Personnel	1,800
No. of Colleges/Universities	102
No. of DoDEA Students	140
No. of DoDEA Teachers	24
No. of Other Collaborating Organizations	120
Total Cost	$1,962,881
Scholarships/Awards Cost	$402,000
Cost of Regional Symposia (47) Support	$699,081
Cost of National Symposium (Additional cost due to Science and Engineering Festival)	$525,994

Administrative Cost to AAS	$335,806
Cost per Student Participant	$265
Junior Solar Sprint (JSS) **Program Administrator: Technology Student Association (TSA)**	
Description	STEM Competition - Solar car competition regional events at 3 Army laboratories and at 19 TSA state events, 1 national event hosted in conjunction with the TSA national conference
Participant Population	5th-8th grade students
No. of Applicants	891
No. of Students	891
Placement Rate	N/A (all students who register are participants)
No. of Adults (Mentors and Volunteers – incl. Teachers and Army S&Es)	341
No. of Army S&Es	10
No. of Army/DoD Research Laboratories	3[†]
No. of K-12 Schools	71
No. of K-12 Schools – Title I	31
No. of Other Collaborating Organizations	21
Total Cost	$145,535
Scholarships/Awards Cost	$6,964
Stipend Cost	$500
Administrative Cost to TSA	$138,071
Cost Per Student Participant	$163
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
No. of Applicants	426
No. of Students (Apprentices)	117
Placement Rate	27%
No. of Adults (Mentors)	74
No. of College/University S&Es	74
No. of K-12 Schools	117
No. of K-12 Schools – Title I	97
No. of College/Universities	36[†]
No. of HBCU/MSIs	18[†]
Total Cost	$347,392
Stipend Cost	$254,709
Administrative Cost to AAS	$92,683
Cost Per Student Participant	$2,969

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
No. of Applicants	810
No. of Students (Apprentices)	92
Placement Rate	11%
No. of Adults (Mentors)	86
No. of Army S&Es	86
No. of Army Research Laboratories	9†
No. of K-12 Schools	58
No. of K-12 Schools – Title I	N/A
Total Cost	$259,719
Stipend Cost (Paid by participating Labs)	$220,966
Administrative Cost to ASEE	$38,753
Cost Per Student Participant	$2,823
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 10^{th} and 11th grade students from groups historically underserved and under-represented in STEM
No. of Applicants	437
No. of Students (Apprentices)	280
Placement Rate	64%
No. of Adults	162
No. of Army S&Es	20
No. of Army Agencies	12
No. of K-12 Teachers	48
No. of K-12 Schools	121
No. of K-12 Schools – Title I	53‡
No. of Colleges/Universities	10†
No. of HBCU/MSIs	7†
Total Cost	$359,940
Stipend Cost	$80,400
Administrative Cost to TSA	$102,200
Administrative Cost to Host Sites	$177,340
Cost Per Student Participant	$1,286
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
No. of Applicants	90
No. of Students (Apprentices)	59
Placement Rate	66%
No. of Adults (Mentors)	31
No. of College/University S&Es	31
No. of Army-Funded College/University Laboratories	27
No. of College/Universities	27†
No. of HBCU/MSIs	10†
Total Cost	$210,185
Admin/Overhead Costs (Host Sites)	$30,719
Stipend Cost (Paid by AEOP and ARO)	$179,466
Cost Per Student Participant	$3,562

† *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.*

There were 41,802 youth and 9,970 adult participants in 2014 AEOP activities, of which, 982 students and 71 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. More details on AEOP adult participants and collaborating schools and organizations are presented in Table 3.

Table 2. 2014 AEOP Participation Numbers

		Youth	Adults
CII	Camp Invention Initiative	860	163
CQL	College Qualified Leaders	307	288
eCM	eCYBERMISSION	29,682	4,582
GEMS	Gains in the Education of Mathematics & Science	2,095	390
HSAP	High School Apprenticeship Program	10	7
JSHS	Junior Science & Humanities Symposium	7,409	3,846
JSS	Junior Solar Sprint	891	341
REAP	Research & Engineering Apprenticeship Program	117	74
SEAP	Science & Engineering Apprentice Program	92	86
UNITE	UNITE	280	162
URAP	Undergraduate Research Apprenticeship Program	59	31
	Total 2014 AEOP Participants	**41,802**	**9,970**

In providing STEM outreach to youth, AEOP engages with collaborating partners throughout the country. Army and DoD laboratories, Army and DoD S&Es, K-12 schools, K-12 teachers, colleges/universities, and college/university S&Es are critical to the AEOP's success. In 2014, 1,216 of the 9,970 adults who participated in AEOP were Army and DoD S&Es who served in the key role of mentor (374 S&Es) to student apprentices through the SEAP and CQL programs; served as judges for the eCM, JSHS, and JSS competitions (576 S&Es); and served as presenters at the GEMS and UNITE programs (266 S&Es). Four of the 11 AEOP initiatives (GEMS, JSS, SEAP, and CQL) took place at Army laboratories. Apprentices in the HSAP and URAP programs were mentored by college/university S&Es (38 S&Es) in Army-funded laboratories (34 labs) at colleges/universities. The leveraging of Army and DoD S&Es and Army and DoD laboratories make the AEOP unique to other STEM outreach initiatives.

The 2014 AEOP engaged with youth and teachers representing 2,918 K-12 schools, of which at least 798 have Title I recognition, and 47 were DoDEA schools from Pacific, Europe, and the U.S. K-12 teachers were 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 2014, 2,357 K-12 teachers participated in eCM and 1,046 K-12 teachers participated in JSHS.

College/university S&Es, students, and other personnel formed a third key group of collaborators for the 2014 AEOP. Colleges/universities throughout the country serve as host sites for JSHS regional symposia (47), the UNITE summer program (10), and both HSAP (7) and URAP (27) apprenticeship programs. The AEOP engaged with 412 colleges/universities in 2014, including 54 HBCU/MSIs. A significant proportion of the adults involved with 2014 JSHS (1,800) were college/university personnel.

Table 3. Number of 2014 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††	104	13	10†	NA††	288	NA††
eCM	671	340	98	___§	38	NA††	266	65
GEMS	755	126	28	3	13†	NA††	246	NA††
HSAP	10	___§	7 †	3†	NA††	7	NA††	NA††
JSHS	1,100	137	102	___§	57	NA††	300	120
JSS	71	31	NA††	NA††	3†	NA††	10	21
REAP	117	97	36†	18†	NA††	NA††	NA††	NA††
SEAP	58	___§	NA††	NA††	9†	NA††	86	NA††
UNITE	121	53‡	10†	7†	12	NA††	20	18
URAP	NA††	NA††	27†	10†	NA††	27	NA††	NA††
Total Sites	**2,918**	**798‡**	**412**	**54**	**145**	**34**	**1,216**	**224**

† *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.*
[§] *Data not available.*
[††] *Does not apply.*
* *Camp Invention Initiative (CII) was not part of program evaluations in 2014.*

Table 4 summarizes the costs for the individual 2014 AEOP elements. Per student participant costs have also been calculated. The cost of the AEOP summer apprenticeship programs range between $2,823 (SEAP) to $3,824 (URAP). CQL is the most costly of the apprenticeship programs at an average cost of $11,933 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). The 2014 AEOP competitions ranged in cost from $105 (eCM) to $265 (JSHS) per participant. GEMS, which is primarily a 1-week summer STEM experience in the Army labs, has the average cost of $475 per student. While UNITE, a 4-6 week summer STEM experience for students from historically underserved and under-represented groups, has an average cost of $1,286 per student.

In 2014, the apprenticeship programs were the most costly and the competitions were the least costly of the AEOP elements on a per student basis. 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. For example, $11,512 of the $11,933 cost of a 2014 CQL apprenticeship funded the student's stipend. The administrative cost per CQL participant was $421.

Table 4. 2014 AEOP Costs				
		Program Cost	**Cost Per Student Participant**	**Average Stipend Per Student Participant**
CII	STEM Enrichment Program (elementary K-6)	$193,500	$225	NA
CQL	STEM Apprenticeship Program (undergrad/grad)	$3,663,463	$11,933	$11,512
eCM	STEM Competition	$3,127,314	$105	NA[†]
GEMS	STEM Enrichment Program	$994,139	$475	$100
HSAP	STEM Apprenticeship Program (high school)	$38,239	$3,824	$3,312
JSHS	STEM Competition	$1,962,881	$265	NA[†]
JSS	STEM Competition	$145,535	$163	NA[†]
REAP	STEM Apprenticeship Program (high school)	$347,392	$2,969	$2,177[‡]
SEAP	STEM Apprenticeship Program (high school)	$259,719	$2,823	$2,402
UNITE	STEM Enrichment Program	$359,940	$1,286	$287
URAP	STEM Apprenticeship Program (undergrad)	$210,185	$3,562	$3,042

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

[‡] *Both students and mentors in REAP are eligible for a stipend. In 2014, the average student stipend is $1,500 while the average mentor stipend was $677. The combined 2014 stipend per student participant was $2,177.*

Evaluation Strategy

The 2014 AEOP portfolio (with the exception of the Camp Invention Initiative) was assessed by Virginia Tech, the Lead Organization (LO) of the AEOP CA. Virginia Tech assessed and evaluated nine of the AEOP elements in collaboration with AEOP CA consortium members,[2] individual program 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 2014 AEOP evaluation was standardized across these programs to allow for the reporting of consistent information about program quality and impacts. In addition, David Heil & Associates was contracted by NSTA to conduct the evaluation of eCM and collaborated with Virginia Tech to determine assessment and evaluation processes.

The 2014 evaluation was informed by AEOP objectives[3] (established in 2012) and by the objectives of individual AEOP elements.

Table 5. AEOP Priorities and Objectives (2014)
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.

[2] The 2014 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 2014 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.

[3] 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.

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 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 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. Figure 1 below provides a simple graphical depiction of the AEOP Evaluation logic model.

ARMY EDUCATIONAL OUTREACH PROGRAM

Table 1: AEOP Evaluations Logic Model

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

In 2014, 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).

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?

The 2014 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. 2014 AEOP Evaluation Strategy

AEOP Element	Assessment Tools	Program-Level Objectives
CQL	Program Evaluation: • Apprentice questionnaire • Mentor questionnaire • Apprentice focus groups • Mentor focus groups	• 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:[4] • 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.
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 focus group • 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.

[4] Conducted by David Heil & Associates

		• 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 • Student interviews • Mentor interviews • Mentor focus group • Mentor questionnaire[5]	• 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 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 groups • Student interviews • 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 • Apprentice focus group • Mentor focus group • 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.

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

		• 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 focus groups • Mentor focus groups	• 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 their 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 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 focus groups • Mentor focus groups	• 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 focus groups • Mentor focus group	• 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.

Improvements in the 2014 AEOP evaluation generally focused on attending to 2013 AEOP and element-specific recommendations pertaining to evaluation, including stronger alignment of program evaluation with AEOP priorities and objectives. Strengthening the alignment of the AEOP evaluation with federal requirements for evaluating STEM investments also continued in 2014. In addition, the evaluation was revised to focus more on AEOP Priority 1 and less on Priority 2, as the STEM Teacher Program Initiative (STPI) was suspended for 2014.

Existing program-level instruments were reviewed and revised to ensure alignment with AEOP objectives under Priority 1 and to provide common metrics and measures across the AEOP or program types where possible, such as in the apprenticeship programs. 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.

With the exception of the eCM evaluation conducted by David Heil & Associates, the AEOP evaluation was led by Virginia Tech, the Lead Organization (LO) in the AEOP CA consortium, including data collection, entry, and analysis. Data analyses and reports were prepared in collaboration with Horizon Research, Inc. 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 evaluation of each program 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). Although some of the margins of error are within acceptable limits, most are quite large. In addition, because random sampling was not used to select respondents, even the instances when the margin of error is less than

5%, there is still the 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. 2014 AEOP Questionnaire Participation

Program	2014 Questionnaire	Sample	Population	Participation Rate	Margin of Error @ 95% Confidence[6]
CQL	Apprentice	139	307	45%	±6.2%
	Mentor	19	288	7%	±21.8%
eCM	Student (pre-questionnaire)	938	29,682	3%	±3.2%
	Student (post-questionnaire)	1,302	15,859	4%	±2.7%
	NJ&EE Student	74	80	93%	±3.1%
	Team Advisor	329	1,828	18%	±4.9%
GEMS	Student	1,899	2,095	91%	±0.7%
	Mentor (incl. NPM, RT, S&Es)	84	390	22%	±9.5%
HSAP	Apprentice	8	10	80%	±16.3%
	Mentor	2	7	29%	±63.3%
JSHS	Regional Symposia Student	106	7,409	1%	±9.5%
	National Symposium Student	43	220	20%	±13.4%
	Mentor	88	1,046	8%	±10.0%
JSS	Student	78	891	9%	±10.6%
	Mentor	16	336	5%	±24.0%
REAP	Apprentice	56	117	48%	±9.5%
	Mentor	39	74	53%	±10.6%
SEAP	Apprentice	58	92	63%	±7.9%
	Mentor	17	86	20%	±21.4%
UNITE	Student	116	280	41%	±7.0%
	Mentor	48	162	30%	±11.9%
URAP	Apprentice	36	59	61%	±10.29%
	Mentor	16	31	52%	±17.32%
Total AEOP Questionnaire Participation		**5,437**	**61,351**	9%	

Focus groups were conducted with participants 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, 205 students, apprentices, and mentors participated in focus groups in 2014.

Additionally, interviews were conducted with participants from some of the programs to maximize qualitative data collection. Evaluators purposively sampled from programs' enrollment data to identify phone interview candidates

[6] "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.

exhibiting geographic, demographics, and STEM interest diversity. In total, 46 students, apprentices, and mentors participated in interviews. Table 6 summarizes focus group and interview participation.

Table 8. 2014 AEOP Focus Group and Interview Participation			
Program	**2014 Focus Group and Interview**	**Focus Group Sample**	**Interview**
CQL	Apprentice	17	
	Mentor	13	
eCM	NJ&EE Student	20	
	NJ&EE Team Advisor	20	
GEMS	Student	26	
	Mentor	19	
HSAP	Apprentice		4
	Mentor	3	
JSHS	National Symposium Participant	4	11
	Regional Director	6	2
	Competition Advisor/Mentor		1
	Judge	2	3
	Chaperone	1	3
	Parent		1
JSS	Student	8	8
	Mentor	1	10
REAP	Apprentice	1	3
	Mentor	3	
SEAP	Apprentice	16	
	Mentor	12	
UNITE	Student	13	
	Mentor	5	
URAP	Apprentice	10	
	Mentor	5	
Total AEOP Focus Group/Interview Participation		**205**	**46**

Evaluation Findings

The findings from 2014 program evaluations are grouped according to 2014 AEOP priorities and address objectives under each priority.

Priority One: STEM Literate Citizenry

Most program findings in 2014 provide evidence of the AEOP's success at contributing to the first priority, a STEM literate citizenry. Major trends that support the achievement of this AEOP priority along with evidence from assessment data that inform the findings are presented below.

<u>Finding #1</u>: The AEOP provided outreach to 41,802 students through its comprehensive portfolio of programs. 37,982 students participated in AEOP competitions (eCM, JSHS and JSHS). AEOP provided 585 STEM apprenticeships (CQL, HSAP, REAP, SEAP, and URAP) and 3,235 students participated in hands-on summer STEM enrichment activities (CII, GEMS and UNITE). However, there is a considerable unmet need with over 8,500 applicants who were not accepted into the programs.

AEOP offered a comprehensive portfolio 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.

In 2014 AEOP provided outreach to 41,802 youth which is an increase to the number who participated in 2013 (41,312). Despite the West Point Bridge Design Competition no longer being a program under the AEOP in 2014, AEOP still served a growing number of students. 2014 AEOP outreach included:

- 585 apprenticeships (CQL, HSAP, REAP, SEAP, and URAP);
- 920 participant awards (state, regional, and national levels), 4 participant STEM-in-Action grants, 53 mini-grants to foster participation (incl. 4 district grants, 6 teacher grants, 5 school grants, 1 grant to SECME, and 37 chapter grants), and 92 travel awards for national competition eCM participants (70 students, 20 team advisors, 1 advisor of the year);
- 141 participant awards, 47 teacher awards, and 220 travel awards for JSHS national competition participants; and
- 2,375 weekly stipends to offset the expense of participant travel and meals (GEMS, UNITE).

In addition, more than 3,403 K-12 teachers and 1,216 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.

Despite the large number of youth participants, considerable unmet need exists across the AEOP programs. While 49,686 youth applied to 2014 AEOP opportunities, only 41,802 youth were selected for participation. 2014 AEOP application numbers and placement rates are detailed in Table 9. More than half of 2014 AEOP youth participants (29,682) took part in the eCM program. A web-based STEM competition for 6^{th}-9^{th} grade youth, eCM is open to all who meet registration qualifications. JSS, another STEM competition, was similarly open to all those who registered in 2014 though regional participation may be restricted by space.

Significant differences in the number of applicants versus number of participants occurred within the AEOP apprenticeship programs, enrichment activities, and the JSHS competition. The 2014 apprenticeships (CQL, HSAP, REAP, SEAP, and URAP) were competitive with a placement rate ranging from 11% (SEAP) to 66% (URAP). Overall, there were 1,960 applicants and 585 students selected for apprenticeships, resulting in a 2014 AEOP apprenticeship placement rate of 30%. High school apprenticeships (HSAP, REAP, and SEAP) were most competitive with a combined placement rate of only 17% as compared to an undergraduate/graduate apprenticeship (CQL and URAP) placement rate of 57%.

Acceptance into the 2014 AEOP STEM enrichment activities (UNITE and GEMS) was also competitive. 63% of GEMS applicants were selected for participation and 64% of UNITE applicants were selected. 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 2014 only 55% of JSHS regional applicants were selected to compete – almost 6,000 youth were turned away.

Table 9. 2014 AEOP Number of Applications and Placement Rates

		Youth Applicants	Youth Participants	Placement Rate
CQL	STEM Apprenticeship Program (undergrad/grad)	550	307	56%
eCM	STEM Competition	29,682	29,682	NA†
GEMS	STEM Enrichment Activity	3,343	2,095	63%
HSAP	STEM Apprenticeship Program (high school)	84	10	12%
JSHS	STEM Competition	13,373	7,409	55%
JSS	STEM Competition	891	891	NA†
REAP	STEM Apprenticeship Program (high school)	426	117	27%
SEAP	STEM Apprenticeship Program (high school)	810	92	11%
UNITE	STEM Enrichment Activity	437	280	64%
URAP	STEM Apprenticeship Program (undergrad)	90	59	66%
	Total	**49,686**	**40,942**	**-**

† *In 2014, all youth who meet registration requirements for eCM and JSS were able to participate.*

As in 2013, students and mentors from across the 2014 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;
- 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;
- Expanding programs' visibility locally and nationally to better showcase the DoD's unique and effective outreach programs; and

- Expanding outreach to scientists and engineers from groups historically underserved and under-represented in STEM to help attract and support participation from more diverse groups of students.

<u>Finding #2</u>: The AEOP provided outreach to many students from underserved and under-represented groups with some programs being more effective at serving these groups than others. While 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. In 2014, more than 95% of the students in REAP and UNITE were from groups that are historically underserved and under-represented in STEM. In addition, 4 of the 10 AEOP elements increased the proportion of students they served from these groups. The other programs had mixed results in this regard and may want to improve outreach to specific underserved and under-represented groups.

Table 10 summarizes participant demographics collected through applications and questionnaires in 2013 and 2014. These data indicate that 2014 AEOP programs served participants identifying with groups that are historically underserved and under-represented in STEM. Overall, the data indicate mixed progress in expanding the participation of historically underserved and under-represented groups. For example, GEMS, HSAP, JSHS, REAP, SEAP, UNITE, and URAP appear to have increased the proportion of racial/ethnic minorities participating. However, the proportion of minority students participating decreased in CQL and eCM. Similarly, eCM, HSAP, JSHS, SEAP, UNITE, and URAP appear to have increased the proportion of female participants, but the proportion appears to have decreased in CQL, GEMS, and REAP.

The ability of individual AEOPs to recruit participants from groups that are historically underserved and under-represented in STEM is limited 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. Mixed progress in expanding the participation of historically underserved and under-represented groups across the AEOP portfolio can be expected.

Table 10. 2013 and 2014 Student Demographics

	Females		Racial & Ethnic Minorities		Free or Reduced-Price Lunch Eligible	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**
CQL	35%	25%	15%	8%	NA††	NA††
eCM	36%	49%‡	47%	15%‡	---§	
GEMS	47%	37%	31%	37%	12%	11%
HSAP	8%	50%†	38%	50%†	18%	38%†
JSHS-R	64%	69%†	13%	23%†	19%	19%†
JSHS-N	57%	58%†	9%	6%†	10%	7%†
JSS	---§	29%†	---§	13%†	---§	14%†
REAP	60%	49%	50%	65%	27%	48%†
SEAP	30%	40%	6%	21%	0%	5%
UNITE	61%	66%	81%	96%	47%	34%
URAP	14%	28%†	11%	17%†	NA††	NA††

† Demographic data come from the questionnaire sample and were not available for the entire participant population.
‡ Demographic data come from the eCM pre-questionnaire.

§ *Demographic data not available.*
††*Program serves college-age students for whom Free or Reduced-Price Lunch eligibility does not apply.*

Efforts to increase participation from the underserved and under-represented target group employed by REAP and UNITE in 2014 focused on distributing the solicitation to determine new program host sites to targeted HBCU/MSIs throughout the nation as well as institutionalizing a clear definition of underserved and under-represented to be used in the student selection process. The revised definition of underserved and under-represented moves beyond a singular qualifying factor of race/ethnicity, economic status, or gender. 2014 UNITE and REAP participants were required self-identify with *two* or more of the following criteria to meet the definition of the programs' target population:

- Student self-identifies as qualifying for free or reduced lunch.
- Student self-identifies as a minority historically under-represented in STEM (Alaskan Native, Native American, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander).
- Student is a female pursuing research in physical science, computer science, mathematics, or engineering.
- Student receives special education services.
- Student has a disability.
- English is a second language for the student.
- Student is a potential first-generation college student (parents did not attend college).

According to Annual Program Reports prepared by AAS (REAP) and TSA (UNITE), more than 95% of the students in 2014 REAP and UNITE self-identified as underserved and under-represented according to the expanded definition of the target group.

All of the programs in the 2014 AEOP portfolio implemented 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, including:

- 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.

2014 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, 2014 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 2014, 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 2014 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. 2014 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 2014 – 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. UNITE and REAP deliberately coordinate across programs to promote the participation of talented students in successive AEOP programs over time. In fact, the 2014 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 2014, 18 alumni of UNITE participated in REAP.

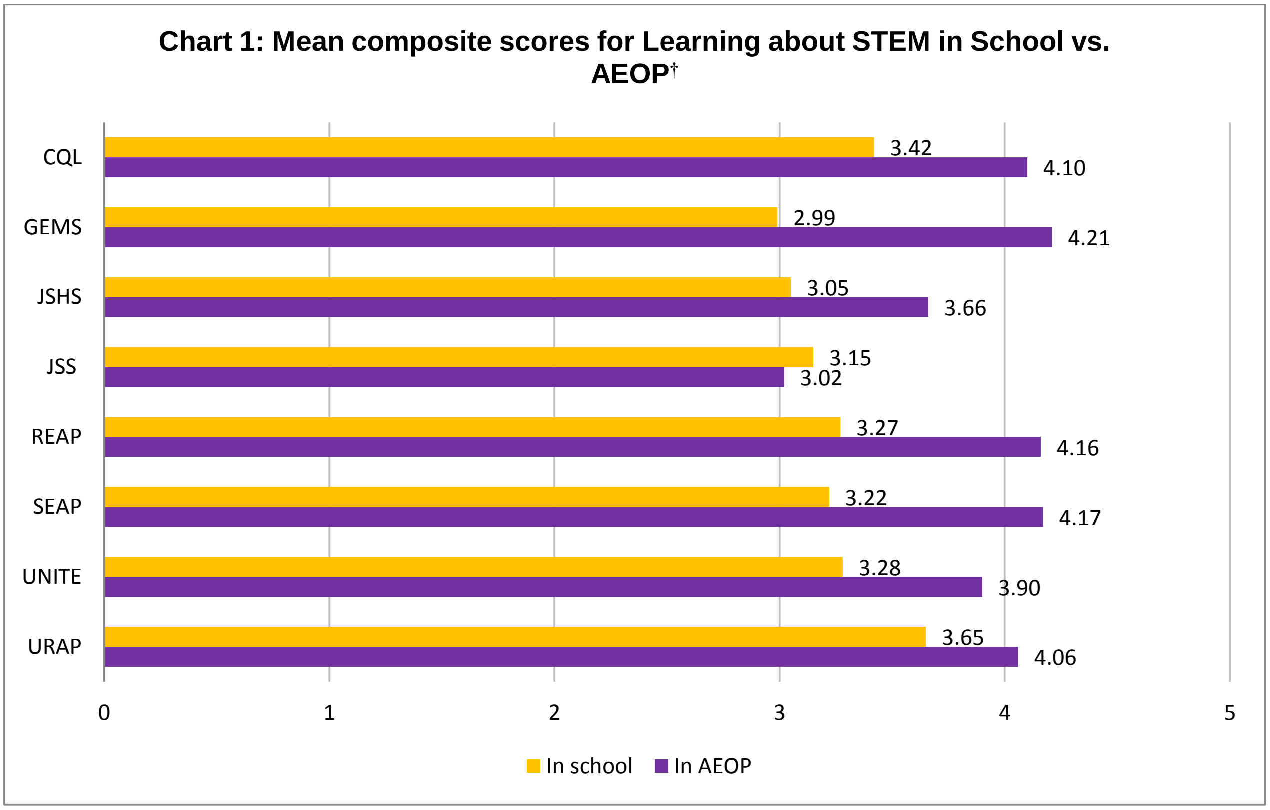
As in prior years, inconsistent demographic data collection limits the extent to which the success of mechanisms to increase and retain participation of students from underserved and under-represented populations in the AEOP can be accurately assessed. 2015 AEOP efforts to centralize the registration/application 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 FY14, as in FY13, 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.

The AEOP aims to engage participants in opportunities to explore STEM topics, practices, and careers through real-world, hands-on, and collaborative STEM activities that participants typically do not experience in school. To this end, apprentice and student questionnaires asked how often they had 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 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
1. Apply STEM knowledge to real life situations
2. Communicate with other students about STEM
3. Interact with STEM professionals
4. Learn about cutting-edge STEM research
5. Learn about different STEM careers
6. Learn about new science, technology, engineering, or mathematics (STEM) topics

The mean composite scores for participants learning about STEM in AEOP and school are shown in Chart 1.[7] Apprentices and students in all programs except JSS reported having significantly more opportunities to learn about STEM in their AEOP than in school, with medium to large effect sizes.[8,9]



† *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.*

†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

Student and apprentice questionnaires also asked for participants' perceptions of the frequency of opportunities to engage in STEM practices in their AEOP as compared to in school, which were also combined into composite variables. These items are shown in Table 12.

[7] 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.

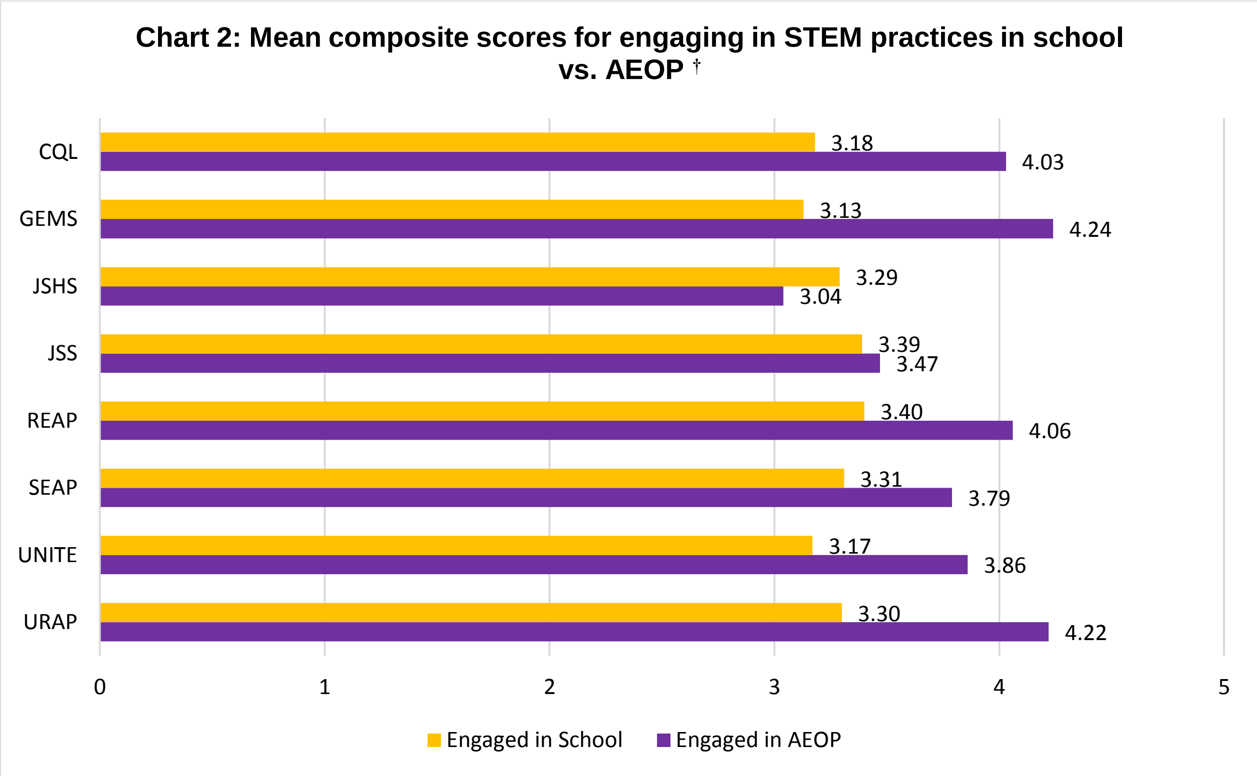
[8] When comparing two means, the effect size "d" is calculated as the difference between the two means divided by the pooled standard deviation. Effect sizes of about 0.20 are typically considered small, 0.50 medium, and 0.80 large. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*.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

[9] Effect sizes: CQL, d = 0.720 standard deviations; GEMS, d = 1.171 standard deviations; JSHS, d = 0.492 standard deviations; REAP, d = 0.902 standard deviations; SEAP, d = 0.993 standard deviations; UNITE, d = 0.545 standard deviations; and URAP, d = 0.718 standard deviations.

Table 12. Items that Form the Engaging in STEM Practices in School and Engaging in STEM Practices in AEOP Composites
1. Analyze and interpret data or information
2. Build (or simulate) something
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
8. Pose questions or problems to investigate
9. Practice using laboratory or field techniques, procedures, and tools
10. Work as part of a team

Chart 2 displays the mean composite scores for CQL, GEMS, JSHS, JSS, REAP, SEAP, UNITE, and URAP. Scores were significantly higher on the Engaging in STEM Practices in AEOP composite than on the in school composite for the majority of the programs, with moderately large to very large effect sizes.[10] The largest differences were found in CQL, GEMS, and URAP. There were no significant differences between engagement in STEM practices in school and engagement in STEM practices in AEOP for JSS and JSHS. This result may be due to the nature of these competition programs, as students typically work on their projects at school before taking part in the competitions.

[10] Effect sizes: CQL, d = 0.958 standard deviations, GEMS, d = 1.104 standard deviations, JSHS, d = -0.207 standard deviations, REAP, d = 0.703 standard deviations, SEAP, d = 0.431 standard deviations, UNITE, d = 0.703 standard deviations, and URAP, d = 1.308 standard deviations.



† 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.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

In questionnaires, focus groups, and interviews, apprentices, students, and mentors frequently reported that one of AEOP's greatest benefits is that it provides opportunities for participants to engage in authentic STEM activities that are not typically available in school experiences. Through these activities, students and mentors report that students develop or expand their STEM abilities and 21st Century STEM Skills. These sentiments are exemplified in the following quotes from apprentices:

> *I realized I do want to pursue biochemistry, and [in REAP] I learned hands-on skills, protocols you don't get much in high school science class; not at the level of the university laboratory. Designing a blood substitute was pretty cool. Like many areas there's been decades of research, figuring out what worked and didn't, how that all comes together with what the professor is doing today, and his advancement.* (REAP Apprentice)

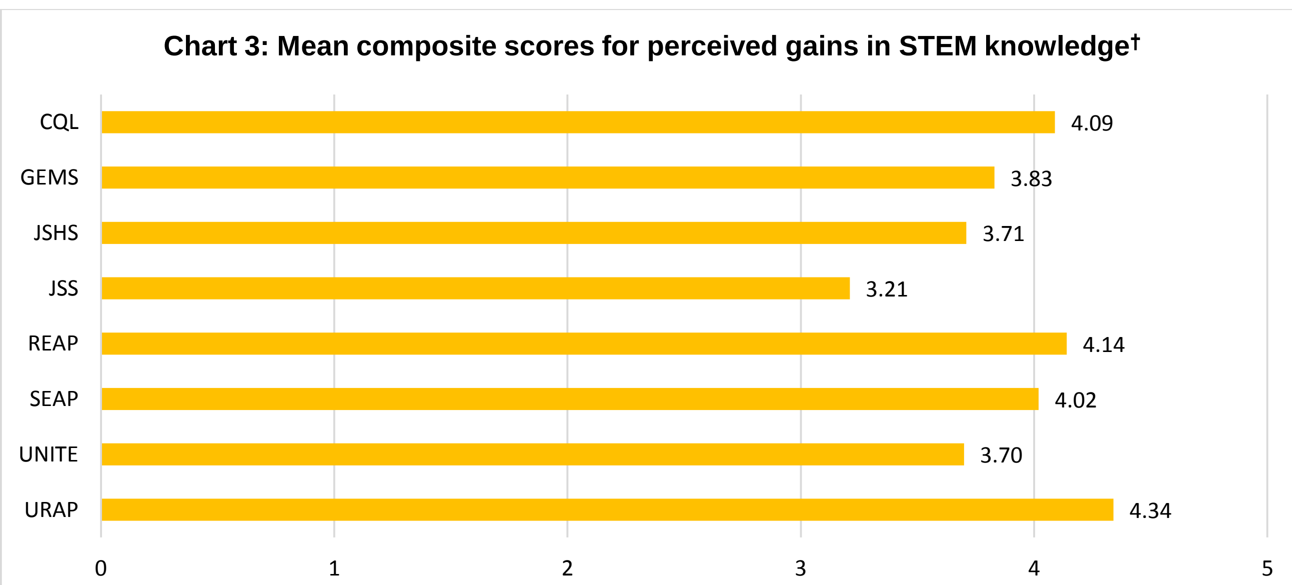
> *I definitely feel like I got an edge on most students considering that most students don't get to have a lab experience, at least at my school we don't have anything close to the lab experience you can get here. (SEAP Apprentice)*

Finding #4: As in 2013, students participating in the AEOP programs in 2014 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.

The AEOP not only intends to inspire interest and engagement in STEM, but to develop students STEM knowledge, skills, and abilities, as well as their 21st Century Skills, and abilities to appropriately apply them. In 2014, the AEOP evaluation examined students' perceptions of gains in their STEM-specific and 21st Century STEM Skills as a result of participating in AEOP. The evaluation also examined impacts on students' STEM confidence and identity.

Five items, listed in Table 13, form a composite related to apprentices' and students' perceptions of gains in STEM knowledge. Apprentices and students rated their perceived gains using a 5-point scale from "no gain" to "extreme gain." Chart 3 suggests that apprentices and students from all programs perceived at least some gain in their STEM knowledge after participating in AEOP.

Table 13. Items that form the Perceived Gains in STEM Knowledge Composite
1. Knowledge of how professionals work on real problems in STEM
2. Knowledge of research conducted in a STEM topic or field
3. Knowledge of research processes, ethics, and rules for conduct in STEM
4. Knowledge of a Science, Technology, Engineering, or Mathematics topic or field in depth
5. Knowledge of what everyday research work is like in STEM



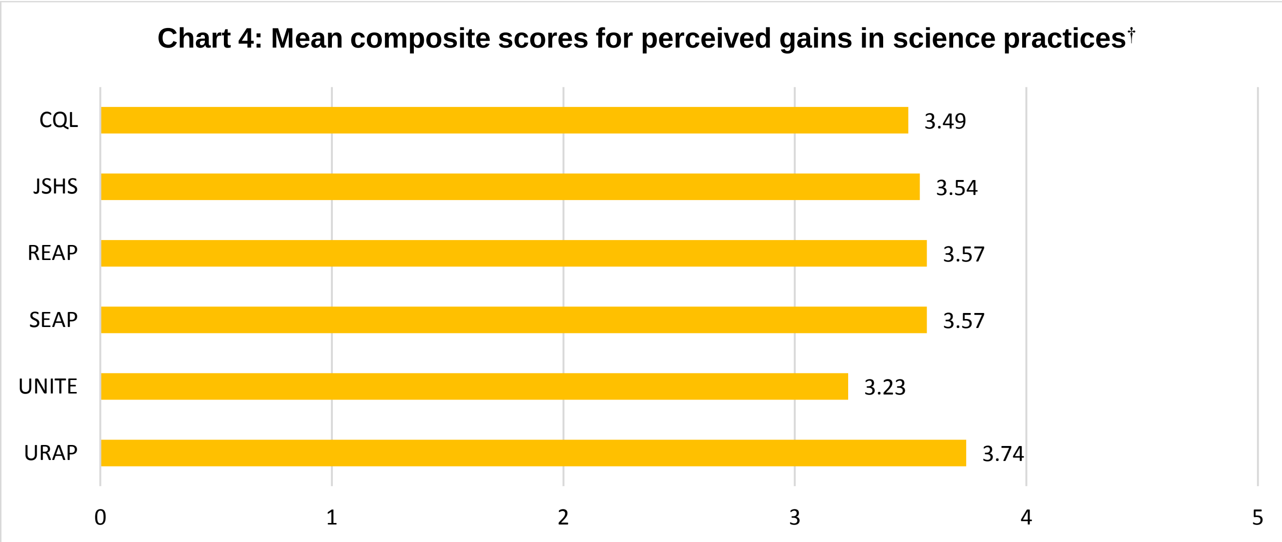
† Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

The evaluation also examined the impact of participation on students' abilities to use the science and engineering practices described in the NGSS. Students 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.[11] The science-related items (see Table 14) form a composite called Perceived Gains in Science Practices. As can be seen in Chart 4, mean composite scores indicate that students from across the programs reported at least some gains in their abilities to use the science practices as a result of participating in AEOP. The somewhat lower score for UNITE may be due to the fact that UNITE is primarily an engineering program, and only a small number of students reported working on science projects.

Table 14. Items that form the Perceived Gains in Science Practices Composite
1. Applying knowledge, logic, and creativity to propose explanations that can be tested with investigations
2. Asking a question (about a phenomenon) that can be answered with one or more investigations
3. Asking questions based on observations of real-world phenomena
4. Asking questions to understand the data and interpretations others use to support their explanations
5. Carrying out procedures for an investigation and recording data accurately
6. Communicating information about your investigations and explanations in different formats (orally, written, graphically, mathematically, etc.)
7. Considering alternative interpretations of data when deciding on the best explanation for a phenomenon
8. Deciding what type of data to collect in order to answer a question
9. Deciding what additional data or information may be needed to find the best explanation for a phenomenon
10. Designing procedures for investigations, including selecting methods and tools that are appropriate for the data to be collected
11. Displaying numeric data from an investigation in charts or graphs to identify patterns and relationships
12. Identifying the limitations of data collected in an investigation
13. Identifying the strengths and limitation of data, interpretations, or arguments presented in technical or scientific texts
14. Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations
15. Integrating information from multiple sources to support your explanations of phenomena
16. Making a model to represent the key features and functions of an observed phenomenon
17. Reading technical or scientific texts, or using other media, to learn about the natural or designed worlds
18. Supporting a proposed explanation (for a phenomenon) with data from investigations
19. Supporting a proposed explanation with relevant scientific, mathematical, and/or engineering knowledge
20. Testing how changing one variable affects another variable, in order to understand relationships between variables
21. Using computer-based models to investigate cause and effect relationships of a simulated phenomenon
22. Using data from investigations to defend an argument that conveys how an explanation describes an observed phenomenon
23. Using data or interpretations from other researchers or investigations to improve an explanation
24. Using mathematics or computers to analyze numeric data

[11] Students from GEMS and JSS were asked about their abilities related to "STEM practices." The data from their version of the item can be found in Chart 6.



† 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.

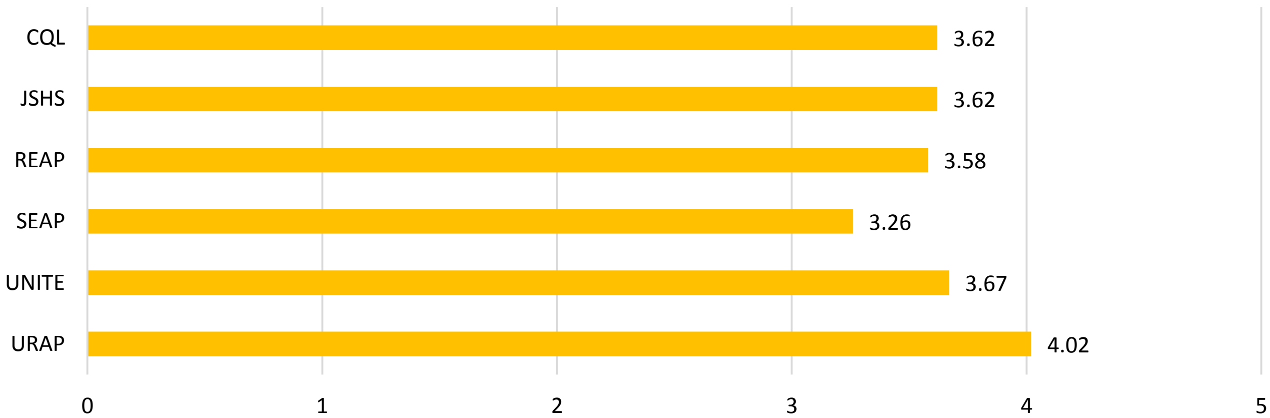
†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

The items related to engineering practices (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[12] felt they made at least some gains in their engineering practices as a result of participating in the AEOP.

[12] Students from GEMS and JSS had a different version of this item on their questionnaire. The data from their version of the item can be found in Chart 6.

Table 15. Items that form the Perceived Gains in Engineering Practices Composite
1. Applying knowledge, logic, and creativity to propose solutions that can be tested with investigations
2. Asking questions to understand the data and interpretations others use to support their solutions
3. Carrying out procedures for an investigation and recording data accurately
4. Communicating information about your design processes and/or solutions in different formats (orally, written, graphically, mathematically, etc.)
5. Considering alternative interpretations of data when deciding if a solution functions as intended
6. Deciding what additional data or information may be needed to find the best solution to a problem
7. Deciding what type of data to collect in order to test if a solution functions as intended
8. Defining a problem that can be solved by developing a new or improved object, process, or system
9. Designing procedures for investigations, including selecting methods and tools that are appropriate for the data to be collected
10. Displaying numeric data in charts or graphs to identify patterns and relationships
11. Identifying real-world problems based on social, technological, or environmental issues
12. Identifying the limitations of the data collected in an investigation
13. Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts
14. Identifying the strengths and limitations of solutions in terms of how well they meet design criteria
15. Integrating information from multiple sources to support your solution to a problem
16. Making a model that represents the key features or functions of a solution to a problem
17. Reading technical or scientific texts, or using other media, to learn about the natural or designed worlds
18. Supporting a proposed solution (for a problem) with data from investigations
19. Supporting a proposed solution with relevant scientific, mathematical, and/or engineering knowledge
20. Testing how changing one variable affects another variable in order to determine a solution's failure points or to improve its performance
21. Using computer-based models to investigate cause and effect relationships of a simulated solution
22. Using data from investigations to defend an argument that conveys how a solution meets design criteria
23. Using data or interpretations from other researchers or investigations to improve a solution
24. Using mathematics or computers to analyze numeric data

Chart 5: Mean composite scores for perceived gains in engineering practices†



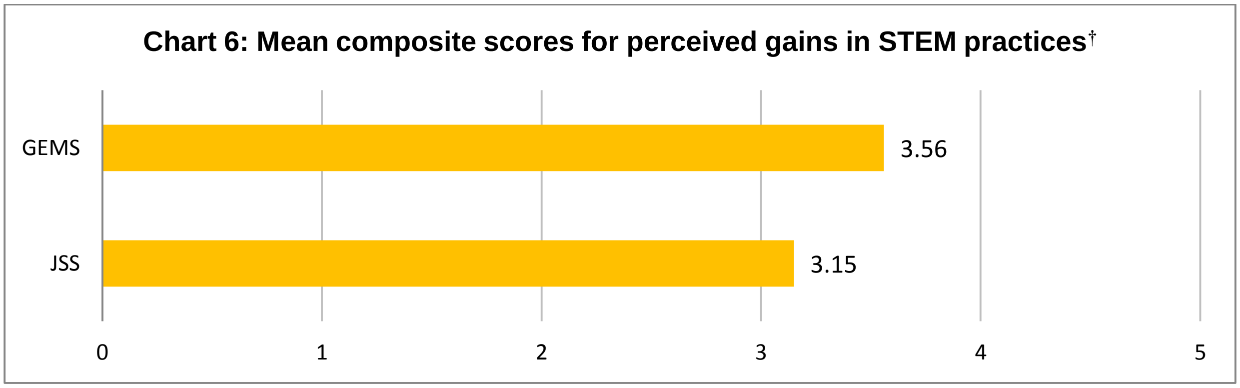
† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*

†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

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. For example, students in the UNITE program reported larger gains in their abilities with the engineering practices than with the science practices (in fact, the composite score for engineering practices in UNITE was among the highest of the programs). In contrast, students in SEAP reported higher gains in the science practices than the engineering practices, likely due to the nature of the SEAP program. However, conclusions about the relative strengths or weaknesses of programs on these outcomes should be made with caution. Different students in each program responded to the different sets of items, based on their unique experiences within the program, meaning that respondents represented herein may not be representative of *all* students who participated in the program.

Because GEMS and JSS involve students from middle-school grades, their questionnaire included a version of the practices item that was more appropriate for the age of the audience. GEMS and JSS students were asked about perceived gains on 11 STEM practices, displayed in Table 16. As can be seen in Chart 6, students from both programs reported at least some gains in STEM practices as a result of participating in the AEOP.

Table 16. Items that form the Perceived Gains in STEM Practices Composite for GEMS and JSS
1. Asking a question that can be answered with one or more investigations
2. Applying knowledge, logic, and creativity to propose scientific explanations or engineering solutions that can be tested with investigations
3. Carrying out procedures for an investigation and recording data accurately
4. Communicating information about your investigations and explanations in different formats (orally, written, graphically, mathematically, etc.)
5. Considering different ways to analyze or interpret data when answering a question
6. Designing procedures for investigations, including selecting methods and tools that are appropriate for the data to be collected
7. Displaying numeric data from an investigation in charts or graphs to identify patterns and relationships
8. Making a model to represent the key features and functions of an object, process, or system
9. Supporting a scientific explanation or engineering solution with data from investigations
10. Supporting a scientific explanation or engineering solution with relevant scientific, mathematical, and/or engineering knowledge
11. Using mathematics or computers to analyze numeric data

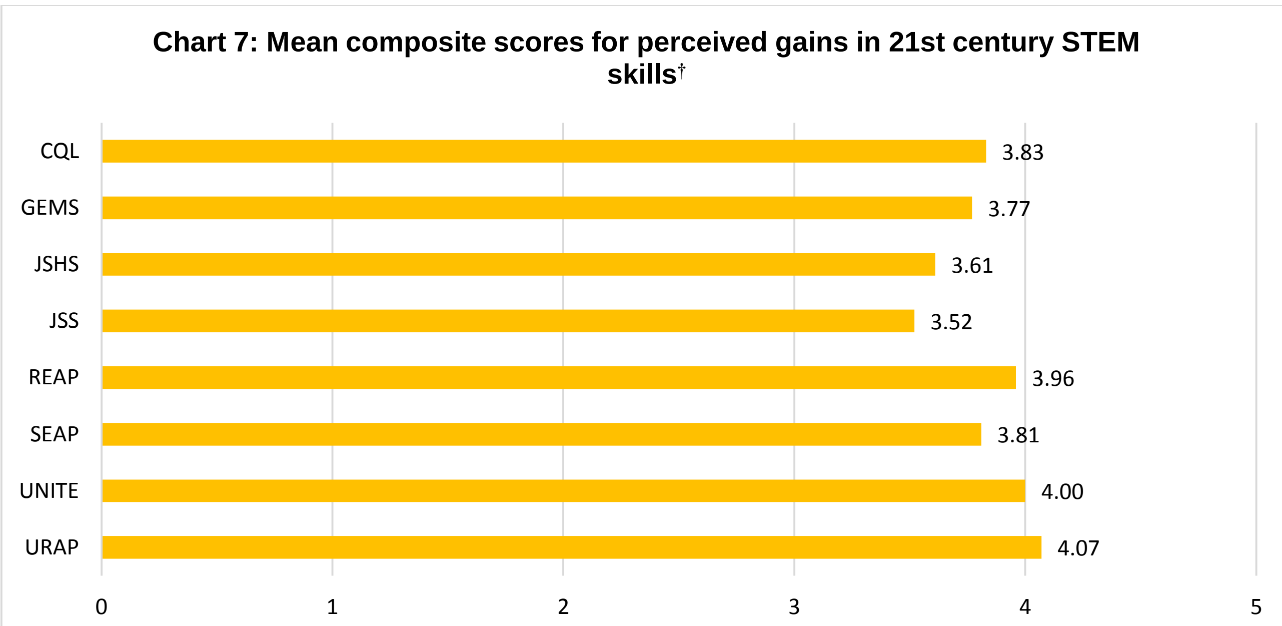


† Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.

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. Table 17 lists the items[13] that form the Perceived Gains in 21st Century Skills composite. Chart 7 displays the mean composite scores for each of the programs. The scores indicate that participants felt that they made at least some gains in 21st Century STEM Skills as a result of participating in AEOP, with apprentices and students from REAP, UNITE, and URAP reporting large gains.

[13] Items 5, 7, 9, and 10 were not included on the student questionnaire for GEMS, JSS, and UNITE.

Table 17. Items that form the Perceived Gains in 21st Century STEM Skills Composite
1. Building relationships with professionals in a field
2. Communicating effectively with others
3. Connecting a topic or field and my personal values
4. Including others' perspectives when making decisions
5. Learning to work independently
6. Making changes when things do not go as planned
7. Patience for the slow pace of research
8. Sense of being part of a learning community
9. Sense of contributing to a body of knowledge
10. Setting goals and reflecting on performance
11. Sticking with a task until it is complete/Persevering with a task
12. Working collaboratively with a team



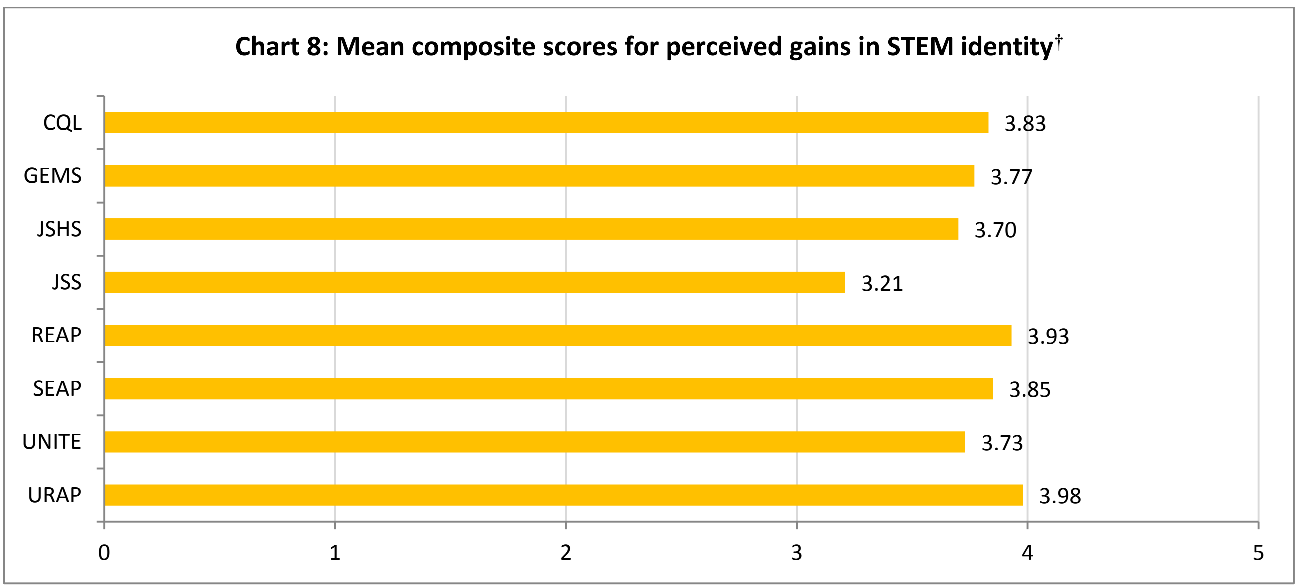
† *Response options for the items forming this composite were: 1 – No gain, 2 – A little gain, 3 – Some gain, 4 – Large gain, 5 – Extremely large gain.*
†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

Another indicator of the AEOP's impact is whether the program helps participants develop a STEM identity (i.e., see themselves as capable of succeeding in STEM). The questionnaire included items asking about the extent to which students' perceived that the program enhanced their STEM identity, and these items were used to create the Perceived Gains in STEM Identity composite; items are listed in Table 18.[14] Chart 8 shows that apprentices and students from all of

[14] Items 5, 6, 8, and 12 were not included on the student questionnaire for GEMS, JSS, and UNITE.

the represented programs perceived that students' made at least some gains in their STEM identity as a result of participating in the AEOP.

Table 18. Items that form the Perceived Gains in STEM Identity Composite
1. Building academic or professional credentials in STEM
2. Clarifying a STEM career path
3. Confidence to contribute to STEM
4. Confidence to do well in future STEM courses
5. Feeling like part of a STEM community
6. Feeling like a STEM professional
7. Feeling prepared for more challenging STEM activities
8. Feeling responsible for a STEM project or activity
9. Interest in a new STEM topic or field
10. Sense of accomplishing something in STEM
11. Thinking creatively about a STEM project or activity
12. Trying out new ideas or procedures on my own in a STEM project or activity



† *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.*

†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

Students were also asked to rate the extent of their agreement with items describing program impacts related to their STEM confidence and identity. These items also asked about their interest in taking additional STEM classes in school and pursuing STEM activities outside of school, both of which may be a result of increased STEM confidence and identity. Table 19 shows the percentage of students agreeing that the program contributed at least somewhat to the impact described. For each program, at least half of the responding students agreed that the program contributed to each impact. Most notably, the vast majority of students in each program (74-100%) agreed that the program had at least some impact on their confidence in their STEM knowledge, skills, and abilities. The programs appear to have had an impact on students' interest in taking STEM classes in school (51-73%) and on their interest in participating in STEM activities outside of school requirements (71-100%). The fact that somewhat fewer students expressed interest in taking additional STEM courses in school may possibly be attributed to their interest in taking STEM classes in school before participating in the AEOP.

Table 19. Students Agreeing that the Program Contributed to their STEM Confidence and Identity.

	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	UNITE	URAP
I am more confident in my STEM knowledge, skills, and abilities.	91%	84%	100%	74%	87%	80%	87%	90%	85%	94%
I am more interested in participating in STEM activities outside of school requirements.	71%	81%	100%	72%	73%	73%	77%	74%	80%	80%
I am more interested in taking STEM classes in school.	59%	62%	67%	57%	60%	63%	59%	51%	73%	62%

Taken together, the data indicate that the AEOP portfolio impacts apprentices' and students' perceived STEM knowledge, ability to use STEM practices, 21st Century STEM skills, and STEM identity. These impacts were also highlighted in focus groups, interviews, and in responses to open-ended questionnaire items, which can be seen in the following quotes:

> *I think [GEMS] also firms up a lot of what [students] do learn in class, like the science and math skills. Because a lot of the time you're just looking at textbooks, it just goes in one ear and out the other. You know [students] actually have to use it and you know that it makes it a little more valuable.* (GEMS Mentor)

> *I benefitted through learning more about engineering and other types of careers. We were also hands on with other specific things, such as circuit boards, we learned how to harvest energy and charge other electronics. We also had another class where we learned about nonviolence and how to deal with the situation. It kind of helps us with real life situations where it's very tense, and you don't know what to do, but at the same time you know how to problem solve and fix the issue.* (UNITE Student)

> *I am working with 3 students. They are doing really well at learning how to work together; I think that is beneficial for them. They didn't know each other before, just for them to all sit together and work together on the same projects and try to meet the same goals; it is a little different for them to do that in the workplace than at school. I think that helps get them ready for what they need to be doing in the future for them.* (CQL Mentor)

Finding #5: The AEOP continues to expand the number of students who are engaged in and exposed to DoD research. Students reported positive attitudes toward DoD STEM research and researchers, which can be attributed to their AEOP experience.

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 20 summarizes some of these efforts in 2014.

Table 20. 2014 Participant Engagement in and Exposure to DoD Research	
AEOP	**Engagement in DoD Research**
CQL, SEAP	**399** high school and undergraduate participants serving as apprentices on DoD research projects at Army or DoD research laboratories.
HSAP, URAP	**69** high school and undergraduate participants serving as apprentices on Army research projects at college/university research laboratories.
GEMS	**2,095** elementary, middle and high school participants, **93** undergraduate NPMs, and **53** K-12 teachers were engaged in DoD research through GEMS activities hosted by Army research laboratories.
AEOP	**Exposure to DoD Research**
eCM	**70** participants and their **21** 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	**220** participants and their **60** 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. More than **2,500** students were exposed to DoD research through DoD S&Es who engage at regional JSHS symposia.
UNITE	**280** high school participants and **162** program mentors participated in career day events that included learning about the work of DoD STEM personnel and/or DoD research facilities.
JSS	**83** participants in regional competitions and **225** 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. In 2014, 2,709 apprentices, students, NPMs, and K-12 teachers engaged in DoD research projects or used DoD research facilities for enrichment; an increase of 4% over the 2,603 participants in 2013.

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. Over 1,100 students, K-12 teachers, university faculty and students, and other volunteers were exposed to DoD research through these kinds of activities. Many more participants are likely to have been exposed to DoD STEM research through AEOP program activities that were not as well documented as these, such as a higher and more accurate number of students at the JSHS Regional Symposia which included DoD programming.

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. As can be seen in Table 21, a large proportion of mentors in all programs discussed STEM opportunities in the DoD with participants (47-100% of mentors).

Table 21. Percent of Mentors Who Report Discussing STEM Opportunities in the DoD with Apprentices and Students

CQL	GEMS	HSAP	JSHS	JSS	REAP	SEAP	UNITE	URAP
58%	74%	100%	30%	47%	63%	76%	57%	53%

Looking specifically at apprenticeship programs, greater percentages of mentors in the CQL, HSAP, REAP, SEAP, and URAP programs reported educating their apprentices about STEM opportunities with the DoD in 2014 than in 2013 (see Chart 9). The most significant increase happened with HSAP – while 45% of mentors reported educating apprentices about STEM opportunities with the DoD in 2013, 100% reported doing so in 2014.

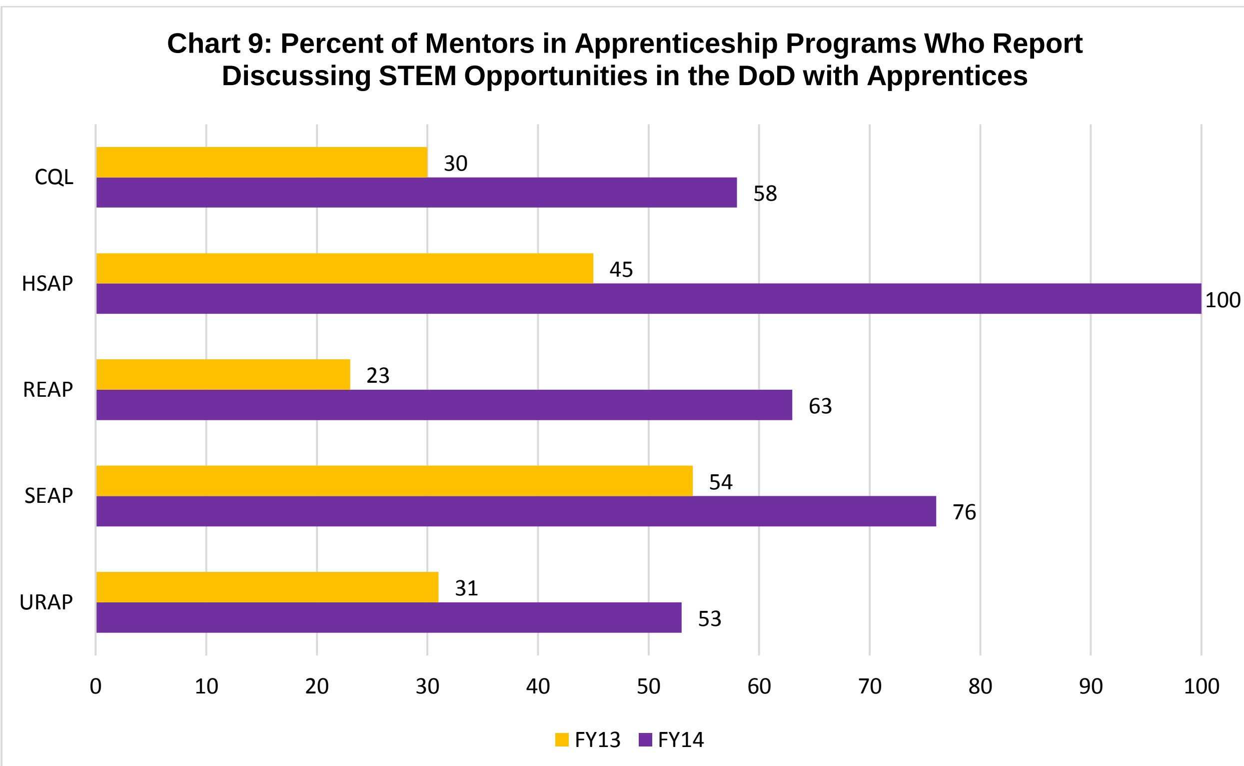


Table 22 summarizes apprentices' and students' attitudes toward Army/DoD research and researchers. In all cases, the proportion responding "agree" or "strongly agree" to questionnaire items are given. The majority of participants agree that Army/DoD research and researchers develop new, cutting-edge technologies (62-93%) and help advance science and engineering fields (54-95%). These finding are similar to those from 2013.

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 more positive attitudes about DoD research than regional JSHS symposia participants.

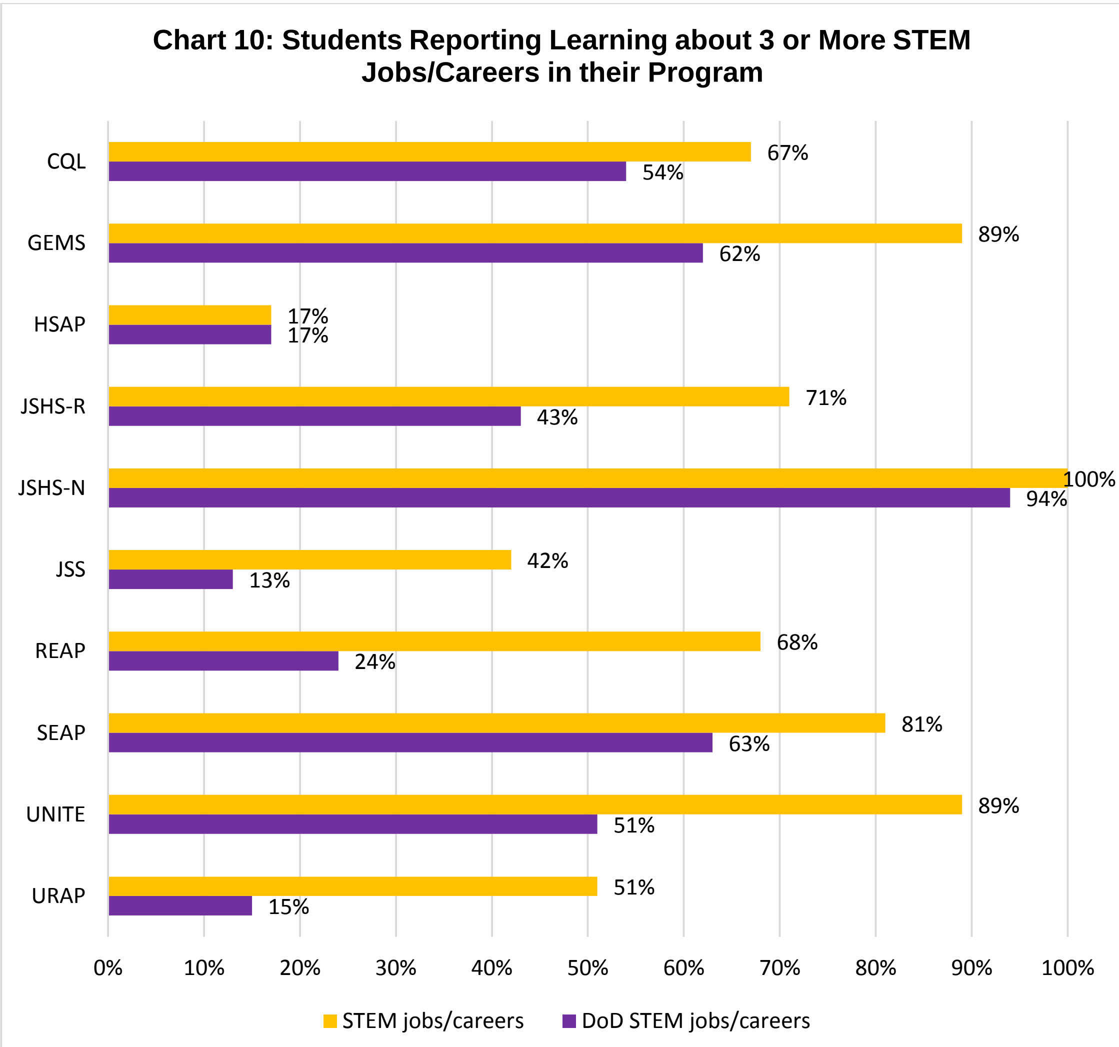
Table 22. AEOP Participants' Agreeing with Various Statements about DoD STEM Research

	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	UNITE	URAP
DoD researchers advance science and engineering fields	95%	76%	83%	56%	100%	54%	66%	88%	58%	73%
DoD researchers develop new, cutting edge technologies	93%	78%	83%	59%	100%	62%	70%	86%	65%	76%
DoD researchers support non-defense related advancements in science and technology	86%	63%	66%	53%	84%	45%	54%	86%	53%	59%
DoD researchers solve real-world problems	95%	79%	83%	60%	100%	56%	66%	90%	63%	73%
DoD research is valuable to society	94%	79%	83%	56%	97%	52%	58%	90%	68%	70%

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., CQL and GEMS) at doing so than others (e.g., REAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities are 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. Some programs reported that they encountered barriers when they attempted to engage Army personnel to participate in program activities.

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 10.

Most 2014 AEOP participants reported learning about 3 or more STEM jobs; however, Army and DoD STEM careers received less attention. 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 2014 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. (JSHS-N students may have reported learning about more DoD STEM jobs due to their engagement with DoD S&Es at the national event.) Apprentices and students at Army research laboratories have substantial exposure to Army and DoD STEM professionals in their daily work. The data in Chart 9 potentially provide evidence of the significance of program location on exposing participants to Army and DoD STEM careers. Of the two programs for which similar 2013 data are available (GEMS and UNITE), there was little movement on this measure for one and a slight improvement for the other.



Students were also asked about their awareness of and interest in STEM careers in general and with the DoD. 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, and more than two-thirds did so for six programs (CQL, GEMS, HSAP, JSHS, SEAP, and UNITE; see Table 23). Most 2014 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, GEMS, HSAP, 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 three-fourths of participants in several programs (CQL, HSAP, JSHS-N, SEAP, and UNITE).

Table 23. 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 STEM career	60%	81%	67%	60%	70%	58%	65%	51%	70%	59%
I am more aware of DoD STEM research and careers	86%	81%	83%	69%	97%	57%	63%	78%	77%	62%
I have a greater appreciation of DoD STEM research and careers	83%	66%	84%	64%	94%	53%	64%	88%	76%	68%
I am more interested in pursuing a STEM career with the DoD	74%	84%	83%	53%	84%	53%	49%	68%	62%	59%

In 2013, AEOP mentors reported that their limited awareness of and lack of research about Army and DoD STEM careers hindered their ability to educate participants about Army/DoD STEM careers. To better understand the utility of resources that AEOP provides, mentors across the 2014 AEOP programs were asked to report how useful a variety of resources were for exposing their students to DoD STEM careers. Table 24 displays the resources that mentors found somewhat or very useful. Mentors from all of the programs reported that participating in the AEOP program was useful (66-100%) for exposing students to DoD STEM careers. In contrast, mentors tended not to find the centralized AEOP resources (e.g., the AEOP website, AEOP social media, the AEOP brochure, and AEOP instructional supplies) useful for this purpose.

Table 24. 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.)	11%	23%	50%	42%	77%	60%	6%	31%	53%
AEOP website	11%	48%	100%	7%	33%	51%	18%	33%	40%
AEOP social media	6%	22%	0%	3%	14%	22%	6%	29%	7%
AEOP brochure	17%	48%	50%	11%	20%	58%	12%	35%	28%
AEOP instructional supplies (Rite in the Rain notebook, Lab coats)	17%	71%	100%	4%	14%	59%	12%	28%	36%
Program administrator or site coordinator	53%	80%	100%	12%	53%	59%	59%	51%	40%
Invited speakers or "career" events	39%	81%	50%	26%	7%	22%	36%	59%	14%
Participation in [program]	83%	91%	100%	56%	66%	74%	83%	76%	80%

In some cases, 2014 AEOP mentors reported encountering challenges when they attempted to engage Army personnel to increase participants' awareness of Army and DoD STEM research and careers. These challenges may have lowered mentors' ratings of the utility of invited speakers or "career" events. For example, in spring 2014 TSA made contact with the Army to ask for assistance in securing local Army contacts so that UNITE sites could arrange Army engineers as speakers at career days. However, TSA contacts with the Army did not result in any connections for sites in 2014, although those sites with established relationships with nearby Army facilities or existing local Army contacts made use of their pre-existing resources. In another example, JSHS coordinated with tri-service leadership to identify DoD laboratories within commuting distance of regional symposia, but found that lack of travel funds for military personnel were sometimes a barrier to their participation.

In 2014, AEOP mentors continued to report in questionnaires, focus groups, and interviews that their limited awareness and lack of resources about Army and DoD STEM careers hindered their ability to educate participants about Army and DoD STEM careers, as exemplified in the following quotes:

> *I'm not sure if I'm aware of all of the STEM programs that are offered through the DoD…as it relates to being exposed to STEM research, there's definitely exposure in my lab, or through collaborating labs, or labs that are physically located near where my lab is located, but as it relates to specifically DoD STEM research, I'm not sure if I'm addressing that part of the question.* (REAP Mentor)

> *I'm afraid that's a weakness in our region. We go to a number of universities because our region is so large, we're not based in one single one. Some do not have ROTC programs and in some areas there's not a military presence. We're lucky enough to have a navy post-graduate school in [region] that actually hosts our programs once in every three years. That's total immersion in DoD.* (JSHS Mentor)

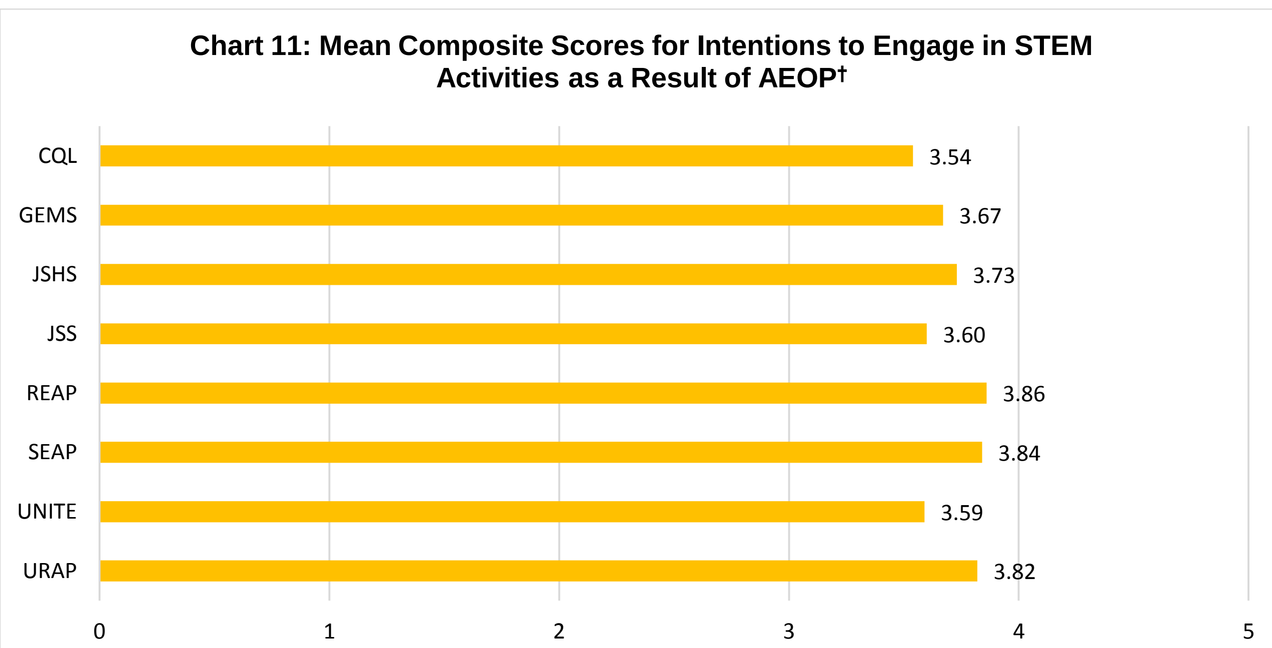
As in 2013, mentors suggested a number of programmatic revisions that might help them better educate participants about Army and DoD STEM careers:

- Provide comprehensive resources, such as interactive websites, video series, or booklets that detail various research foci and possible careers at Army/DoD laboratories. These could be disseminated through mentors or directly to apprentices;
- Provide information about Army/DoD funding for STEM pathways, including internship programs, scholarships, fellowships, and ROTC; and
- Provide opportunities for guest speakers from Army/DoD to visit program sites or opportunities for AEOP participants to visit Army/DoD sites.

<u>Finding #7</u>: 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, HSAP, and JSHS-N). As compared to AEOP apprentices in 2013, there was at least a 20% increase in interest in pursuing DoD STEM careers across the 2014 apprentice programs.

2014 program evaluations captured a range of apprentices' and students' interests and aspirations in STEM, such as their intentions to engage in STEM-related activities, including extracurricular activities at home, in communities, and after school as a result of their participation in their respective AEOP. The items from the questionnaire that form the Intentions to Engage in STEM Activities composite can be seen in Table 25. Chart 11 displays the mean composite scores for the apprentices and students across the AEOP programs. The composite scores indicate that the majority of participants reported being somewhat more likely to pursue STEM and STEM-based activities after participating in AEOP programs.

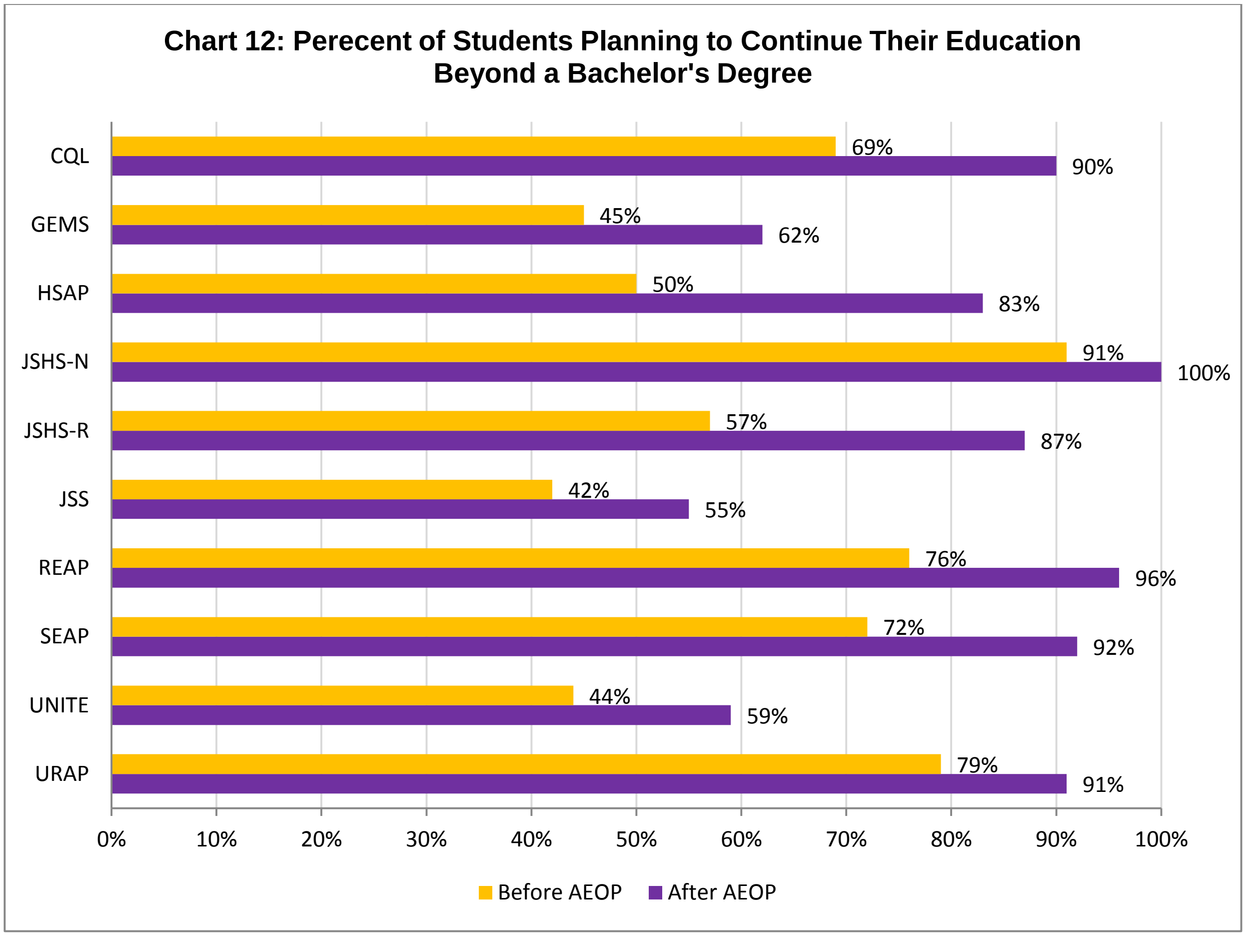
Table 25. Items that form the Intentions to Engage in STEM Activity Composite
1. Design a computer program or website
2. Help with a community service project that relates to STEM
3. Look up STEM information at a library or on the internet
4. Mentor or teach other students about STEM
5. Observe things in nature (plant growth, animal behavior, stars or planets, etc.)
6. Participate in a STEM club, student association, or professional organization
7. Participate in STEM camp, fair, or competition
8. Receive an award or special recognition for STEM accomplishments
9. Take an elective (not required) STEM class
10. Talk with friends or family about STEM
11. Tinker (play) with a mechanical or electrical device
12. Visit a science museum or zoo
13. Watch or read non-fiction STEM
14. Work on a STEM project or experiment in a university or professional setting
15. Work on solving mathematical or scientific puzzles



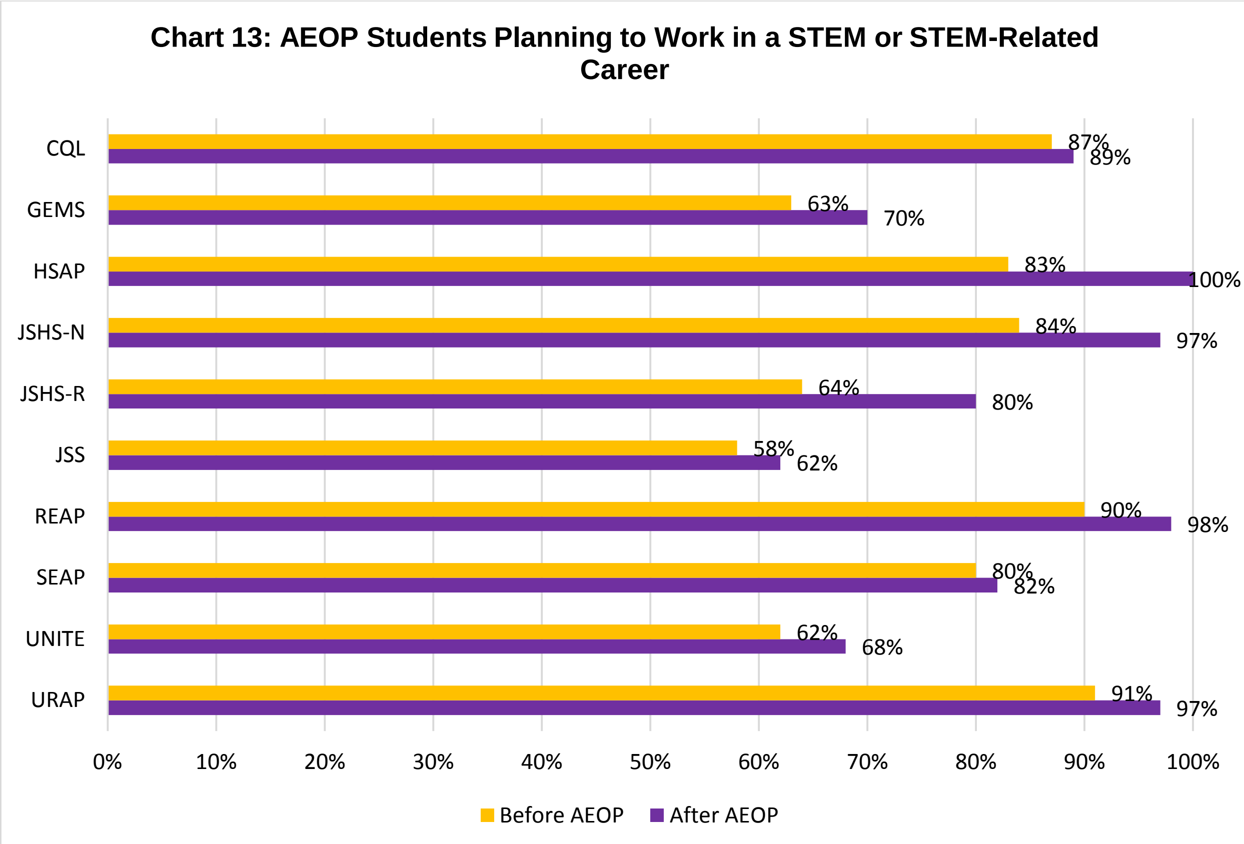
† *Response options for the items forming this composite were: 1 – Much less likely, 2 – Less likely, 3 – About the same before and after, 4 – More likely, 5 – Much more likely.*
†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

eCM questionnaires also included pre- to post-eCM comparisons of students' engagement in nine different STEM extracurricular activities such as reading books/magazines about science or math, using tools to observe things, watching science TV programs, and visiting museums or zoos. Total pre- and post-eCM engagement scores were calculated and compared, and a statistically significant increase was found in students' engagement for almost all of the activities across the participant sample, including "I read books or magazines about science or math," "I watch television programs about science," and "I take things apart to see how they work."

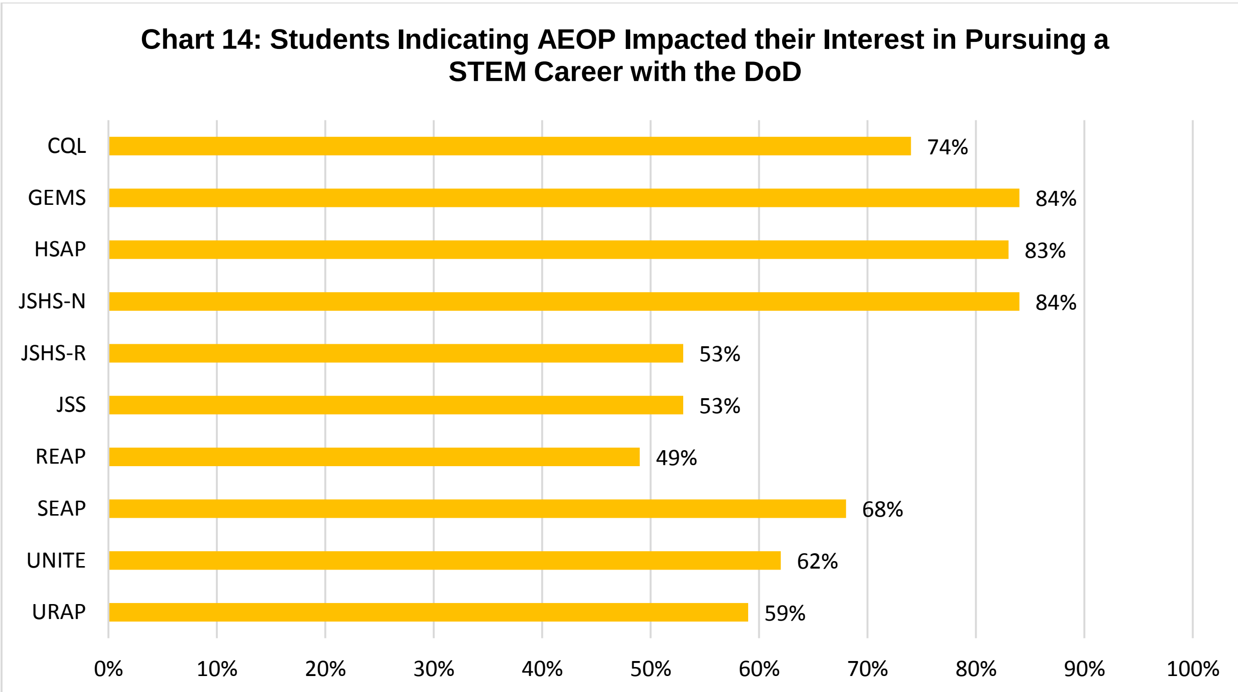
Students were also asked about how much education they intended to pursue, reflecting back on their aspirations prior to participating in the AEOP and at the conclusion of their experience. These data are shown in Chart 12. Across all of the AEOP programs, a greater proportion of students planned to pursue education beyond an undergraduate degree after participating in 2014 AEOP programming than they had before. The greatest increases in education aspirations tended to be for the participants in apprentice programs (CQL, HSAP, REAP, and SEAP had increases of at least 20%), though participants in JSHS-R also reported large changes on this indicator.



Participants were also asked on the questionnaires about their career goals prior to and after participating in AEOP. The data were coded into STEM-related and non-STEM-related careers. As can be seen in Chart 13, the majority of AEOP participants (58-91%) had already intended to work in a STEM-related field prior to participating. However, there was a slight increase among participants in all programs in desire to pursue a STEM career as a result of participating in AEOP (62-100%).



Participants not only reported being more interested in STEM careers generally, but they reported that their participation in AEOP contributed to their interest in pursuing a STEM career with the DoD. As can be seen in Chart 14, 49-84% of participants reported that participating in their AEOP program increased their interest in STEM DoD careers. Students from GEMS and CQL (both hosted at Army laboratories), HSAP (hosted at Army-funded college/university laboratories), and JSHS-N (which included sessions on DoD STEM careers) reported the greatest interest.



Participants in the apprenticeship programs were asked about their interest in DoD STEM careers in both 2013 and 2014. As can be seen in Table 26, the percentage of apprentices reporting being interested was at least 20% higher in 2014 for each of the programs.

Table 26. Apprentices' Interest in DoD STEM Careers in 2013 vs. 2014

	2013	2014
CQL	43%	74%
HSAP	25%	83%
REAP	21%	49%
SEAP	44%	68%
URAP	24%	59%

Across the AEOP programs, youth and adult participants reported in questionnaires, focus groups, and interviews that AEOP programs afforded opportunities for students to clarify, explore, and/or advance their STEM pathways. Students stated that they had opportunities to explore new STEM topics and fields of interest, clarify education or career goals, build applications and resumes, prepare for and preview college studies, engage in professional networking, and preview unique professional working environments, as evidenced by the following quotes:

> *I think I'd like to be some kind of engineer or aviation person someday, and I also benefited from the talk about the summer programs or internship because I was planning on doing some kind of summer job in a fast food place this summer but I think an internship with some STEM or Army, or Air Force or Navy place would be much better.* (JSHS Student)

[After REAP], I realized I do want to pursue Biochemistry, and I learned hands on skills, protocols, you don't get much at high school science class; not at the level of the university laboratory. (REAP Apprentice)

I think one of the main values [of CQL] is experience that exposes [apprentices] to more of how a future job position might work. And it just exposes them to a lot of different techniques and machinery and procedures that they wouldn't have any exposure to in their college setting, so it gives them more of a real world feel of what goes on. (CQL Mentor)

Advancement of students' STEM pathways - occurring implicitly and explicitly in program activities - is clearly a success of AEOP. However, generating more interest in Army and DoD STEM careers, especially for those students participating in programs that are not located at DoD affiliated laboratories, may require additional effort. As described in Finding #6, mentors from many of the programs report not being familiar with DoD careers. It may be beneficial for mentors to receive training on DoD STEM research and careers prior to participating in the AEOP program. In addition, participating students should have opportunities to learn about DoD research and careers beyond what is offered to them by their mentors through avenues such as webinars, invited speakers, and field trips to DoD laboratories.

Priority Two: STEM Savvy Educators

STEM educators 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 2014 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 used a large number, and wide variety, 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. However, mentors tended to use fewer strategies for supporting mentees' educational and career pathways, which may help explain the relatively low numbers of mentees reporting learning about multiple STEM careers during their experience.

The mentor questionnaire asked whether or not mentors used a number of strategies when working with apprentices/students. These strategies comprised five main areas of effective mentoring:[15]

[15] 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.

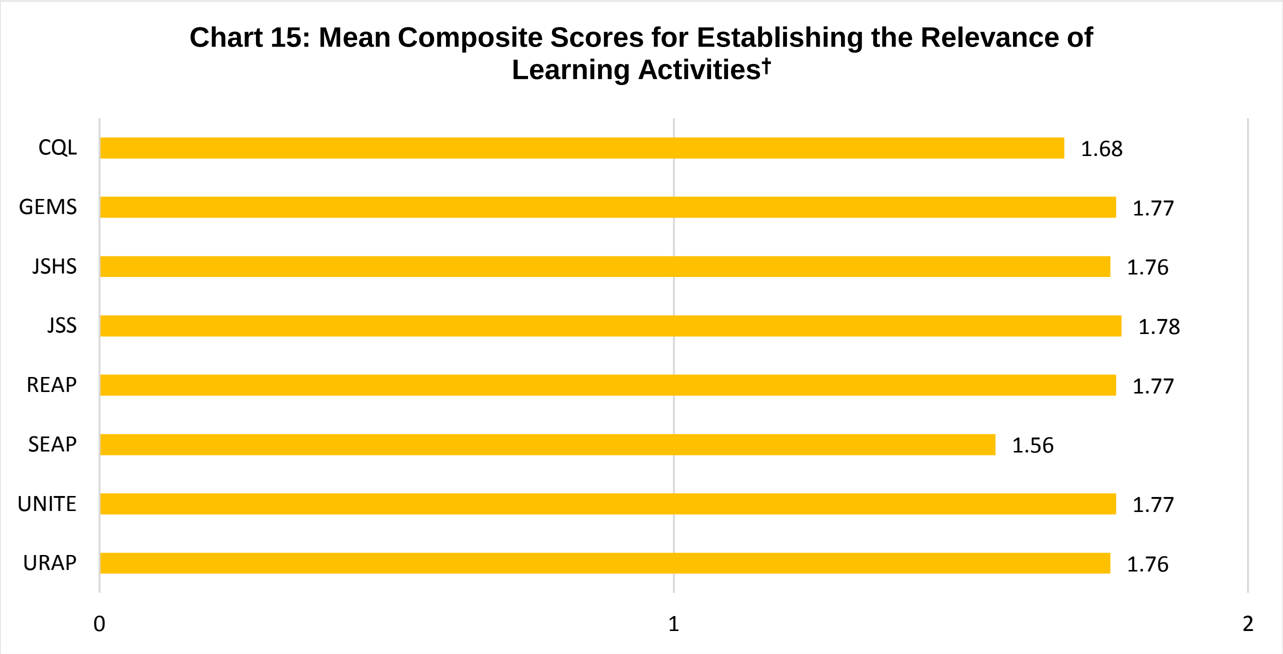
Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

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.[16]

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 27, and mean composite scores are shown in Chart 15. The data indicate that, across the 2014 AEOP elements, most mentors used many of these strategies for making activities relevant to participants.

Table 27. Items that form the Establishing the Relevance of Learning Activities Composite
1. Asking students to relate outside events or activities to topics covered in the program
2. Giving students real-life problems to investigate or solve
3. Helping students become aware of the roles STEM plays in their everyday lives
4. Helping students understand how STEM can help them improve their communities
5. Finding out about students' backgrounds and interests at the beginning of the program
6. Encouraging students to suggest new readings, activities, or projects
7. Selecting readings or activities that relate to students' backgrounds
8. Making explicit provisions for students who wish to carry out independent studies

[16] 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 2014. Student data on mentor instructional and mentoring strategies can be found in the individual program reports.

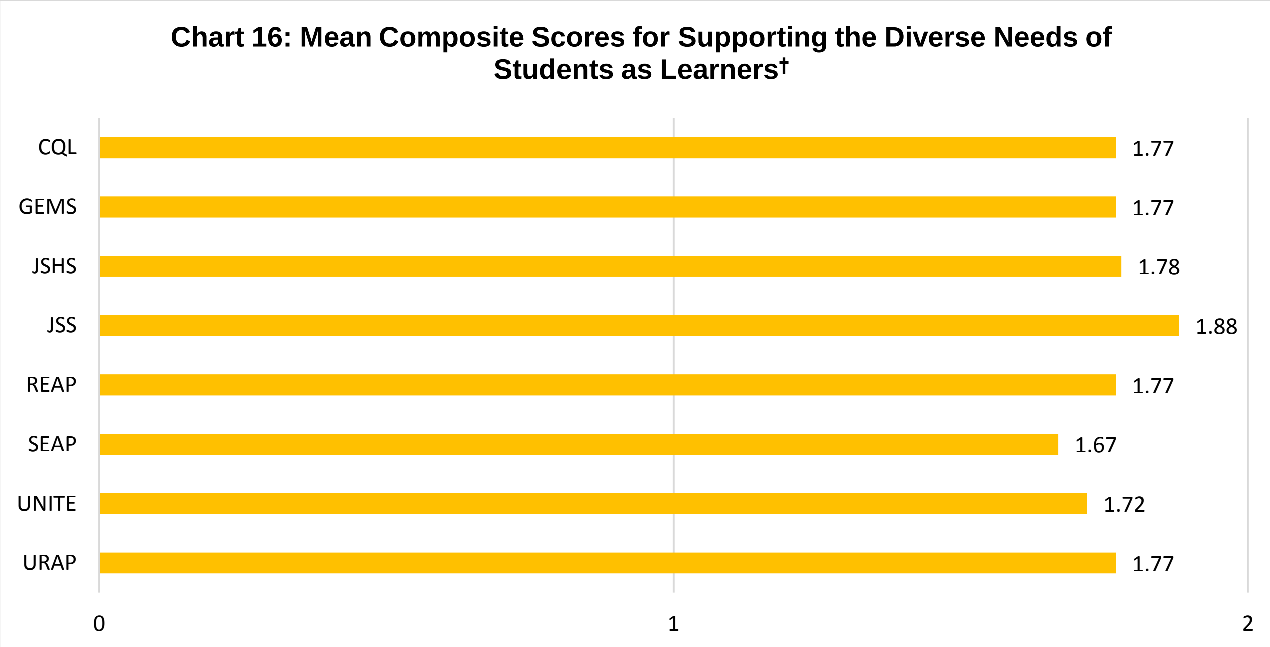


† Response options for the items forming this composite were: 1 – No, 2 – Yes.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

Similarly, the items comprising the Supporting the Diverse Needs of Students as Learners composite are shown in Table 28, and mean composite scores are shown in Chart 16. Again, the data indicate that most mentors used many of these strategies for supporting the learning of all participants.

Table 28. Items that form the Supporting the Diverse Needs of Students as Learners Composite
1. Interacting with all students in the same way regardless of their gender or race and ethnicity
2. Using diverse teaching/mentoring activities to address a broad spectrum of students
3. Using gender neutral language
4. Directing students to other individuals or programs if I can only provide limited support
5. Finding out about students' learning styles at the beginning of the program
6. Integrating ideas from the literature on pedagogical activities for women and under-represented students
7. Providing extra readings, activities, or other support for students who lack essential background knowledge or skills

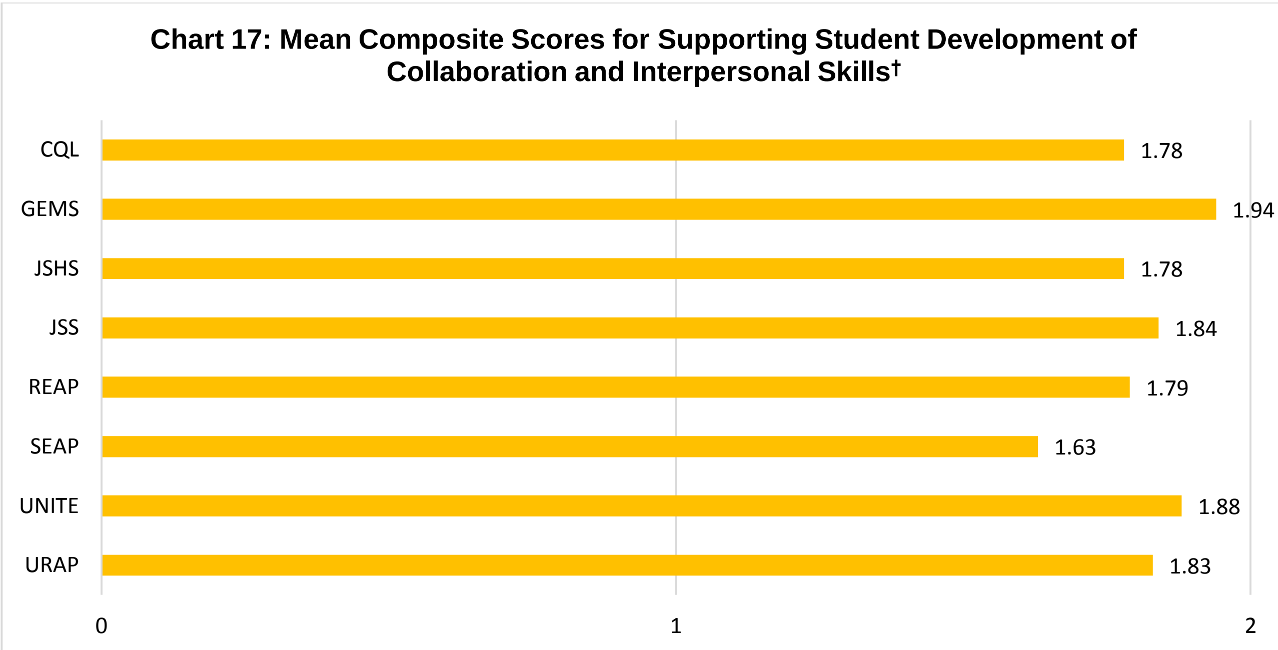


† Response options for the items forming this composite were: 1 – No, 2 – Yes.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

The items making up the third mentoring strategies composite, Supporting Student Development of Collaboration and Interpersonal Skills, are shown in Table 29 and mean composite scores are shown in Chart 17. Across all of the represented 2014 AEOPs, mentors report using a majority of these strategies, with GEMS mentors being the most likely to use them and SEAP mentors the least likely.

Table 29. Items that form the Supporting Student Development of Collaboration and Interpersonal Skills Composite
1. Having students work on collaborative activities or projects as a member of a team
2. Having students listen to the ideas of others with an open mind
3. Having students exchange ideas with others whose backgrounds or viewpoints are different from their own
4. Having students participate in giving and receiving feedback
5. Having students develop ways to resolve conflict and reach agreement among the team
6. Having students explain difficult ideas to others
7. Having students pay attention to the feelings of all team members
8. Having students tell others about their backgrounds and interests

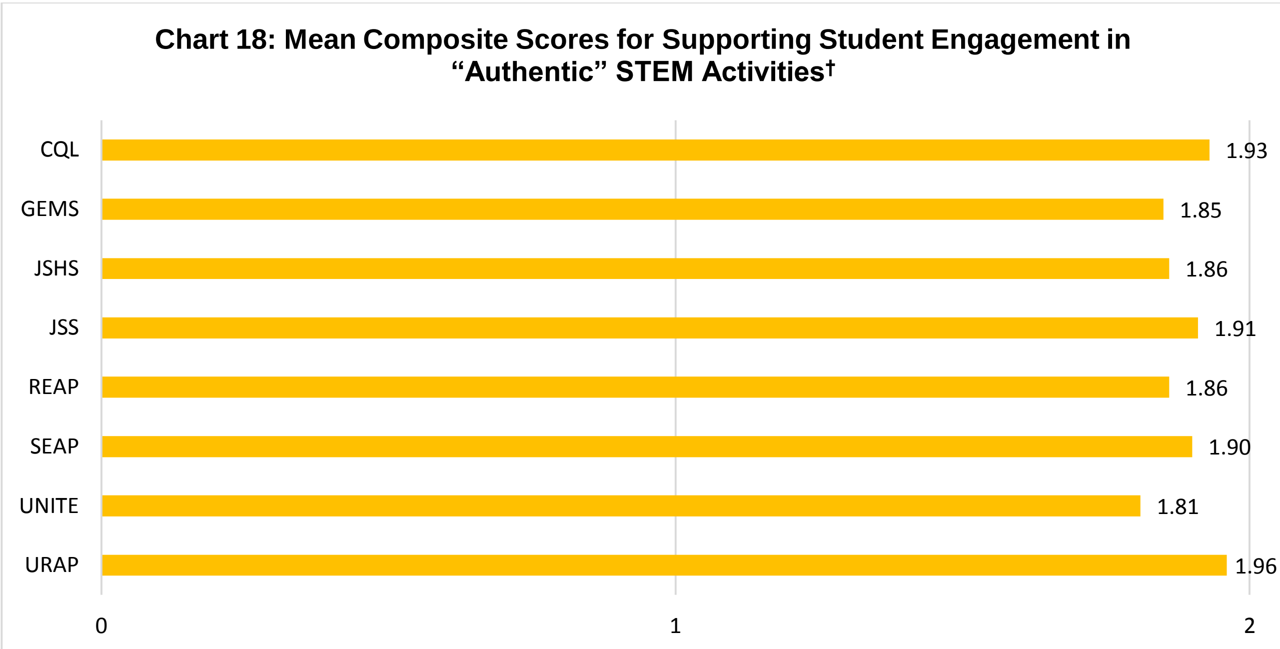


† Response options for the items forming this composite were: 1 – No, 2 – Yes.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

The fourth set of mentoring strategies focused on supporting student engagement in "authentic" STEM activities; the items are shown in Table 30. As can be seen in Chart 18, mean scores on this composite are very high in each program, indicating that mentors reported using nearly all of these strategies. Scores on this composite for the apprentice programs (CQL, REAP, SEAP, and URAP) tend to be higher than scores on the other mentoring composites, likely due to the fact that these programs engaged apprentices in the STEM research being conducted in host laboratories.

Table 30. Items that form the Supporting Student Engagement in "Authentic" STEM Activities Composite
1. Encouraging students to seek support from other team members
2. Allowing students to work independently as appropriate for their self-management abilities and STEM competencies
3. Encouraging opportunities in which students could learn from others (team projects, team meetings, journal clubs)
4. Giving constructive feedback to improve students' STEM competencies
5. Helping students practice STEM skills with supervision
6. Demonstrating the use of laboratory or field techniques, procedures, and tools students are expected to use
7. Teaching (or assigning readings) about specific STEM subject matter
8. Having students access and critically review technical texts or media to support their work

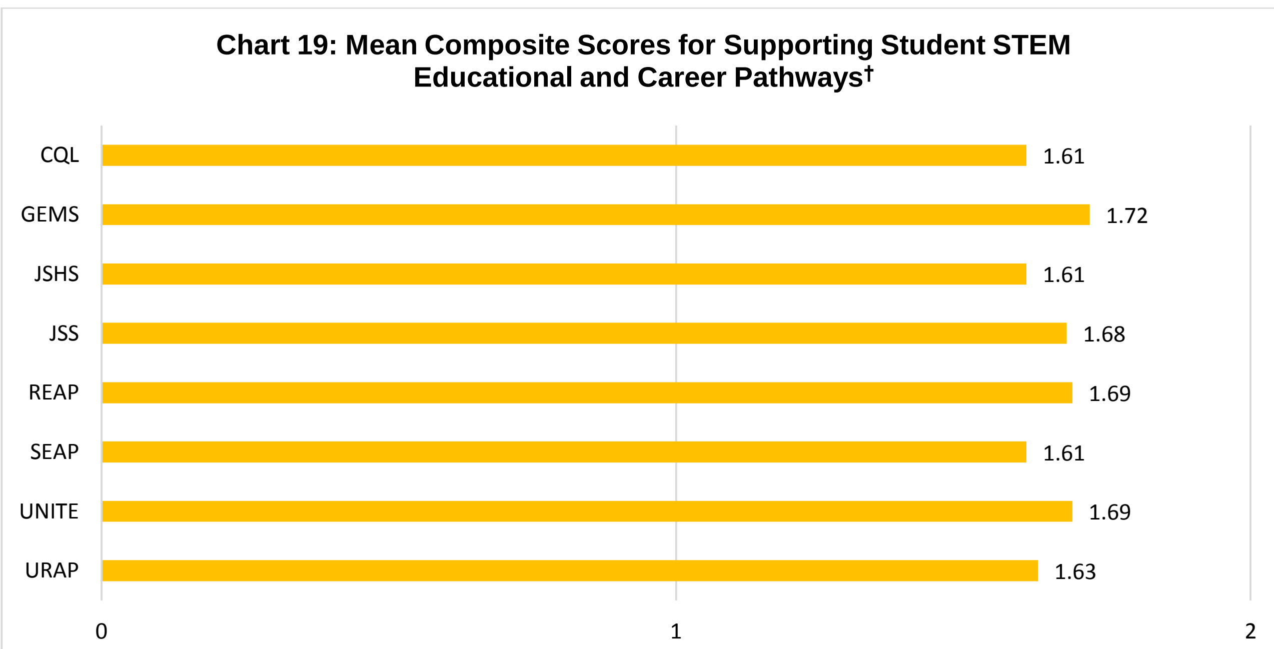


† Response options for the items forming this composite were: 1 – No, 2 – Yes.

†† HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.

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 31, and mean composite scores are shown in Chart 19. Although the composite scores indicate that mentors reported using a majority of these strategies, the scores tend to be lower than on the other mentoring strategies composites. In part, the lower scores may be a result of the composite having more items than the others. They may also be due to mentors focusing on, engaging and training apprentices on the particular research project, rather than discussing education and career pathways. However, given that many apprentices/students reported not learning about STEM careers, particularly those within the DoD, the scores on this composite are additional evidence of the need to emphasize and provide resources about DoD STEM careers across the AEOP elements.

Table 31. Items that form the Supporting Student STEM Educational and Career Pathways Composite
1. Asking about students' educational and career interests
2. Sharing personal experiences, attitudes, and values pertaining to STEM
3. Providing guidance about educational pathways that would prepare students for a STEM career
4. Recommending extracurricular programs that align with students' educational goals
5. Discussing non-technical aspects of a STEM career (economic, political, ethical, and/or social issues)
6. Recommending student and professional organizations in STEM
7. Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM
8. Discussing STEM career opportunities outside of the DoD or other government agencies (private industry, academia)
9. Discussing STEM career opportunities with the DoD or other government agencies
10. Recommending Army Educational Outreach Programs that align with students' educational goals
11. Helping students build effective STEM networks
12. Critically reviewing students' résumé, application, or interview preparations



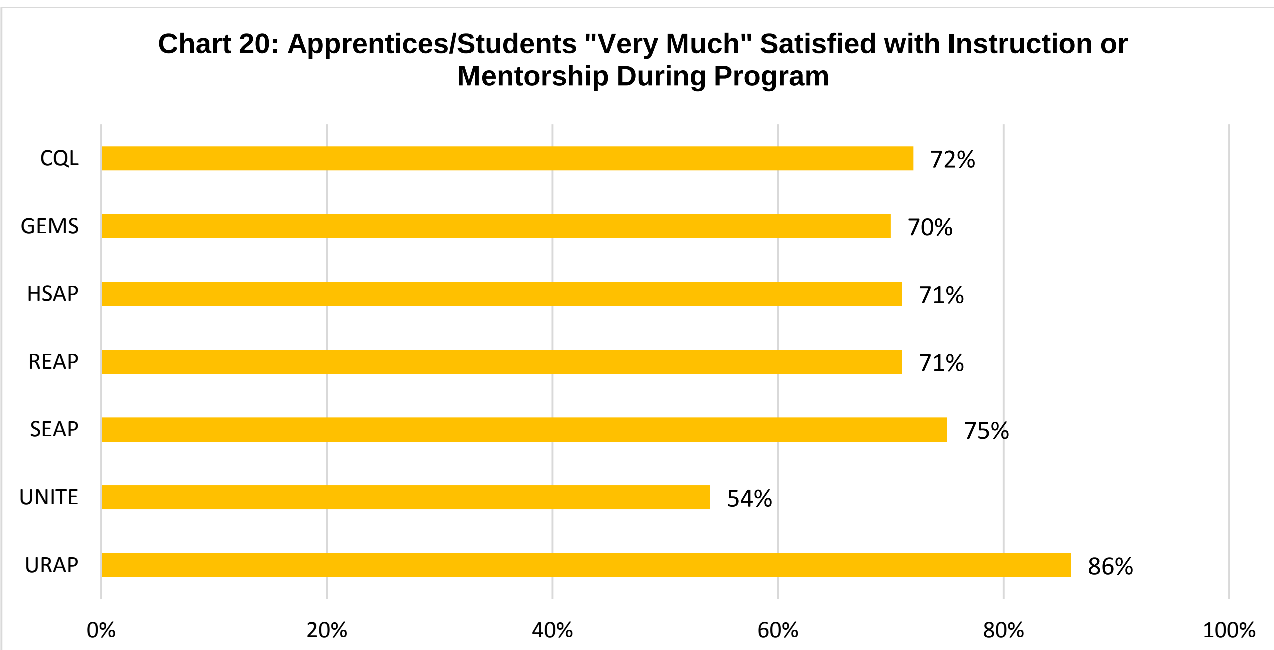
† *Response options for the items forming this composite were: 1 – No, 2 – Yes.*

†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

Overall, 2014 AEOP mentors reported using a large number and wide variety 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. However, mentors tended to use fewer strategies for supporting mentees' educational and career pathways, which may help explain the relatively low numbers of mentees reporting learning about multiple STEM careers during their experience.

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

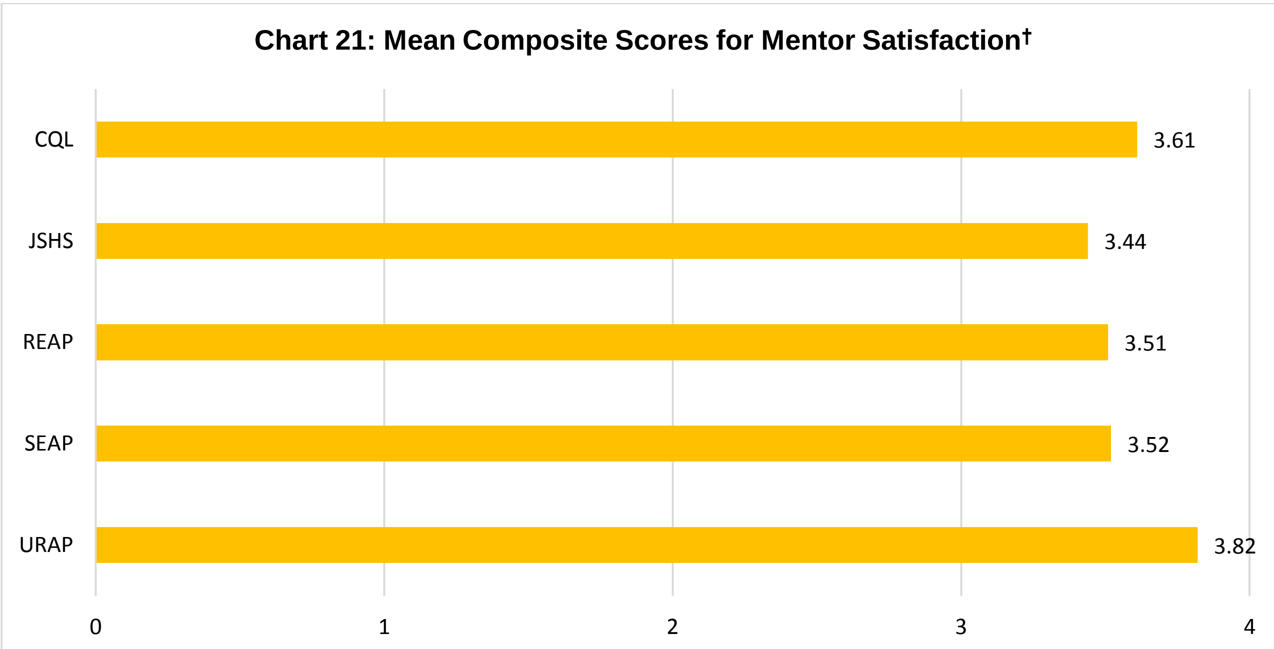
Another indicator of whether AEOP is engaging STEM savvy educators is the quality of instruction/mentorship apprentices and students receive during their experience. Apprentices/Students in most of the 2014 AEOPs were asked on the questionnaire how satisfied they were with their program's instruction or mentorship. As can be seen in Chart 20, a large majority of students across AEOP elements indicating being "very much" satisfied with this aspect of their experience. URAP participants were most likely to report being very much satisfied (86%); UNITE participants were the least likely (54%). These results are similar to those from 2013, when the vast majority of apprentices reported wanting to work with their mentor again.



The 2014 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 32 and were used to create a "Mentor Satisfaction" composite variable. As can be seen in Chart 19, scores on this composite were high, indicating that participants were very satisfied about the quality of the mentoring they received.

Table 32. Items that form the Mentor Satisfaction Composite
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



† *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.*

†† *HSAP is not included in this chart as the population and sample are too small to calculate composite variables and to have confidence in the calculation of margin of error.*

Priority Three: Sustainable Infrastructure

While the AEOP Consortium took a number of steps in 2014 to better develop a sustainable infrastructure, additional efforts will likely be needed. The implementation of a centralized application system across all AEOP elements in 2015 will significantly advance the AEOP's ability to capture accurate and consistent data on all applicants as well as both youth and adult participants.

Finding #1: 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 the future, evaluators and program administrators will benefit from efforts to improve response rates to evaluation assessments including earlier planning and incentives for participation. Additionally, the continued refinement of questionnaires to enhance reliability, validity, and alignment with federal reporting standards will ensure quality assessment of AEOP programs in the future.

The Lead Organization (LO) of the AEOP CA, Virginia Tech, provides 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 evaluation conducted by the LO has undergone continuous development and expansion in the four years since the inception of the AEOP CA. In 2013, the evaluation was revised to improve the rigor of the evaluation, better align the AEOP's evaluation with Federal and field guidance, and improve the capacity of the evaluation team and Consortium members to contribute to and use evaluation.

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;[17]
- 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.

In 2014, efforts were made to better align the evaluation of eCM with the rest of the AEOP evaluation system, even though the eCM evaluation is conducted by a separate entity. Although this alignment is not yet complete, progress continues to be made.

The major weakness of the 2014 AEOP evaluation system, across programs, was the low response rate on questionnaires from both adult and youth participants. These low response rates raise concerns about the generalizability of results, including the possibility of bias in results because certain groups are opting out of the evaluation. Consequently, 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.[18] 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.

Additionally, the implementation of a centralized AEOP application system in 2015 will enable evaluators to collect data from a common set of core questions across all AEOP elements from both youth and adult participants. The common

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

[18] 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."

questions will incorporate many of the items previously included with AEOP evaluation surveys (e.g., demographics and previous AEOP experience), thereby allowing for the shortening of 2015 evaluation surveys. Further, 2015 AEOP evaluation surveys will be offered through the same platform that hosts the application. Participants in apprentice programs (apprentices and mentors) will receive the evaluation survey through direct email from the system. It is the hope that the new application/evaluation technology will increase both the quality and consistency of data collected as well as response rates across the AEOP portfolio.

Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in 2013, the 2014 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.

In 2014 the LO worked with the CAMs and Consortium members to synchronize the overall marketing, promotion, and branding toward unified messaging of AEOP programs as a pipeline of opportunities for students, teachers and schools. The priorities for AEOP communications efforts are:

- Educating target audiences and the broader public about why generating interest in STEM is of vital importance to the U.S. Army;
- Improving coordination, efficiency, and effectiveness of AEOP programs through communication; and
- Increasing communication and promotion of AEOP to under-represented groups.

In 2014, the Army established a solicitation process internal to the Consortium that enabled consortium members to submit proposals to supplement the marketing efforts already in place for the individual AEOP elements. The purpose of the AEOP Central Branding Initiative was to expand the AEOP brand and its value in STEM education/outreach. The following AEOP Central Branding Initiatives were funded in 2014:

- Support for marketing JSHS and the AEOP at the U.S. Science & Engineering Festival (complete);
- AEOP marketing items for JSS national event (complete);
- AEOP marketing items for UNITE (complete);
- AEOP pathways poster (initiated); and
- AEOP STEM careers magazine (initiated).

Table 33 summarizes 2014 AEOP communication activities produced by the CAMs, LO, and/or Consortium members.

Table 33. 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.) • Production of event-specific video highlighting student participants (JSHS-N). • 2014 AEOP Student Research Abstract Book (electronic). • 2013 Year In Review Publication (print and electronic). • News releases highlighting specific 2014 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. • Initiation of social media-based "People's Choice" award at the eCM NJ&EE. • Production of instructional videos (8) for eCM website. • eCM instructional webinars (18)

Addressing a short-fall in the 2013 evaluation efforts, the 2014 AEOP evaluation surveys systematically inquired about the role AEOP external communication activities played in participants' awareness of the AEOP.

Tables 34 and 35 provides illustrates the ways in which students (table 34) and mentors (table 35) reported learning about their AEOP programs. For example, many indicated learning about the programs via their personal contacts (shaded rows), including teachers or professors, immediate family members, and friends, especially those participating in the apprentice programs. Other sources of information selected relatively frequently included program websites and school or university newsletters, emails, or websites. Although some students found out about their program from the AEOP website, it tended to not be the primary source of information for most students. According to data, social media had almost no impact (0%-5%) in reaching new program participants.

Table 34. How Students Learned about their AEOP Program										
	CQL	GEMS	HSAP	JSHS-R	JSHS-N	JSS	REAP	SEAP	UNITE	URAP
Extended family member (grandparents, aunts, uncles, cousins)	4%	2%	0%	0%	0%	0%	4%	9%	3%	0%
Friend	17%	14%	0%	8%	28%	28%	9%	14%	13%	3%
Friend of the family	7%	25%	11%	0%	5%	3%	0%	16%	7%	2%
Guidance counselor	1%	2%	11%	1%	2%	3%	7%	7%	5%	2%
Immediate family member (mother, father, siblings)	19%	25%	11%	6%	7%	5%	13%	43%	16%	0%
Mentor from the program	16%	2%	0%	4%	5%	5%	15%	12%	21%	17%
News story or other media coverage	0%	1%	11%	0%	0%	0%	2%	0%	0%	0%
Past participant of program	16%	31%	11%	11%	28%	13%	13%	19%	10%	0%
School or university newsletter, email, or website	18%	11%	11%	13%	21%	15%	20%	12%	34%	20%
Social media	0%	1%	0%	0%	5%	3%	2%	0%	2%	0%
Someone who works at an Army laboratory	26%	8%	0%	0%	0%	0%	2%	16%	0%	5%
Someone who works with the Department of Defense	9%	NA†	0%	1%	0%	0%	0%	7%	0%	0%
Teacher or professor	23%	14%	33%	88%	72%	54%	56%	21%	21%	72%
Website: Program or Program Administrator	1%	NA†	0%	8%	33%	72%	5%	2%	6%	0%
Website: AEOP	13%	NA†	NA†	1%	2%	1%	15%	24%	16%	NA†
Website: Program Program Administrator or AEOP	NA†	20%	44%	NA†	NA†	NA†	NA†	NA†	NA†	3%
Other	4%	7%	0%	4%	0%	4%	4%	0%	13%	2%
Choose not to report	NA†	NA†	0%	NA†	NA†	NA†	NA†	NA†	NA†	2%

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

Table 35. How Mentors Learned about their AEOP Program								
	CQL	GEMS	JSHS	JSS	REAP	SEAP	UNITE	URAP
Colleague	32%	13%	27%	13%	26%	29%	42%	0%
News story or other media coverage	0%	1%	0%	0%	0%	0%	0%	0%
Past participant	5%	27%	32%	6%	10%	24%	10%	31%

School, university, or professional organization newsletter, email, or website	5%	20%	15%	0%	3%	0%	21%	19%
Site host/director	26%	19%	13%	19%	15%	12%	23%	6%
Social media	0%	1%	0%	0%	0%	0%	0%	0%
Someone who works at an Army laboratory	16%	13%	0%	0%	3%	12%	0%	0%
Someone who works with the Department of Defense	11%	21%	1%	6%	5%	24%	0%	19%
State or national educator conference	0%	0%	0%	0%	3%	0%	0%	0%
STEM conference	0%	2%	1%	13%	0%	0%	4%	0%
Student	0%	8%	19%	6%	5%	6%	2%	0%
Supervisor or superior	16%	11%	8%	0%	21%	18%	38%	6%
Website: AEOP	5%	20%	2%	13%	21%	0%	4%	6%
Website: Program or Program Administrator	0%	2%	16%	69%	23%	0%	4%	31%
Workplace communications	21%	7%	2%	0%	8%	24%	8%	0%
Other	0%	7%	7%	13%	5%	0%	4%	6%

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 2014 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.

Communicating about the pipeline of AEOP initiatives is important to the AEOP. Upon completion of a program, AEOP participants should be aware of their future options in the portfolio. To examine how strong the pipeline is, students in each 2014 AEOP element were asked about past participation in other AEOP programs, as well as their interest in future participation. As can be seen in Table 36, some programs have been more successful at recruiting participants with previous AEOP experience than others. For example, a sizeable proportion of 2014 UNITE and URAP participants reported previous experiences in a variety of AEOPs. In addition, 17% of HSAP participants reported participating in eCM and REAP, 18% of REAP participants took part in UNITE, 29% of SEAP participants experienced GEMS, and 32% of CQL participants took part in SEAP.

Table 36. 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	NA†	NA†	NA†	NA†	NA†	NA†	NA†	NA†	35%	___‡
eCM	___‡	5%	5%	6%	13%	17%	2%	8%	35%	4%
GEMS	3%	5%	7%	___‡	20%	0%	4%	29%	35%	13%
HSAP	1%	NA†	6%	5%	13%	___‡	6%	0%	50%	3%
JSHS	1%	NA†	___‡	7%	15%	0%	8%	2%	41%	2%
JSS	1%	___‡	5%	5%	13%	0%	2%	2%	35%	2%
REAP	2%	NA†	8%	6%	20%	17%	___‡	2%	48%	4%
SEAP	2%	NA†	8%	7%	20%	0%	4%	___‡	41%	32%
UNITE	NA†	NA†	6%	5%	NA†	0%	18%	6%	35%	2%
URAP	NA†	NA†	NA†	NA†	NA†	NA†	NA†	NA†	___‡	2%

† It is not possible for students to have participated in these programs due to age restrictions.
‡ It is not possible to determine from the data if students reported their current participation or past participation in the program. Survey item requires revision.

Table 37 shows data related to participant interest in future participation in AEOP programs. Two patterns are evident. One is that across the different AEOPs, participants expressed a great deal of interest in repeating participation in their current program. For example, 55% of JSS participants indicated being "very much" interested in participating in JSS in the future. Second, large proportions of participants also expressed interest in other AEOPs. This trend is especially noticeable in data from the high school apprenticeship programs, where many participants expressed interest in the college-level apprenticeship programs (e.g., 67% of HSAP participants reported having very much interest in URAP).

Table 37. 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	16%	14%	19%	18%	22%	33%	30%	47%	15%	51%
eCM	45%	17%	NA‡	12%	NA‡	NA‡	NA‡	NA‡	NA‡	NA‡
GEMS	14%	20%	17%	57%	15%	33%	NA‡	12%	NA‡	NA‡
HSAP	15%	16%	20%	22%	20%	50%	36%	18%	NA‡	NA‡
JSHS	14%	12%	52%	13%	15%	50%	22%	4%	NA‡	NA‡
JSS	13%	55%	NA‡	11%	NA‡	NA‡	NA‡	NA‡	NA‡	NA‡
REAP	15%	20%	21%	21%	24%	67%	53%	22%	NA‡	NA‡
SEAP	17%	21%	22%	26%	25%	50%	42%	61%	NA‡	NA‡
UNITE	10%	15%	9%	13%	50%	17%	18%	4%	NA‡	NA‡
URAP	13%	14%	24%	18%	20%	67%	53%	24%	50%	19%

† For all programs except eCM, the data represent participants indicating "very much" interest; for eCM, data represent participants indicating "very interested" or "interested."

‡ *It is not possible for students to have participated in these programs due to age restrictions.*

Program evaluations 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 2014 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 36.

Table 36. 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: The AEOP provided outreach to 41,802, students through its comprehensive portfolio of programs. 37,982 students participated in AEOP competitions (eCM, JSHS and JSHS). The AEOP provided 585 STEM apprenticeships (CQL, HSAP, REAP, SEAP, and URAP) and 2,375 students participated in hands-on summer STEM enrichment activities (GEMS and UNITE). However, there is a considerable unmet need with over 8,500 applicants who were not accepted into the programs. • Finding #2: The AEOP provided outreach to many students from underserved and under-represented groups with some programs being more effective at serving these groups than others. While 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. In 2014, more than 95% of the students in REAP and UNITE were from groups that are historically underserved and under-represented in STEM. In addition, 4 of the 11 AEOP elements increased the proportion of students they served from these groups. The other programs had mixed results in this regard and may want to improve outreach to specific underserved and under-represented groups. • Finding #3: In 2014 as in 2013, 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 2013, students participating in the AEOP programs in 2014 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 continues to expand the number of students who are engaged in and exposed to DoD research. Students reported positive attitudes toward DoD STEM research and researchers, which can be attributed to their AEOP experience. • 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., CQL and GEMS) at doing so than others (e.g., REAP). Direct engagement with Army and DoD STEM researchers and/or facilities during program activities are 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. Some programs reported that they encountered barriers when they attempted to engage Army personnel to participate in program activities.

	• Finding #7: The AEOP programs served both 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 their interest in pursuing DoD STEM careers as a result of participation in AEOP (e.g., GEMS, CQL, HSAP, and JSHS-N). As compared to AEOP apprentices in 2013, there was at least a 20% increase in interest in pursuing DoD STEM careers across the 2014 apprentice programs.
Priority 2: STEM Savvy Educators *Support and empower educators with unique Army research and technology resources.*	• Finding #1: AEOP mentors used a large number, and wide variety, 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. However, mentors tended to use fewer strategies for supporting mentees' educational and career pathways, which may help explain the relatively low numbers of mentees reporting learning about multiple STEM careers during their experience. • 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: 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 the future, evaluators and program administrators will benefit from efforts to improve response rates to evaluation assessments including earlier planning and incentives for participation. Additionally, the continued refinement of questionnaires to enhance reliability, validity, and alignment with federal reporting standards will ensure quality assessment of AEOP programs in the future. • Finding #2: The AEOP has worked hard to develop and present a consistent, uniform message about the programs in the portfolio. As in 2013, the 2014 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.

What AEOP participants are saying…

*"My [**CQL**] mentors were very helpful, and I learned so much from them in the one-on-one setting that I got to work in. The hands-on experience was incredible. I got to use equipment that I could only look at in catalogs before my internship...I am very thankful for this internship and I feel like it has contributed a lot to my overall engineering education."* – CQL Apprentice

*"My [**CQL**] student was great to work with and I look forward to the opportunity to work with him again possibly in the future. I enjoy working with the students and giving them an opportunity to gain real work experience prior to graduation. It is what steered me into research while I was attending undergraduate school. I will continue to mentor students as long as possible as I feel it's an invaluable tool in promoting STEM."* – CQL Mentor

*"I decided to participate in **eCYBERMISSION** because it helps the military and the world."* -eCM Student

*"I now want to have a career in biomedical engineering, thanks to the **GEMS** program. I also feel more comfortable being a woman going into an engineering field, and not scared to be the only one, but proud :) Thanks for this amazing opportunity!!!!"* – GEMS Student

*"I really enjoyed working with the **GEMS** program. It was not only a great opportunity for me to learn about the topics and about myself but also gave the students a great opportunity to learn, have fun and make connections in science."* **–** GEMS Mentor

*"Above all, I am really enthusiastic knowing that the work I'm doing could contribute to real life situations. It feels great knowing that the research that I'm working on could help people in the world. While I continue to have a never ending passion for STEM learning, **HSAP** has made me grow more interested in STEM learning."* – HSAP Apprentice

*[T]he students in the high school, they're doing work that's different from the research program we're doing in the university. We [**HSAP**] give them more freedom and more independent thinking. That allows them to put more of their own thoughts into the research problem. This is quite challenging for them, and quite different from their experience in high school.* – HSAP Mentor

*"[**JSHS**] gave me confidence in public speaking. I learned so much from other's research and met amazing new people from all across the country. I learned the technical aspects of presenting research, writing technical papers and effectively communicating my research to the public."* – JSHS Student

*"**JSHS** is one of the greatest programs available for bringing youth together and allowing them to work side by side with the foremost people in science, engineering and research. The exposure to STEM through **JSHS** is invaluable to increasing students' desires to follow career pathways."* – JSHS Mentor

*"**JSS** was a fun and educational experience. I enjoyed engineering an effective car, modeling it, and creating it. I would recommend this program. "* – JSS Student

*"I think [**JSS**] helps the children learn teamwork and helps them to use their brain cells a little bit, instead of focusing on an iPad, or iPod, or cell phone. I think it brings out their creativity and origination as well, because they are creating their own masterpiece and when it works they can see what they can do."* – JSS Mentor

"*Overall, I was very satisfied with the* **REAP** *experience. I was exposed first hand to a lab environment, and was able to conduct my very own research with help from others in my lab. Research had always been a field that I'd been interested in, and this was a fantastic opportunity to explore it firsthand. I gained vast amounts of scientific knowledge, as well as the ability to present scientific results to others through papers and presentations. Everyone was friendly and eager to help, and that comfortable lab environment was one of the most important factors that contributed to my success."* - REAP Apprentice.

"I think the **REAP** *program is very essential in providing high school students a scientific experience that's more realistic…being able to work in a scientist or engineering lab or place of work, it just provides a great opportunity for that student to really get a true taste of what science is all about."* – REAP Mentor

*"***SEAP** *has been the deciding factor in what I want to do in college and what kind of career I want to pursue after my education. Working in a real lab removed all of my uncertainties of what research is like. I know that I can do work in research that will directly benefit the well-being of countless people. I also better understand the responsibilities a scientist has such as the importance of publishing research and requesting funding. All of these things I learned from work in the lab as well as talking with other scientists and my mentor.* **SEAP** *has been the greatest experience of my educational career thus far. I hope that AEOP can continue their work in finding students like me who want nothing more than to experience work in a STEM field while also serving their country."* – SEAP Apprentice

"I have been mentor or **SEAP** *coordinator for [many] years; it is a great program!! I have had kids go on to science/medicine careers both in DoD and without. I am very proud of all their achievements and the fact that our lab contributed in some way to their success."* – SEAP Mentor

"Overall, I really enjoyed the **UNITE** *program. I loved the classes and fun, educational field trips that deal with science, technology, engineering, and mathematics careers. I also liked the other scholars in the program, my classmates. It was very interesting being around intelligent people like me. One of my favorite activities of the program was the opportunity to do engineering projects, such as building earthquake towers and roller coasters made out of paper, dealing with physics. I really enjoyed the program and I can't wait to come back next year."* – UNITE Student

"I think the benefit that the students get from **UNITE** *is very good and very dear. They have the ability to know what is going on outside of their school. They know exactly that there are a lot of specialties, more than they can get inside the high school like physics or math or any kind of computer science they take in the high school, they meet a lot of people from a lot of different majors, like computer science, like robotics, like math, like space centers."* – UNITE Mentor

*"***URAP** *provided me with the opportunity to work in a real research environment. I was able to interact with graduate students, faculty, and other* **URAP** *participants to learn more about what it means to do research. Because of* **URAP**, *I intend to pursue a graduate degree in engineering."* – URAP Apprentice

"I am very satisfied with my experience with the **URAP** *program. The students I have been able to mentor as a result of their participation in* **URAP** *have made meaningful contributions to [our] research and will be encouraged to remain in the research group as undergraduate or graduate research assistants."* – URAP Mentor

Recommendations

1. **Expanding AEOP.** As in previous years, there were many more applicants for the AEOP programs than students enrolled in the programs—over 8,500 students applied, but did not enroll in an AEOP. Although some programs are open to as many students who want to participate (eCM), others are limited by funding availability (REAP, UNITE, GEMS), space at regional event (JSHS and JSS), the number of sites willing to partner for the program (GEMS, SEAP, CQL, HSAP, URAP), or, in the case of the apprenticeship programs, the number of mentors willing to take on apprentices (SEAP, CQL, HSAP, and URAP).

   To encourage greater participation and maximize the impact of the AEOP, pipelines were created for students to progress through programs (GEMS-SEAP-CQL, UNITE-REAP). However, the latter programs in these pipelines could not serve many of the students in the initial programs if they chose to continue. For example, in 2014 GEMS served 2,095 students, while SEAP served 92 (from 810 applicants) and CQL 307 (from 550 applicants). Similarly, UNITE enrolled 280 students, but REAP involved only 117 (426 applied).

   Increasing the marketing of the competition programs would likely help boost enrollment in those programs with minimal additional costs. However, increasing enrollment in other AEOP programs (e.g., GEMS, UNITE) would take additional financial resources to recruit additional sites and build an infrastructure to serve greater numbers of students. Increasing the number of students participating in apprenticeship programs would require greater efforts to recruit mentors, as well as possibly providing funds to cover the resources (both time and materials) needed for a successful apprenticeship.

2. **Broadening Participation of Underserved and Under-represented Populations.** AEOP objectives include expanding participation of historically under-represented and underserved populations. Although AEOP elements conduct program-level marketing that targets those populations, evaluation data suggest that site-level marketing, recruiting, and selection processes have greater influence than national-level marketing in determining participants. Data also suggest that, although some programs have had success in recruiting under-represented and underserved participants to AEOP, there is still substantial room for improvement in this area. For example, in 2014 GEMS, HSAP, JSHS, REAP, SEAP, UNITE, and URAP each increased the proportion of racial/ethnic minorities participating compared to 2013. Similarly, eCM, HSAP, JSHS, SEAP, UNITE, and URAP each had more females participating in 2014. However, CQL and eCM experienced a decrease in racial/ethnic minorities participating, and CQL, GEMS, and REAP each had smaller proportions of females enrolled.

   While the AEOP envisions higher participation of under-represented and underserved students across all of its efforts, it should be noted that the AEOP is growing its under-represented/underserved participation from its efforts in grades k through 8 (e.g., CII, JSS, and GEMS).

   Given this focus, AEOP programs may benefit from more guidance from Army leadership regarding program- and site-level priorities and processes for maximizing the inclusion and retention of under-represented and underserved students as appropriate for the individual programs. This guidance may include recommendations for promising marketing practices employed in the past targeted to specific locations that serve large proportions of students from these groups. In addition, given that many of the participants in the apprenticeship programs were recruited through personal connections with the mentors (e.g., via family, family friends, or school-based connections), the programs may want to focus on recruiting mentors from historically under-represented and underserved groups who may have connections with students of similar backgrounds. These mentors may also better understand the unique aspects of working with students from such groups, resulting in greater success for these students and the programs.

Similarly, the competition programs may want to seek out partnerships with minority-serving organizations in STEM such as the National Society of Black Engineers, Society of Women Engineers, American Indian Science and Engineering Society, and Society of Hispanic Professional Engineers. This approach would leverage groups who work with under-represented and underserved populations, taking advantage of an audience already interested in STEM. The AEOP should consider different types of partnerships such as having these groups use AEOP competitions as part of their curriculum, providing mini-grants to help increase participation in programs like eCM, or holding awards ceremonies for the AEOP at their annual meetings.

Another strategy would be to increase funding and/or the number of sites in programs that have proven successful at recruiting under-represented and underserved students. For example, UNITE received applications from 18 sites wanting to host the program, but awarded only 10. Similarly, REAP received applications from 82 sites, but awarded only 36.

The Army, program administrators, and sites need to also consider practical solutions to other challenges posed to the host-site or event locations, as proximity alone is likely to advantage some populations more than others (e.g. students with greater proximity, or students with means for longer-distance transportation or temporary relocation near the site). In-residence programs and/or travel accommodations (e.g., bus transportation from schools) may be needed to recruit and make participation feasible for underserved populations living at greater distances from the host or event sites. Beyond recruitment, additional support may be necessary to mitigate underserved students' resource and educational gaps (identified by participants, mentors, and event directors), to ensure their participation is both feasible and successful.

As the program works to expand the participation of historically under-represented and underserved populations, it will be important to monitor the demographic characteristics of the applicant pool to assess the extent to which recruiting and selection strategies are successful. The new centralized application system, which will collect student demographic information, will facilitate such data tracking. In addition, it will also be useful for individual programs to develop site-specific recruiting strategies and set goals in this area that can be examined at regular intervals for progress, adjusting strategies as needed.

Finally, Army leadership may want to consider funding a long-term study of its outreach efforts to under-represented and underserved populations, examining strategies that have and have not been successful in increasing participation of under-represented and underserved populations. Such as study might generate findings that could be important in making improvements to all AEOP programs in this area.

3. **Marketing of the AEOP Portfolio of Programs.** Across the AEOP, although participants reported somewhat limited awareness of other AEOP opportunities, a substantial proportion expressed interest in future participation. In many cases, participants were most interested in enrolling again in the same program. In addition, participants in the high school apprenticeship programs tended to be interested in the college apprenticeship programs. Given that participants were most likely to indicate learning about AEOP programs through their local site and/or their mentors, the AEOP program may want to invest additional effort in making sure local sites provide information about other AEOP programs to their participants. One possible strategy would be for program administrators to email students participating in other AEOPs who will be eligible to participate in their program in future years. Further, raising mentors' awareness of the various AEOP programs and asking them to talk with students/apprentices about the programs may result in even greater interest, and enrollment, in other AEOP programs. For example, it may be useful for program administrators and/or sites to institute a mentor orientation to familiarize mentors with other AEOP programs. The 2015 implementation of the new AEOP website and affiliated AEOP newsletter as well as the collection of participant email addresses assembled through the new centralized AEOP registration system may also allow for an increase in direct marketing of AEOP portfolio opportunities to participants, alumni, applicants, and interested community members.

4. **Raising Awareness of Army/DoD STEM Careers.** Across the AEOP, large proportions of participants reported opportunities to learn about STEM research and careers, including Army/DoD STEM research and careers, during program activities. Direct engagement with Army and DoD STEM researchers and/or facilities during program activities is the most promising practice, and likely impacts not only awareness but also interest. However, some programs have been more effective at raising awareness of STEM careers than others, particularly careers within the Army/DoD. Similar to last year, many mentors involved in programs not located at Army installations reported a lack of awareness of STEM careers in the DoD. Thus, the AEOP may want to work with the administrators of these programs on strategies for increasing the emphasis given to Army/DoD STEM careers. One of these strategies should likely focus on educating mentors both about Army/DoD STEM careers and how to effectively engage participants in learning opportunities about Army/DoD STEM careers.

   As was suggested last year, a centralized effort to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army S&Es may be useful for achieving this goal. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public web-based resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or participant to help guide their exploration of Army/DoD STEM interests, careers, and available positions.[19] The National Institutes of Health-funded *Building Bridges: Health Science Education in Native American Communities* annually evolving Community Poster Project (http://www.unmc.edu/mmi/education/sepa/role-model-posters.html) provides a promising model for encouraging underserved populations in considering STEM careers.

Given the importance of raising student awareness of DoD/STEM careers, it might be productive to have program administrators develop specific plans for increasing this focus in their program, including developing specific measurable goals. Specifying, short- and long-term goals along with developing strategies for achieving them will allow for better monitoring of this goal of the AEOP.

5. **Aligning with NGSS.** While AEOP mainly operates under informal STEM education, some of AEOP's competitions and STEM enrichment activities may benefit from alignment of educational resources with the *Next Generation Science Standards* (NGSS), attending both to AEOP objectives and the national call for shared standards across formal and informal education settings. Creating a central repository of high-quality, standards-aligned resources, along with documentation of how to use those resources effectively, may greatly enhance the quality and effectiveness of the AEOP experience for large numbers of students and teachers. However, care will need to be taken to help ensure that these resources truly align with the three-dimensional nature of the NGSS (i.e., disciplinary core ideas, science and engineering practices, and cross-cutting concepts) rather than being superficial connections. The recently released EQuIP rubric (available at http://www.nextgenscience.org/resources) may be useful for helping evaluate and improve the alignment of such resources. Having such a repository of materials may also be useful in marketing and serve to expand recruitment, as participating sites and mentors would have access to high-quality, ready-made materials.

6. **Improving Response Rates to Program Evaluation Surveys.** The standardization and rigor of the evaluation continued to improve in 2014; however, response rates for the apprentice/student and mentor questionnaires were poor in most AEOP programs—just over 5,000 youth and adult participants responded to a questionnaire out of over 50,000 who were involved in the AEOP (a somewhat worse participation rate than in 2013). Although all programs were asked to administer a mentor questionnaire in 2014, resulting in more mentor data than in the past, the low response rates among students and mentors raise concerns about the representativeness of the data. As the evaluation system continues to be refined, consideration should be given to how to improve response rates. One possible strategy is to have individual programs and sites better advertise the importance of participating in the evaluation. Another is to consider reducing the response burden, as the estimated time for completing a questionnaire is 45 minutes. Although triangulation of data is an important aspect of an evaluation, the program should carefully consider which elements of the data collection system are important to triangulate and which may be unnecessary. In addition, items that are collected in 2015 through the new, centralized registration and those that may provide difficult-to-interpret data should be considered for removal. It is critical

[19] For example, http://www.goarmy.com/careers-and-jobs/army-civilian-careers.html,http://www.goarmy.com/careers-and-jobs/stem.html, individual directorate STEM webpages and resources such as RDECOM's Army Technology magazine, and usajobs.gov.

to the AEOP evaluations effort that IPAs, Government POCs, local program coordinators and/or regional directors as well as senior leaders at Army laboratories and/or partner universities are synchronized to ensure integrated program planning, execution and messaging.

Appendices

Appendix A: 2014 AEOP Evaluation

Methods and Design

The AEOP Evaluation used mixed methods approaches[20,21,22] 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.[23] 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:"[24] 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.

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

Measures and Sampling

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".[25] 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 2014 through May 2014. 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.

[25] 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: 2014 College Qualified Leaders (CQL) Evaluation

Executive Summary

The College Qualified Leaders (CQL) program, managed by the American Society for Engineering Education (ASEE), 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 FY14 CQL 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 CQL included questionnaires for students and mentors, three focus groups with students and one with mentors, and an annual program report compiled by ASEE.

2014 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), and the Engineering Research and Development Center in Vicksburg, MS (ERDC-MS).

2014 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
No. of Applicants	550
No. of Students (Apprentices)	307
Placement Rate	56%
No. of Adults (Mentors)	288
No. of Army S&Es	288
No. of Army Research Laboratories	10
No. of Colleges/Universities	104
No. of HBCU/MSIs	13
Total Cost	$3,663,463

Stipend Cost (paid by participating labs)	$3,534,144
Cost Per Student Participant	$11,933

Summary of Findings

The FY14 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.

2014 CQL Evaluation Findings	
Participant Profiles	
CQL had limited success at serving students of historically under-represented and underserved populations.	• CQL attracted some participation of female students—a population that is historically under-represented in engineering fields. However, enrollment data suggests that participation of female students was limited: 75% of enrolled apprentices were male, 25% were female.
	• CQL served some students from historically under-represented and underserved race/ethnicity groups, however that involvement was limited. The vast majority of enrolled apprentices identified themselves as "White" or "Asian"; only 8% identified themselves as being from an under-represented or underserved minority group (5% Black or African American & 3% Hispanic or Latino).
CQL had limited success in recruiting past AEOP program participants.	• Questionnaire data indicate that the vast majority of responding apprentices had participated in CQL at least once (although it's not clear whether the one time was including or in addition to current participation), and 30% had participated more than once. In addition, just over 30% of students had participated in SEAP at least once. However, for other AEOP programs, the vast majority of responding apprentices have never participated (ranging from 87% to 98%).
Actionable Program Evaluation	
CQL recruitment was largely the result of pre-existing relationships	• Mentor questionnaire data indicate that recruitment of students was most commonly done through colleagues, personal acquaintances, and contact from the student.
	• Apprentice questionnaire data indicate that apprentices 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 focus group data support the idea that pre-existing relationships were instrumental in making students aware of CQL.
CQL apprentices were motivated to participate in CQL by a variety of factors.	• Apprentices were motivated to participate in CQL, according to questionnaire data, by an interest in STEM, the desire to expand laboratory and research skills, and the opportunity to learn in ways that are not possible in school. Other highly motivating factors included building a college application or résumé, earning a stipend or award while doing STEM, networking opportunities, and opportunities to use advanced laboratory technology. Focus group data also suggest that apprentices were motivated by the opportunity to gain job and research experience.

CQL engages apprentices in meaningful STEM learning.	• Most apprentices (67-93%) report learning about STEM topics, applications of STEM to real-life situations, STEM careers, and cutting-edge STEM research on most days or every day of their CQL experience.
	• Most apprentices had opportunities to engage in a variety of STEM practices during their CQL experience. For example, 93% reported participating in hands-on STEM activities; 88% practicing using laboratory or field techniques, procedures, and tools; 81% working as part of a team; 77% carrying out an investigation; and 76% analyzing and interpreting data or information on most days or every day.
	• Apprentices reported greater opportunities to learn about STEM and greater engagement in STEM practices in their CQL experience than they typically have in school.
	• A clear majority of mentors report using 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 DoD STEM research and careers but can improve marketing of other AEOP opportunities.	• Most mentor interviewees and questionnaire respondents reported limited awareness of AEOP initiatives. Subsequently, mentors did not consistently educate their apprentices about AEOPs or encourage apprentices to participate in them. The majority of responding mentors (61-89%) mentioned never experiencing AEOP informational resources including the AEOP website, AEOP instructional supplies, the AEOP brochures, and AEOP social media.
	• Nearly all CQL participants reported learning about at least one STEM career, and about half (51%) reported learning about 4 or more. Similarly, 86% of students reported learning about at least one DoD STEM job, with 54% reporting they learned about 3 or more. Mentors and the CQL experience contributed the most to this impact.
The CQL experience is valued by apprentices and mentors, although program administration is an area for improvement.	• Responding apprentices reported satisfaction with their mentor and working experience 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.
	• In an open-ended item on the questionnaire, almost all of the responding participants had something positive to say about the program. However, about 30% described frustration with administrative aspects of the program including a lack of communication, payment problems, and delays in getting clearance and access that limited their ability to do meaningful work. Perhaps more notably, when asked how the program could be improved, the most common theme by far (86% of students responding to the question) was logistical issues including payment, communication, and obtaining clearance and access. In addition, in focus groups, apprentices described difficulties associated with late notification of acceptance (e.g., having to decide on other job opportunities before being notified of CQL acceptance, having to find housing on short notice).
Outcomes Evaluation	

CQL had positive impacts on apprentices' STEM knowledge and competencies.	• A majority of apprentices 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, a STEM topic or field in depth, and the research processes, ethics, and rules for conduct in STEM. These impacts were identified across all apprentice groups.
	• Many apprentices also reported impacts on their abilities to do STEM, including such things as carrying out procedures for an investigation and recording data accurately; supporting a proposed solution with relevant scientific, mathematical, and/or engineering knowledge; using mathematics or computers to analyze numeric data; reading technical or scientific tests, or using other media, to learn about the natural or designed worlds; deciding what type of data to collect in order to answer a question; identifying the limitations of data collected in an investigation; asking a question that can be answered with one or more investigations; designing procedures for investigations, including selecting methods and tools that are appropriate for the data to be collected; and using data or interpretations from other researchers or investigations to improve a solution.
CQL had positive impacts on apprentices' 21st Century Skills.	• A large majority of apprentices reported large or extreme gains in the areas of making changes when things do not go as planned, building relationships with professionals in the field, learning to work independently, patience for the slow pace of research, sticking with a task until it is complete, and sense of being part of a learning community.
CQL positively impacted apprentices' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many apprentices reported a large or extreme gains on items related to STEM identify including feeling prepared for more challenging STEM activities, building academic or professional credentials in STEM, confidence to do well in future STEM courses, feeling responsible for a STEM project or activity, confidence to contribute in STEM, feeling like part of a STEM community, and feeling like a STEM professional.
	• Apprentices also reported positively on the likelihood that they would engage in additional STEM activities outside of school. A majority of apprentices indicated that as a result of CQL they were more likely to 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, receive an award or special recognition for STEM accomplishments, and look up STEM information at a library or on the internet.
CQL succeeded in raising apprentices' education aspirations, but did not change their career aspirations.	• After participating in CQL, apprentices indicated being more likely to go further in their schooling than they would have before CQL, with the greatest change being in the proportion of apprentices who wanted to get a Ph.D. (19% before CQL, 35% 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. Although the vast majority of apprentices indicated interest in a STEM-related career, there was not a statistically significant difference from before CQL to after.
CQL apprentices are largely unaware of AEOP initiatives, but apprentices show interest in future AEOP opportunities.	• Apprentice and mentors were largely unaware of other AEOP initiatives, but 73% of responding apprentices were at least somewhat interested in participating in CQL in the future, 54% in SMART, 40% in NDSEG, and 34% 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.	• The vast majority of apprentices reported that they agreed or strongly agreed that DoD researchers solve real-world problems (95%), DoD researchers advance science and engineering fields (95%), DoD research is valuable to society (94%), DoD researchers develop new, cutting edge technologies (92%), and DoD researchers support non-defense related advancements in science and technology (86%).

Recommendations

1. The CQL program has the goal of broadening the talent pool in STEM fields. Overall, the program has had limited success in attracting students from groups historically under-represented and underserved in these fields. In addition, personal relationships continue to factor highly into how students learn about and are recruited to CQL. The program may want to consider doing more to increase the number and diversity of students who participate in CQL. In particular, the program may consider how to more actively recruit students nationwide. Given that the program involves college students and includes a stipend to help with housing expenses, recruitment does not need to be limited to locations near CQL sites. By more actively recruiting, and broadening recruitment efforts beyond local sites, the program is likely to receive more applications, including more from groups that are historically under-represented and underserved. Mentor focus groups elicited some suggestions for changes to recruitment strategies. These suggestions include having a centralized CQL recruitment and application process (rather than site specific) as well as advertising more with high schools (so that future college students are aware of the program) and with colleges, including working with college job placement services and posting fliers prominently where students will see them. In addition, the program may want to consider how students are recruited and subsequently selected to serve as apprentices. Although some mentors did not know how students were recruited, others reported that there were no targeted recruitment strategies for students from under-represented and underserved groups. In order to meet the goal of serving more students from under-represented or underserved groups, the program could develop guidance to balance selecting the strongest candidates (e.g. best match between apprentice interest and mentor work), regardless of race or gender, and providing more opportunities for students from under-represented and underserved groups to participate.

2. Similarly, efforts to recruit mentors should be considered. The number of apprentices who can participate in CQL is limited by the number of mentors available. In order to broaden participation and provide more opportunities to qualified candidates, the program needs to recruit more mentors. One potential factor impacting mentor participation – time – came out in a focus group; mentors noted that colleagues were not interested in serving as mentors because of the time it takes them to work with apprentices, which can detract from other responsibilities. In addition, on the questionnaire, some responding mentors suggested providing more support for mentors. 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. 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 well as potential benefits to their project from involving apprentices in their work.

3. Given the goal of having students progress from other AEOP programs into CQL, and from CQL into other programs, the program may want to consider implementing marketing and recruitment efforts targeting past AEOP participants and to work with sites to increase both mentors' and students' exposure to AEOP. Apprentice questionnaire data indicate that few apprentices had previously participated in other AEOPs. Implementing marketing and recruitment efforts targeted at past AEOP participants may increase the number of participants in other AEOP programs who progress into CQL and may broaden CQL participation of students from under-represented and underserved groups as several other AEOP programs specifically target these students. In addition, responding CQL mentors and apprentices tended to lack knowledge of AEOP programs beyond CQL. In focus groups, mentors indicated that they would be willing to educate students about other AEOP programs if they knew more about those programs themselves, suggesting that improving mentor awareness of programs would also improve student awareness. Alternatively, given that CQL participants are completing internships on active research, and potential mentors may already be hesitant to participate due to time considerations, the program may want to consider ways to educate apprentices about AEOP opportunities that do not rely on the mentor (e.g., presentations during an orientation; information provided during the student symposium). In addition, given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be adjusted to provide students with more information and facilitate their enrollment in other AEOPs, or what alternative strategies may be more effective.

4. Efforts should be made to address administrative difficulties. Although participants were pleased with their experience, frustration with administrative and logistical aspects was quite evident in responses, and in some cases detracted from program goals. In particular, students reported difficulties due to late notification of acceptance, including missing out on participating in the past, and late payment. Students also reported negative impacts on their ability to do meaningful work because of delays in getting clearance and computer access. In addition, some students indicated that they, and their mentors, expended considerable time and effort to remedy these administrative issues. Although some students indicated that these issues would not keep them from participating again, other students indicated that they would not participate again, may work at the lab again but would do so through other channels, or were discouraged from participating in CQL or working for the DoD in the future. Given that one AEOP goal is to "broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base," efforts should be made to remedy these administrative issues so as not to detract from apprentices' or mentors' experience with the program. One suggestion that came out of apprentice questionnaire and focus group data is to begin the process for students to obtain clearance and computer access early, so that they have computer access when they begin the internship and can begin doing meaningful work.

5. Additional efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the student and mentor questionnaires raise questions about the representativeness of the results. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to better tailoring questionnaires to particular programs and whether the

parallel nature of the student and mentor questionnaires is necessary, with items being asked only of the most appropriate data source. Given that CQL apprentices are career age, as well as the significant investment that Army research installations make in each apprentice, it may prove important to conduct a CQL alumni study in the near future. The purpose of which would serve to establish the extent to which CQL apprentices subsequently become employed in the Army or DoD.

Appendix C: 2014 eCYBERMISSION (eCM) Evaluation Executive Summary

eCYBERMISSION 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 U.S., U.S. territories, and Department of Defense Educational Activities (DoDEA)'s schools worldwide, have participated in eCYBERMISSION. 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. eCYBERMISSION teams work collaboratively to research and implement their projects, which are documented and judged via the submission of "*Mission Folders*" hosted on the eCYBERMISSION website.

In support of the eCYBERMISSION program's implementation efforts, David Heil and Associates, Inc. (DHA) provides independent research and evaluation services to the National Science Teachers Association (NSTA) and the U.S. Army. As an external research and evaluation firm, DHA conducts an annual evaluation and efficacy study of the web-based eCYBERMISSION competition. This yearlong study focuses on program efficacy and quality of experience; student attitudinal, performance, and behavioral changes; team advisor behavioral change; implementation of recommended changes to improve future program implementation and impact; and the competition's National Judging & Education Event (NJ&EE).

Methodology

The study included broad-based data collection through DHA's and NSTA's administration of online surveys to 2013-2014 participating students and Team Advisors. DHA designed data collection instruments to assess participants' community demographics, eCYBERMISSION and Army Education Outreach Program (AEOP) participation, competition satisfaction, and the impact program participation had on students' STEM interests, attitudes, and awareness; 21st century skills; and perceptions of and interests in STEM fields and careers. An invitation and link to the survey were emailed to all participants after program registration, while a link to a second post-survey was emailed to participants after the submission of their *Mission Folder*. A survey containing similar sets of question was administered via email to all Team Advisors.
A separate survey assessed student perceptions of and satisfaction with the NJ&EE. NJ&EE participants completed the survey during a two-week period immediately following the competition. A DHA evaluator attended the 2014 NJ&EE to observe the event and to conduct focus groups with Team Advisors and students regarding their NJ&EE experience and their perceptions of the strengths and weaknesses of the event.

2014 eCYBERMISSION Fast Facts	
Description	STEM Competition – Nationwide (including DoDEA schools), web-based, including one national event
Participant Population	6th-9th grade students

No. of Applicants/Students	29,682 registered and 15,859 completed mission folders (of whom 71 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	53%
No. of Adults (Team Advisors and Volunteers – incl. S&Es and Teachers)	4,582
No. of Team Advisors (Predominantly math and science teachers)	1,828
No. Volunteers (Ambassadors, Cyberguides, Virtual Judges)	2,754
No. of Army S&Es	266
No. of Army/DoD Research Laboratories	38
No. of K-12 Teachers (incl. pre-service)	2,357
No. of K-12 Schools	671
No. of K-12 Schools – Title I	340
No. of Colleges/Universities	98
No. of DoDEA Students	827
No. of DoDEA Teachers	46
No. of Other Collaborating Organizations	65
Total Cost	$3,127,314
Mini-grant Costs	$200,074
Scholarships/Awards Cost	$452,685
STEM Research Kits Cost	$160,174
Cost of National Event (NJ&EE)	$299,336
Administrative Cost to NSTA	$2,015,045
Cost Per Student Participant	$105

Key Findings

- Students who competed in eCYBERMISSION reported that their participation was prompted by required classroom assignments, an interest in savings bonds prizes, or the opportunity to explore and/or prepare for a STEM career path, create something new, or have fun.
- 2013-2014 was the first year of program participation for the majority of the eCYBERMISSION survey respondents.
- With the exception of Gains in the Education of Mathematics and Science (GEMS), less than 5% of the eCYBERMISSION students reported participating once in another AEOP. Most frequently the students reported that they had never heard of the programs. The majority (at least 75%) of the Team Advisors, similarly, shared that they had never heard of the AEOPs.
- One third of the eCYBERMISSION students reported that participation in eCYBERMISSION, the program's website, and their Team Advisors increased their awareness of both AEOPs and STEM careers most. One third to half of the Team Advisors similarly reported an increased awareness of AEOPs and STEM careers due to eCYBERMISSION participation and website.

- Student focus group participants reported limited awareness and minimal use of the eCYBERMISSION website's collaborative tools and instead utilized communication and resources sharing tools that they were already familiar with (e.g. Google Drive, Gmail, etc.).
- Students shared that the expertise provided by CyberGuides was highly valued when requested.
- Team Advisors considered Mission Control, Mission Folder questions, the Team Advisor Resource Guide, the Student Registration Template, and scoring rubrics to be the most useful resources provided by the eCYBERMISSION website.
- Team Advisors identified the response time of Mission Control and CyberGuides, the regularity of blog updates, and the overall navigability of the eCYBERMISSION website as the aspects of the website most in need of improvement.
- Team Advisors' were most frustrated with and concerned by the Mission Folder judging process and the judges' overall lack of feedback regarding students' work.
- Statistical analyses of the eCYBERMISSION students' quantitative feedback indicated that comparisons between students' pre- and post-program participation in STEM activities, frequency of teaching others how to use a new technology, confidence regarding eleven 21st Century skills, and interests in and attitudes toward STEM fields and careers demonstrated statistically significantly gains.
- Analyses of students' pre- and post-survey feedback indicated that student STEM attitudes and perceptions of military research and researchers were weaker after participation. However, this trend was less prominent within the matched sample data set.
- Approximately 75% of the NJ&EE competitors rated the event's meals, hotel accommodations, facilities, overall experience, and arrival and check-in process as excellent or good, while the event's provision of recreational time and advanced planning and communication with teams were rated most poorly.
- Focus group discussions with NJ&EE competitors and Team Advisors revealed that the scheduling, logistics, and limited exposure to Washington DC's monuments, museums, and government representatives was one of the most disappointing aspects of the NJ&EE event.
- Finally, the majority (over 75%) of the NJ&EE students either strongly agreed or agreed that NJ&EE was exciting, educational, rewarding, respectful, and engaging.

Recommendations

1. Increase awareness and interest in additional AEOPs by targeting Team Advisors.
2. Provide students and Team Advisors a brief introductory video that highlights the location and purpose of online eCYBERMISSION resources.
3. Enhance program communications by posting blog updates more regularly and further prioritizing Mission Control and CyberGuides' timely feedback to teams.
4. Address Team Advisors' frustration with eCYBERMISSION judging by providing more feedback regarding the rational of Mission Folders' final scores and encouraging their review as a team activity.

5. Introduce more examples of military research and researchers into program examples, communications, or website highlights.
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.
7. Enhance the NJ&EE experience by increasing the team's understanding of the exact schedule and activities of the Washington DC Excursion Day, in addition to providing interested teams the opportunity to spend more time exploring the capitol at their discretion, liability, and cost.

Appendix D: 2014 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. GEMS is driven by the overarching mission: 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 2014, GEMS provided outreach to 2,095 students and 92 Near-Peer Mentors at 12 different sites. The number of GEMS students in 2014 represents about a 3% increase in enrollment over the 2,038 student participants in 2013. 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 FY14 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, 5 focus groups with students and 4 with mentors, and an annual program report compiled by ASEE.

2014 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)
No. of Applicants	3,343
No. of Students	2,095
Placement Rate	63%
No. of Adults (incl. NPM, RT, S&Es)	390
No. of Near-Peer Mentors (NPM)	92
No. of Resource Teachers (RT)	52
No. of Army S&Es	246
No. of Army Research Laboratories	13[†]
No. of K-12 Teachers	52
No. of K-12 Schools	755
No. of K-12 Schools – Title I	126
No. of Colleges/Universities	28
No. of HBCU/MSIs	3
No. of DoDEA Students	15

No. of DoDEA Teachers	1
Total Cost	$994,139
Stipend Cost	$727,676
Supplies & Equipment (GEMS sites)	$116,999
Administrative Cost to ASEE	$149,464
Cost Per Student Participant	$475

†*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*

The student questionnaire response rate of 91% and corresponding margin of error of ±0.7% provide strong evidence that the questionnaire results are generalizable to the population of participants. In contrast, the response rate for the mentor survey was only 26%. Because of the small number of responses to the mentor survey, caution is warranted when interpreting these data, as the responses may not be representative of the mentor populations participating in the GEMS program.

Summary of Findings

The FY14 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.

2014 GEMS Evaluation Findings	
Participant Profiles	
GEMS student participation in evaluation yields high level of confidence in the findings.	• The student questionnaire response rate of 91% and corresponding margin of error of ±0.7% provide strong evidence that the questionnaire results are generalizable to the population of participants.
	• Additional evaluation data contribute to the overall narrative of GEMS's efforts and impact, and highlight areas for future exploration in programming and evaluation, though findings from these data are not intended to be generalized to all GEMS sites and participants.
GEMS serves students of historically underrepresented and underserved populations.	• GEMS attracted participation from female students—a population that is historically underrepresented in engineering fields; student questionnaire respondents included more females (55%) than males (44%).
	• GEMS provided outreach to students from historically underrepresented and underserved minority race/ethnicity and low-income groups. Student questionnaire respondents included minority students identifying as Black or African American (22%), Hispanic or Latino (7%), and American Indian or Alaskan Native (1%). A small proportion (12%) of students reported qualifying for free or reduced-price lunch.

	• GEMS served students across a range of school contexts. Most student questionnaire respondents attended public schools (80%) in suburban settings (68%).
GEMS engages a fairly diverse group of adult participants as STEM mentors.	• GEMS mentor participants, based on questionnaire data, included almost two times as many males than females (64% vs. 33%). Although the majority of mentors identified themselves as white (68%), 9% of questionnaire respondents identified as Hispanic or Latino and 8% identified as Black or African American. Forty-one percent of the mentor group reported being a scientist, engineer, or mathematician in training, 24% were teachers, and 31% specified an "other" occupation such as an education student or college/university student.
Actionable Program Evaluation	
GEMS is marketed to schools and teachers serving historically underserved groups.	• ASEE and GEMS sites employed multiple strategies to disseminate information about the GEMS program. Email blasts were sent to over 4,000 teachers, guidance counselors, and principals in areas near participating GEMS labs. Promotional materials, e.g., AEOP brochures, were mailed to requesting teachers. Outreach efforts via social media were also coordinated with Virginia Tech and a cross-promotional outreach effort was organized with eCYBERMISSION. In addition, outreach efforts targeted historically underrepresented and underserved populations through events such as: Event it. Build it. Career Expo at the Society of Women Engineers Conference; Hispanic Association for Colleges and Universities Conference; DCPS Event at ASEE Headquarters; and 2014 ASEE Annual Conference.
	• Students most frequently learned about the local GEMS program, other than from past participation, from an immediate family member (25%) or family friend (25%).
GEMS students are motivated to participate by learning opportunities provided by GEMS.	• Students were most frequently motivated to participate in GEMS this year because of their desire to learn something new or interesting (95%), interest in STEM (94%), and learn in ways that are not possible in school (90%). Large proportions also wanted the opportunity to use advance laboratory technology (87%), have fun (85%), and expand their laboratory or research skills (83%).
GEMS engages students in meaningful STEM learning, through team-based and hands-on activities.	• Most students (73-85%) report 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.
	• Most students had opportunities to engage in a variety of STEM practices during their GEMS experience. For example, 92% of responding students indicated working as part of a team on most days or every day; 90% reported participating in hands-on activities, 83% reported practicing laboratory/field techniques, procedures, and tools; and 81% reported building/simulating something on most days or every day.

	• Students reported greater opportunities to learn about STEM and greater engagement in STEM practices in their GEMS experience than they typically have in school.
	• Large proportions of mentors report 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 promotes AEOP initiatives and Army STEM careers available at Army research laboratories.	• About three-fourths of the responding mentors indicated discussing at least one AEOP other than GEMS with students, most commonly SEAP (49%) and CQL (35%). Other programs discussed with students by about a quarter of responding mentors were HSAP (27%), WPBDC (27%), REAP (25%), eCYBERMISSION (24%), SMART (24%), and URAP (24%).
	• Mentors found the participation in GEMS, program managers or site coordinators, invited speakers or career events, and AEOP instructional supplies as most useful in exposing students to other AEOP programs. A large proportion of mentors have no experience with a number of other resources for exposing student to AEOP and DoD careers (AEOP website, brochure, ASEE website, AEOP social media) or did not find them useful.
	• Nearly all of the responding mentors reported asking students about their educational and career interests and sharing their own experiences, attitudes, and values about STEM. Many also provided guidance to students, either about educational pathways that would prepare them for a STEM career or recommending extracurricular programs that align with their educational goals.
	• Nearly all students reported learning about at least one STEM job/career, and the majority (66%) reported learning about five or more. Similarly, 84% of students reported learning about at least one DoD STEM job/career, though only about a third reported learning about many different STEM jobs/careers in the DoD.
The GEMS experience is valued by students and mentors.	• The majority of students indicated being somewhat or very much satisfied with most program features, including the stipend, instruction and mentorship, and availability of program topics. Most students also commented on their overall satisfaction with the program, most often describing areas where they learned, the quality of the mentors, and their enjoyment with the program.
	• About half of GEMS students suggested improvements to the program's content including proposing additional topics, or increasing the amount of time on topics already addressed. A similar number of students (46%) made suggestions for the format of the program activities, most frequently suggesting more labs and hands-on activities.
	• The majority of mentors indicated being somewhat or very much satisfied with most program features, including the location, support of instruction and mentorship, and invited speakers or career events. Nearly all responding mentors indicated having a

	positive experience. Further, many commented on the quality of the experience for students and that they enjoyed seeing students excited about learning.
Outcomes Evaluation	
GEMS had positive impacts on students' STEM knowledge and competencies.	• A majority of 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. These impacts were identified across all student groups.
	• Many students 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; carrying out procedures for an investigation and record data accurately; considering different ways to analyze or interpret data when answering a question; making a model to represent the key features and functions of an object, process, or system; and supporting a scientific explanation or engineering solution with relevant scientific, mathematical, and/or engineering knowledge.
GEMS had positive impacts on students' 21st Century Skills.	• A large majority of students reported large or extreme gains in a number of 21st Century Skills, such as their ability to work collaboratively with a team, communicate effectively with others, sense of being part of a community, including others' perspectives when making decisions, and building relationships with professionals in a STEM field.
GEMS positively impacted students' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many students reported a large or extreme gain on their ability to think creatively about a STEM project or activity (67%), their confidence to do well in future STEM courses (69%), feelings of preparedness for more challenging STEM activities (68%), sense of accomplishing something in STEM (68%), and confidence to contribute to STEM (66%). In addition, 61% reported building academic credentials in STEM, increasing interest in a new STEM topic or field (60%), and clarifying a STEM career path (51%).
	• Students also reported on the likelihood that they would engage in additional STEM activities outside of school. A majority of students indicated that as a result of GEMS, they were more likely to tinker with mechanical or electrical devices, work on a STEM project in a university or professional setting, participate in a STEM camp, fair, or competition, or participate in a STEM club, student association, or professional organization.
GEMS succeeded in raising students' education and career aspirations.	• After participating in GEMS, students indicated being more likely to go further in their schooling than they would have before GEMS, with the greatest change being in the proportion of students who expected to continue their education beyond a Bachelor's degree (45% before GEMS, 62% 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. There was a

	small, statistically significant increase in the proportion of students aspiring to a STEM-related career after participating in GEMS.
GEMS students may be unaware of the full portfolio of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• Although large proportions of students are unaware of many other AEOP initiatives, the majority of students indicated interest in participating in future AEOP programs. Most participants (88%) credited GEMS with increasing their interest in participating in other programs.
GEMS raised student awareness of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of students reported that they had a greater awareness (81%) of DoD STEM research and careers. In addition, 84% indicated that GEMS raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. In FY14, GEMS received 3,343 applications to participate in GEMS and funded 2,095 positions (not including GEMS Near-Peer mentors). From FY13 to FY14 the evaluation 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. Evaluators continue to recommend that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interest in more communities. Additionally, evaluators continue to recommend that existing sites expand their capacity to accommodate more students so that they may meet existing needs and interest in communities that are already served by GEMS programs. Increasing the number of existing GEMS sites' administrative staff, teaching staff, physical infrastructure, and mentor (S&E's specifically) participation is the most effective way to increase enhance existing site's capacities to meet the very large needs and interest of potential GEMS participants.

2. GEMS and AEOP objectives include expanding participation of historically underrepresented and underserved populations. ASEE has conducted targeted marketing of GEMS to underrepresented and underserved populations to meet this objective. However, the demographic characteristics of GEMS participants have not changed significantly from FY13 to FY14. Specifically, about one-third of GEMS students report that they are from underrepresented or underserved racial/ethnic groups (Black or African American, Hispanic or Latino, & Native American or Alaska Native) and only 12% report that they qualify for free or reduced-price lunches at school. It is likely that GEMS will need to implement more aggressive marketing and recruitment practices than years past. Proven practices include; targeted marketing and partnerships with low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations. As in FY13, FY14 guidance includes the directive to ensure other "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. Finally, The Army, ASEE, and GEMS sites will need to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes. Most notably, as a day program, 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. Given the goal of having students progress from GEMS into other AEOP programs, the program may want to work with sites to increase students' exposure to AEOP. Although, many students expressed interest in participating in other AEOP programs, a substantial proportion indicated having no interest. Given the proportion of students who reported learning about other AEOPs from their mentors, 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. In addition, given that a relatively large proportion of mentors have not experienced many of the resources provided for exposing students to AEOPs, it would likely be useful for the program to familiarize mentors with these resources and how these can be used to provide students with more information and facilitate their enrollment in other AEOPs.

4. Similarly, mentors play an important role in exposing students, especially students from underrepresented and underserved populations, to Army STEM careers. Evaluation data indicate that only about three-quarters of mentors discuss STEM career opportunities, DoD or otherwise, with students, with only 67% of mentors report recommending AEOPs that align with students' educational goals. Further, only 40% of mentors highlighted the under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM as part of supporting students educational and career pathways. Similar to providing resources for helping raise student awareness of other AEOPs, it would be useful for the program to familiarize mentors with resources available to expose students to DoD STEM careers as many mentors have indicated that they have had "no experience" with a number of the resources available to them. In addition, it would be beneficial to familiarize mentors with strategies that to increase the likelihood that the program will have a long-term impact on the number of students who pursue STEM. For example, interactions with role models with similar backgrounds as the students and providing coaching on the "soft skills" (e.g., time management, communication skills) needed to be successful in STEM careers.

5. Continued efforts should be undertaken to improve participation in completion of the mentor survey, as the low response rate raises questions about the representativeness of the results. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the mentor survey may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the student and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

Appendix E: 2014 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 2014, HSAP provided outreach to 10 apprentices and their mentors at seven Army-sponsored university or college laboratory sites (herein called HSAP sites).

This report documents the evaluation of the 2014 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.

2014 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
No. of Applicants	84
No. of Students (Apprentices)	10
Placement Rate	12%
No. of Adults (Mentors)	7
No. of College/University S&Es	7
No. of K-12 Schools	10
No. of K-12 Schools – Title I	NA
No. of Army-Funded College/University Laboratories	7
No. of College/Universities	7
No. of HBCU/MIs	3
Total Cost	$38,239
Admin/Overhead Costs (Host Sites)	$5,132
Stipend Cost (paid by AEOP and ARO)	$33,107

Cost Per Student Participant	$3,824

The response rate for the post-program apprentice survey was 80%. Although some caution is warranted when interpreting these data, it appears that the respondents are generally representative of apprentices as a whole participating in the HSAP program. In contrast, the response rate for the mentor survey was only 29%. Because of the small number of responses to the mentor survey, these data are not included in this report, both because of the extremely large margin of error (63.26% @ 95% confidence[26]) indicating low confidence that the data would be representative of all mentors, and because the data may allow the respondents to be identified (violating assurance of anonymity given when collecting the data).

Summary of Findings

The FY14 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.

2014 HSAP Evaluation Findings	
Participant Profiles	
HSAP serves students of historically under-represented and underserved populations.	• HSAP has been somewhat successful in attracting participation of female students; half (5 of 10) of enrolled participants are female—a population that is historically under-represented in engineering fields.
	• HSAP has moderate success in providing outreach to students from historically under-represented and underserved race/ethnic and low-income groups. Of enrolled apprentices, 2 of 10 are Black or African American, 3 of 10 qualify for free or reduced-price lunch (FRL), and 5 of 10 attend school in urban areas.
Actionable Program Evaluation	
HSAP marketing and recruitment occurs at the site-level.	• When recruiting potential host sites, HSAP's marketing and advertising campaigns target the very specific population of Army-funded university and college researchers.
	• Marketing to recruit student participants targets students in proximity to specific HSAP host sites. Responding apprentices most frequently learned about HSAP from the program or AEOP website (4 of 9) and a teacher/professor (3 of 9).
HSAP apprentices are motivated by opportunities to learn about STEM in ways not possible in school.	• According to information collected at registration, 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.

[26] "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.

HSAP engages apprentices in meaningful STEM learning, through team-based and authentic STEM experiences.	• 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.
	• Apprentices had opportunities to engage in a variety of STEM practices during their HSAP experience. For example, 5 of 8 reported practicing laboratory/field techniques, procedures; participating in hands-on STEM activities, drawing conclusions from an investigation, and analyzing or interpreting data/information every day of their HSAP experience.
	• Apprentices reported greater opportunities to learn about STEM and greater engagement in STEM practices in their HSAP experience than they typically have in school.
HSAP can improve its promotion of DoD STEM research and careers and marketing of other AEOP opportunities.	• The majority of responding apprentices have favorable opinions of what DoD researchers do and the value of DoD research more broadly.
	• Only half of responding apprentices (3 of 6) reported learning about one or more DoD STEM careers during their participation in HSAP.
	• A substantial proportion of apprentices reported never hearing about or never participating in AEOP programs beyond HSAP.
Apprentices value the HSAP experience.	• Responding apprentices were largely satisfied with their HSAP experience, including communications from Army Research Office, the application/ registration process, available of interesting program topics/fields, and mentorship during program activities.
Outcomes Evaluation	
HSAP had positive impacts on apprentices' STEM knowledge and competencies.	• A majority of responding 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, research conducted in a STEM topic or field, and the research processes, ethics, and rules for conduct in STEM.
	• Apprentices reported impacts on their abilities to do STEM, including such things as communicating information about their design processes and/or solutions in different formats; integrating information from multiple sources to support their explanations of phenomena; 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 a number of areas, including their ability to work independently, make changes when things do not go as planned, communicate effectively with others, and work collaboratively with a team.
HSAP positively impacted apprentices' confidence and identity in STEM, as well as their interest in future STEM	• All 6 responding 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.

engagement.	• Apprentices also reported on the likelihood that they would engage in additional STEM activities outside of school. A majority of apprentices indicated that as a result of HSAP, they were more likely to engage in such activities as solving mathematical or scientific puzzles, looking up STEM information at a library or on the internet, helping with a community service project that relates to STEM, mentoring or teaching other students about STEM, and tinkering with a mechanical or electrical device.
HSAP succeeded in raising students' education aspirations, but did not affect career aspirations.	• After participating in HSAP, some responding apprentices indicated being more likely to go further in their schooling than they would have before HSAP.
	• 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.
HSAP apprentices show interest in future AEOP opportunities.	• Although apprentices reported limited exposure to and past participation in AEOP programs beyond HSAP, 5 of 6 apprentices reported interest in participating in other AEOP programs in the future.
HSAP raised apprentice awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• Although only half of responding apprentices (3 of 5) reported learning about one or more DoD STEM careers during their participation in HSAP, a majority also reported that they had a greater awareness (5 of 6) and appreciation (5 of 6) of DoD STEM research and careers. In addition, 4 apprentices agreed that HSAP increased their interest in earing a STEM degree in college, and 5 agreed that HSAP made them more interested in pursuing a STEM career with the DoD.

Recommendations

1. The HSAP program was moderately successful in 2014 at attracting students from groups historically under-represented and underserved in these fields. HSAP recruitment of apprentices occurs at the site-level using connections or mechanisms available to the university or college site and community in which they are situated. Therefore, the ability of HSAP to recruit under-represented or underserved populations of students depends upon the diversity of the local communities, and especially high schools, in which recruitment takes place. Consistent with the recommendation in FY13, the program should continue to consider practical solutions to the challenge posed by HSAP locations, such as expanding to alternative research sites or offering travel stipends, transportation, and/or temporary accommodations to students. In addition, the program may want to contemplate expanding to additional research sites, particularly in areas with diverse student populations.

2. The program may want to consider doing more to increase the likelihood that the program has a long-term impact on the number of apprentices who pursue STEM. Strategies that have been shown to be effective in this area 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. The program should consider ways to ensure that these areas are

addressed systematically. For example, the program may want to work with each site to see how these areas could be built into their schedules, or provide more guidance to mentors for how and when to address these issues.

3. Given the goal of exposing apprentices to other AEOP initiatives and encouraging continued participation (including as a mentor or volunteer), HSAP may want to work with sites to increase apprentices' exposure to AEOP. To this end, HSAP should ensure that mentors: (1) are aware of the intended focus on exposing apprentices to AEOP/DoD programs, (2) have the resources to educate themselves and their apprentices about these programs, and (3) are equipped to help apprentices apply to other AEOP/DoD programs. Given the limited use of the program website, print materials, and social media, the program may want to consider how these resources could be leveraged to provide mentors and apprentices with information about AEOP initiatives and facilitate increased enrollment.

4. Additional efforts should be undertaken to improve participation in evaluation activities. Although the FY14 response rate for the apprentice survey increased, 80% in FY14 compared to 63% in FY13, the 29% response rate for the mentor survey was substantially lower than the 100% response rate for the mentor survey in 2013. The low numbers of mentors in 2014, coupled with the low response rate on the mentor questionnaire, raise major questions about the representativeness of the results. Improved communication with the individual program sites about expectations for the evaluation may help. Specifically, it is recommended that the program administrator ensures that mentors are aware they are expected to participate in surveys/focus groups and encourage their apprentices to do the same. In addition, as noted in FY13, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the apprentice and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

Appendix F: 2014 Junior Science & Humanities Symposium (JSHS) Evaluation Executive Summary

The Junior Science & Humanities Symposia Program (JSHS), administered by the Academy of Applied Science (AAS), is an AEOP pre-collegiate science, technology, engineering, and mathematics (STEM) research competition for high school students. 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 FY14 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, one focus group with N-JSHS students and one with mentors, rapid interviews with 11 N-JSHS students and 10 mentors, and an annual program report compiled by AAS.

Regional symposia were held in 47 university campus sites nationwide. The top five students in each region received an expense-paid trip to the N-JSHS. 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.

2014 JSHS Fast Facts	
Description	STEM Competition - Nationwide (incl. DoDEA schools), research symposium that includes 47 regional events and one national event
Participant Population	9th-12th grade students
No. of Applicants	13,373
No. of Students	7,409 Regional Participants (of whom 220 were selected to attend the National JSHS Symposium)
Placement Rate	55%
No. of Adults (Mentors, Regional Directors, Volunteers – incl. Teachers and S&Es)	3,846
No. of Army and DoD S&Es	300
No. of Army/DoD Research Laboratories	57
No. of K-12 Teachers	1,046
No. of K-12 Schools	1,100
No. of K-12 Schools – Title I	137
No. of College/University Personnel	1,800
No. of College/Universities	102
No. of DoDEA Students	140

No. of DoDEA Teachers	24
No. of Other Collaborating Organizations	120
Total Cost	$1,962,881
Scholarships/Awards Cost	$402,000
Cost of Regional Symposia (47) Support	$699,081
Cost of National Symposium (Additional cost due to Science and Engineering Festival)	$525,994
Administrative cost to AAS	$335,806
Cost per Student Participant	$265

Summary of Findings

The FY14 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.

2014 JSHS Evaluation Findings	
Participant Profiles	
JSHS is concerned with diversity and expanding the pool of student applicants but has had limited success in serving students of historically under-represented and underserved populations.	• JSHS appears to have been successful in attracting participation of female students—a population that is historically under-represented in engineering fields. Student questionnaire respondents from both the Regional and National competitions included more females (R-JSHS 69%; N-JSHS 58%) than males (R-JSHS 31%; N-JSHS 42%). Registration data indicates an even split between female and male JSHS students at the national level.
	• JSHS had limited success in attracting students from historically underserved minority race/ethnicity and low-income groups. Student questionnaire respondents included a small proportion of minority students identifying as Hispanic or Latino (R-JSHS 17%; N-JSHS 5%). A majority of respondents reported that they did not qualify for free or reduced-price lunch (R-JSHS 71%; N-JSHS 93%).
	• A large majority of student questionnaire respondents attended public schools (R-JSHS 87%; N-JSHS 86%). Although over a third of respondents attended schools in urban or rural settings, which tend to have higher numbers or proportions of under-represented and underserved groups, most attended suburban schools. JSHS provided outreach to 137 schools (12% of high schools served) in 2014.
	• 937 students from 7 states participated in JSHS regional symposia at HBCU/MSIs.
JSHS engages an extensive and diverse group of adult participants as STEM mentors, STEM ambassadors, and volunteers.	• Approximately 1,100 teachers, 1,800 college/university faculty, 300 Army/DoD scientists/engineers, and 400 adult volunteers served as research mentors or STEM ambassadors in JSHS. Additional STEM professionals from a range of business sectors participated in career day activities.

Actionable Program Evaluation	
JSHS is strongly marketed to schools and teachers serving historically underserved groups.	• JSHS employed a multi-pronged effort to market and recruit students to participate in regional symposia. These efforts stemming from 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, social media (Facebook), and targeted marketing at existing other STEM-related regional initiatives (e.g., university chapter of the National Society of Black Engineers).
	• Students most frequently learned about the regional JSHS program from teachers/professors (R-JSHS 88%; N-JSHS 72%). Other significant sources for N-JSHS students were the JSHS website (33%), a friend (28%), or another past participant of JSHS (28%).
Many JSHS students are motivated by an interest in STEM or the encouragement of a teacher or professor.	• R-JSHS students were most frequently motivated to participate in JSHS by teacher or professor encouragement (R-JSHS 50%), and N-JSHS students were most frequently motivated to participate in JSHS by their interest in STEM (N-JSHS 86%). Other highly motivating factors included: desire to learn in ways that are not possible in school (R-JSHS 43%; N-JSHS 64%); desire to expand laboratory or research skills (R-JSHS 38%; N-JSHS 55%); and desire to have fun (R-JSHS 25%; N-JSHS 55%).
JSHS engages students in meaningful STEM learning through hands-on activities.	• Almost all N-JSHS students (98%) and most R-JSHS students (53%) report learning about STEM topics on most days or every day of their JSHS experience. The overwhelming majority of N-JSHS students (84-93%), but fewer R-JSHS students (44-46%), report applying STEM knowledge to real-life situations, interacting with STEM professionals, and communicating with other students about STEM most or all days of their JSHS experience. The differences between N-JSHS and R-JSHS students in overall learning about STEM were statistically significant.
	• Many students had opportunities to engage in a variety of STEM practices during their JSHS experience. For example, students reported participating in hands-on activities (R-JSHS 36%; N-JSHS 69%), coming up with creative explanations/ solutions (R-JSHS 40%; N-JSHS 56%) and posting questions or problems to investigate (R-JSHS 41%; N-JSHS 56%) on most days or every day.
	• Both R-JSHS and N-JSHS students reported greater opportunities to learn about STEM in their JSHS experience than they typically have in school. However, R-JSHS students reported lower engagement in STEM practices in their JSHS experience than they typically have in school, and N-JSHS students reported similar engagement in STEM practices in both settings.
	• Most mentors reported using 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 promotes DoD STEM research and careers but can improve marketing of other AEOP opportunities.	• The vast majority of mentors had no past participation in or no awareness of an AEOP initiative beyond JSHS. In addition, although most students reported an increase in awareness of other AEOPs, a substantial proportion reported never hearing about any of the other programs.

	• JSHS sites offered a variety of activities for promoting STEM careers which vary by regional event. Activities may include interactive expert panels, off- and on-campus STEM expos, and field trips to Army, university, and other research labs and facilities.
The JSHS experience is greatly valued by students and mentors.	• All N-JSHS students indicated being very satisfied with their JSHS research experience, as did 80% of R-JSHS students who had a research experience. Further, the vast majority of N-JSHS students were satisfied with most elements of N-JSHS. Satisfaction with R-JSHS was more mixed.
	• The vast majority of responding mentors indicated having a positive experience with those program features they experienced. Further, many commented on the benefits the program provides students, including engaging with real-world STEM issues or research and meeting STEM professionals and students.
Outcomes Evaluation	
JSHS had positive impacts on students' perceptions of their STEM knowledge and competencies.	• A majority of R-JSHS students and the vast majority of N-JSHS students reported large or extreme gains on their knowledge of a STEM topic or field in depth; how professionals work on real problems in STEM; research conducted in a STEM topic or field; what everyday research work is like in STEM; and the research processes, ethics, and rules for conduct in STEM. These impacts were greater for N-JSHS students than R-JSHS students, but similar across gender, race/ethnicity, and FRL status.
	• Many students 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; displaying numeric data from an investigation in charts or graphs to identify patterns and relationships; making a model that represents the key features or functions of a solution to a problem; identifying the strengths and limitations of explanations in terms of how well they describe or predict observations; and using mathematics to analyze numeric data.
JSHS had positive impacts on students' perceptions of their 21st Century Skills.	• A majority of students reported large or extreme gains on their ability to make changes when things do not go as planned, persevere with a task, and set goals and reflect on performance. Overall, minority students and FRL-eligible students reported greater gains than their counterparts.
JSHS, especially N-JSHS, positively impacted students' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Almost all N-JSHS students reported a large or extreme gain in feeling like part of a STEM community (94%); feeling responsible for a STEM project or activity (94%); confidence to do well in future STEM courses (93%); and readiness for more challenging STEM activities (90%). However, R-JSHS students were less likely to report gains of this magnitude in these areas (42%, 48%, 51%, and 49% on these items, respectively). Overall, minority students reported greater gains in STEM confidence and identity than non-minority students.
	• Students also reported on the likelihood that they would engage in additional STEM activities outside of school. A majority of students indicated that as a result of JSHS, they were more likely to participate in a STEM club, student association, or professional organization; work on a STEM project or experiment in a university of professional setting; and mentor or teach other students about STEM. N-JSHS students were more likely to indicate impacts in these areas than R-JSHS students.

JSHS succeeded in raising students' education aspirations and their aspirations for a STEM career.	• After participating in JSHS, students indicated being more likely to go further in their schooling than they would have before JSHS, with the greatest changes being in the proportions of Regional students who expected to continue their education beyond a Bachelor's degree (57% before JSHS, 87% after) and National students who aspired to a combined M.D./Ph.D. (22% before and 34% 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. There was a large increase in the proportion of R-JSHS students interested in a STEM-related career. Many N-JSHS students indicated interest in a STEM-related career both before and after JSHS, and there was not a statistically significant difference across time points.
JSHS students are largely unaware of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• Students, particularly R-JSHS students, and mentors were largely unaware of other AEOP initiatives, but 59% of R-JSHS students and 86% of N-JSHS students indicated that JSHS made them more aware of other AEOPs, and most (R-JSHS 52%; N-JSHS 80%) credited JSHS with increasing their interest in participating in other programs.
JSHS raised student awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• Almost all N-JSHS students and most R-JSHS students reported that they had a greater awareness (R-JSHS 69%; N-JSHS 97%) and appreciation (R-JSHS 64%; N-JSHS 94%) of DoD STEM research and careers. In addition, most (R-JSHS 53%; N-JSHS 84%) indicated that JSHS raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. The AEOP has the goal of broadening the talent pool in STEM fields, with a subset of the programs (e.g., REAP, UNITE) specifically targeting under-represented and underserved populations. Although not an explicit goal of JSHS, the questionnaire data indicate that JSHS has limited success at attracting students from groups historically under-represented and underserved in STEM on a national scale. In order to improve on this, the program should continue to collect information from specific regional symposia as well as other AEOPs that are successfully attracting under-represented and underserved students to then disseminate to the larger JSHS community of regional directors. Additionally, JSHS may consider ways to build on 2014 efforts to strengthen its outreach to schools that serve large proportions of such students (e.g., urban schools, Title I schools), and perhaps seek advice from groups or individuals with expertise in engaging these populations of students such as the National Action Council for Minorities in Engineering or the Society for Advancement of Hispanics/Chicanos and Native Americans in Science. 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. Additionally, collecting demographic information on students participating in the R-JSHS through the centralized registration tool in FY15 and beyond will enable a more accurate representation of the JSHS participation pool.

2. Given the goal of having students progress from JSHS into other AEOP programs, JSHS should work with regional symposia to increase students' exposure to AEOP. Only about 1 in 10 mentors recommended each of REAP, HSAP,

SEAP, or SMART to students, and fewer discussed other AEOPs. Further, although many students expressed interest in participating in other AEOP programs, a substantial proportion indicated having no interest. Given the proportion of students who reported learning about other AEOPs from invited speakers, career events, or their mentors, the program may want to work with each R-JSHS 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. In addition, given the limited use of the program website, print materials, and social media, the program should consider how these materials could be adjusted to provide students with more information and facilitate their enrollment in other AEOPs.

3. Efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the student and mentor questionnaires raise questions about the representativeness of the results. Improved communication with the individual program sites about expectations for the evaluation may help. 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. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the student and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

4. The R-JSHS experience is the only JSHS experience for most students, but consistent differences between R-JSHS and N-JSHS student responses suggest that N-JSHS may be having a greater impact on students than R-JSHS. 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. However, other differences may be related to differences in the availability/quality of mentor support or the availability/quality of activities at each symposium. JSHS should consider what guidance and support can be provided to regional directors, mentors, and other supporters of R-JSHS to encourage 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.

Appendix G: 2014 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 FY14 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 10 mentors, and an annual program report compiled by TSA.

In 2014, students participated in JSS through TSA-affiliated competitions in 19 states, 3 regional Army-hosted locations, and a national competition in the Washington, D.C. area.

2014 JSS Fast Facts	
Description	STEM Competition - Solar car competition regional events at 3 Army laboratories and at 19 TSA state events, 1 national event hosted in conjunction with the TSA national conference
Participant Population	5th–8th grade students
No. of Applicants	891
No. of Students	891
Placement Rate	N/A (all students who registered were participants)
No. of Adults (Mentors and Volunteers – incl. Teachers and Army S&Es)	341
No. of Army S&Es	10
No. of Army Research Laboratories	3
No. of K-12 Schools	71
No. of K-12 Schools – Title I	31
No. of Other Collaborating Organizations	21
Total Cost	$145,535
Scholarships/Awards Cost	$6,964

Stipend Cost	$500
Administrative Cost to TSA	$138,071
Cost Per Student Participant	$163

It is important to note that the response rates for the student and mentor surveys were 9% and 5%, respectively. Thus, caution is needed when interpreting these data as the responses may not be representative of the student and mentor populations participating in the JSS program.

Summary of Findings

The FY14 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.

2014 JSS Evaluation Findings	
Participant Profiles	
JSS has more work to do in terms of serving students of historically under-represented and underserved populations.	• JSS has room to improve when it comes to attracting female participants—a population that is historically under-represented and underserved in STEM fields. Student questionnaire respondents included more males (71%) than females (29%).
	• JSS had limited success in providing outreach to students from historically under-represented and underserved races/ethnicities and low-income groups. Only a small percentage of questionnaire respondents identified as Black or African American (10%) or Hispanic or Latino (3%). Only 14% of students responding to the questionnaire reported qualifying for free or reduced-price lunch (FRL).
	• JSS served students across a range of school contexts. The vast majority of student questionnaire respondents attended public schools (97%). A third attended schools in urban or rural settings, which tend to have larger populations of students from under-represented and underserved groups.
JSS engages a diverse group of adult participants as STEM mentors.	• In total, 341 adults, mostly teachers, were involved in JSS. Additional STEM professionals from a range of business sectors participated in career day activities at the TSA-hosted JSS sites.
Actionable Program Evaluation	
JSS uses multiple avenues to market the program.	• JSS employed multi-pronged efforts to market the program to and recruit students. These efforts included providing printed promotional materials to Army-hosted sites, the distribution of solar car kits to middle school TSA advisors and Army-hosted sites, and social media.
	• Students most frequently learned about JSS from the TSA website (72%); teachers/professors (54%); friends (28%); a school newsletter/email/website (15%); and past participants (13%).

JSS students are motivated by multiple factors.	• Students were most frequently motivated to participate in JSS by the desire to have fun (64%), because of their interest in STEM (62%), and because of teacher or professional encouragement (50%).
JSS engages students in meaningful STEM learning, through team-based and hands-on activities.	• Most students (55-59%) report communicating with other students about STEM and learning about new STEM topics on most days or every day of their JSS experience.
	• Most students had opportunities to engage in a variety of STEM practices during their JSS experience. For example, 81% reported working as part of a team, 67% building or simulating something, and 64% participating in hands-on activities on most days or every day.
	• Large proportions of mentors report 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.
JSS promotes DoD STEM research and careers at TSA-based sites but can improve marketing of other AEOP opportunities.	• Many mentors had a history of participating in other AEOPs besides JSS. In addition, although most students reported an increase in awareness of other AEOPs, a substantial proportion reported never hearing about any of the other programs. Mentors reported explicitly discussing only two other AEOP programs with students: eCYBERMISSION and GEMS.
	• TSA-based JSS sites offered a variety of activities for promoting STEM, including participation in STEM leadership activities and STEM breakouts at conferences. All of the three Army-based JSS sites engaged Army engineers and/or Army research facilities in their events. Two Army scientist and engineers participated in the national JSS event.
The JSS experience is greatly valued by students and mentors.	• All responding students indicated being satisfied with their JSS experience, highlighting the opportunity to learn about STEM and the chance to have fun.
	• The vast majority of responding mentors indicated having a positive experience. Further, many commented on the benefits the program provides students, including deepening their knowledge about STEM and their confidence.
Outcomes Evaluation	
JSS had positive impacts on students' STEM knowledge and competencies.	• A majority of students reported at least some gains in their knowledge of what everyday research work is like in STEM, research conducted in a STEM topic or field, a STEM topic or field in depth, how professionals work on real problems in STEM, and the research processes, ethics, and rules for conduct in STEM. Females reported greater gains in these areas than males.
	• Twenty-nine to 44% of responding students reported large or extreme gains in their abilities to do STEM, including such things as making a model that represents the key features or functions of an object, process, or system, communicating information about their investigations in different formats, applying knowledge, logic, and creativity to propose solutions that can be tested with investigations, and supporting a scientific explanation or engineering solution with relevant scientific, mathematical, and/or engineering knowledge. Female and minority students reported greater gains in these areas than males and non-minority students, respectively.

JSS had positive impacts on students' 21st Century Skills.	• A majority of students reported large or extreme gains in their 21st Century Skills, including their ability to work collaboratively with a team, sticking with a task until it is complete, and including others' perspectives when making a decision. Minority students and FRL-eligible students reported greater gains in these areas than non-minority/non-eligible students.
JSS positively impacted students' confidence and identity in STEM, as well as their interest in future STEM engagement.	• The majority of students reported a large or extreme gain in their confidence to do well in their ability to think creatively about a STEM project or activity (53%) and preparedness for more challenging STEM activities (52%). Slightly less than half reported a large or extreme gain in their sense of accomplishing something in STEM (46%), confidence to do well in future STEM courses (46%), and confidence to contribute to STEM (44%).
	• Students also reported on the likelihood that they would engage in additional STEM activities outside of school. A majority of students indicated that as a result of JSS they were more likely to tinker with mechanical or electrical devices, participate in a STEM club, association, or professional organization, take an elective STEM class, participate in a STEM camp, fair, or competition, and work on math/science puzzles.
JSS succeeded in raising students' education aspirations, though did not change their career aspirations.	• After participating in JSS, students indicated being more likely to go further in their schooling than they would have before JSS, with the greatest change being in the proportion of students who expected to continue their education beyond a Bachelor's degree (42% before JSS, 57% 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. Although many students indicated interest in a STEM-related career, there was not a statistically significant difference from before JSS to after.
JSS students are largely unaware of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• Student were largely unaware of other AEOP initiatives, but 64% of students indicated that JSS made them more aware of other AEOPs, and 60% credited JSS with increasing their interest in participating in other programs.
JSS raised student awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of students reported that they had a greater awareness (57%) and appreciation (53%) of DoD STEM research and careers. In addition, 53% indicated that JSS raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. AEOP programs have the goal of broadening the talent pool in STEM fields, yet, overall, JSS continues to be challenged by attracting students from groups historically under-represented and underserved in these fields. As was recommended in the 2013 evaluation report, the program may want to consider doing more to recruit students from schools serving historically under-represented and underserved groups, and work towards increasing the likelihood that the program has a long-term impact on the number of students who pursue STEM, especially given the findings

that females and minority students tended to report larger impacts of participation than males and non-minority students. As many students come to the program via state-level TSA competitions, it will be important to consider additional ways to reach out to a broader range of schools and students through both the TSA-hosted (as TSA structure allows) and Army-hosted events.

2. In order for students to progress from JSS into other AEOP programs, it will be necessary to provide opportunities for students see the connection between JSS and other AEOP programs as well as opportunities in Army/DoD STEM fields. In 2014, only a third of mentors recommended AEOPs to students that align with students' educational goals. In addition, mentors indicated explicitly discussing only two other AEOPs with students: eCYBERMISSION and GEMS. Although a recommendation was made in the 2013 report to increase students' exposure to other AEOP opportunities, no improvement was seen between 2013 and 2014. Further, although many students expressed interest in participating in other AEOP programs, a substantial proportion indicated having no interest. Given the small proportion of students who reported learning about other AEOPs from the JSS program and their mentor, and that most mentors reported never hearing about most of the AEOPs, 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. In addition, given the limited use of the AEOP website, print materials, and social media, the program should consider how these materials could be adjusted to provide students with more information and facilitate their enrollment in other AEOPs.

3. Additional efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the student and mentor questionnaires raise questions about the representativeness of the results, especially across Army-hosted regional events and TSA-hosted regional events. Further, most of the respondents (73 of 78 students and 14 of 16 mentors) to the FY14 survey participated in the JSS national event at the National TSA conference. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the student and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

4. A number of students suggested the JSS program could be improved by clarifying rules and adding more guidance. Mentors also expressed a need for more resources to help students. To help ensure a high-quality experience across sites, the program should continue to clarify the existing rules and making them easier to interpret. In addition, participants would welcome additional resources, such as pictures/videos of cars from previous years' competitions to get a sense of the wide range of possibilities for a car's design. An easy-to-locate schedule for each event and stricter adherence to the schedule would also be appreciated.

Appendix H: 2014 Research & Engineering Apprenticeship Program (REAP) Evaluation Executive Summary

REAP is a paid, summer internship program that focuses on developing STEM competencies among high school students from groups historically under-represented and underserved in STEM. For more than 30 years, REAP has placed talented high school students in research apprenticeships at colleges and universities throughout the nation. Each REAP student (herein referred to as apprentice) 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.

In 2014, REAP provided apprenticeships to 117 students at 38 sites at 36 different colleges and universities.[27] This number represents a 16% increase in enrollment from 101 apprentices in 2013.

This report documents the evaluation of the FY14 REAP 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 REAP included questionnaires for apprentices and mentors, 1 focus group and 3 interviews with apprentices, 1 focus group with mentors, and an annual program report compiled by the Academy of Applied Science (AAS).

2014 REAP Fast Facts	
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
No. of Applicants	426
No. of Students (Apprentices)	117
Placement Rate	27%
No. of Adults (Mentors)	74
No. of College/University S&Es	74
No. of K-12 Schools	117
No. of K-12 Schools – Title I	97
No. of College/Universities	36
No. of HBCU/MSIs	18
Total Cost	$347,392
Stipend Cost (Apprentices & Mentors)	$254,709
Administrative Cost to AAS	$92,683
Cost Per Student Participant	$2,969

[27] Some of the colleges and universities had multiple laboratories participate in REAP.

Summary of Findings

The FY14 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.

2014 REAP Evaluation Findings	
Participant Profiles	
REAP continues to have success in serving historically under-represented and underserved populations.	• REAP was successful in attracting participation of female students (50%)—a population that is historically under-represented in engineering fields.
	• REAP had 100% success meeting the program requirement of providing outreach to students from historically under-represented 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 under-represented 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). Enrollment data from program applications indicate that 42% of apprentices identify as Black or African American, 23% as Hispanic or Latino, and 49% as female. Additionally, 91% of the participating apprentices attend Title I schools (students from Title I schools typically come from under-represented and underserved populations).
	• REAP served apprentices across a range of school contexts. Most apprentice questionnaire respondents attended public schools (91%) and schools in urban settings (64%), which tend to have higher numbers or proportions of under-represented and underserved groups.
	• REAP was successful in implementing a bridge with UNITE, another AEOP STEM education initiative that serves students from under-represented and underserved groups. In 2014, 18 alumni of UNITE participated in REAP apprenticeships.
REAP's mentor diversity did not mirror the diversity of apprentices.	• In 2013, mentors identified as predominantly male (75%) and White (67%). In 2014, there was more diversity among the mentors, as fewer identified as male (64%) or White (49%).
	• A comparison of apprentice and mentor demographics suggested that many apprentices of underserved or under-represented populations are not likely to have mentors sharing the same gender or race/ethnicity. Having a mentor who shares an apprentice's gender or race/ethnicity is a potential motivator for reducing stereotypes and increasing students' performance and persistence in STEM.
REAP provides outreach to the Nation's future STEM workforce.	• 98% of the 50 apprentice respondents indicated their intent to pursue a career in a STEM-related field. More respondents intended to pursue careers in Engineering (36%) than any other field, with Medicine/Health (28%), Biological Science (12%), and Environmental Science (6%) being the next most frequently reported fields.

Actionable Program Evaluation	
REAP marketing and recruitment was largely a site-based endeavor.	• 47% of mentors reported actively recruiting apprentices through connections with local school teachers, 37% through communications generated by a university or faculty, and 26% through communications generated by local high schools or teachers. Applications solicited by the AAS and general AEOP marketing were also used to recruit apprentices (45%).
	• Apprentices most frequently learned about REAP from teachers and professors (56%), school newsletters, emails, or websites (20%) or from a REAP mentor (15%).
	• 26% of mentors learned about REAP from a colleague and 21% from a superior, such as a Department Chair, Center Director, or Dean.
REAP is strongly marketed to students from historically under-represented and underserved groups.	• The RFP specified to university directors/mentors that the targeted participants were under-represented 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 under-represented and underserved groups.
REAP apprentices participate to clarify and advance their STEM pathways.	• 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. Additionally, apprentices participated to clarify and advance their STEM and research knowledge. A small number were motivated by their own previous positive experiences in REAP or other AEOPs.
REAP engages apprentices in meaningful STEM learning through team-based and hands-on activities.	• Most apprentices (74-87%) report learning about STEM topics, interacting with STEM professionals, applying STEM knowledge to real-life situations, and learning about cutting-edge STEM research on most days or every day of their REAP experience.
	• Most apprentices had opportunities to engage in a variety of STEM practices during their REAP experience. For example, 89% participating in hands-on activities, 82% working as part of a team, 77% analyzing or interpreting data or information, and 68% 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.
	• Large proportions of mentors report 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 improve mentors' awareness of and resources for promoting AEOP opportunities and DoD STEM careers.	• Most mentors had limited awareness of or past participation in an AEOP initiative beyond REAP. Nineteen percent of responding mentors had past experience with SMART, an undergraduate scholarship program, and 15% with URAP, an undergraduate research program, but mentors' participation in all other AEOP programs was 10% or less. In addition, although most apprentices reported an increase in awareness of other AEOPs, 68% reported that their mentors never recommended any AEOP programs. However, the majority of the apprentices reported having interest in the SMART and URAP programs, indicating that the mentors did make an impact.

	• Many mentors educated apprentices about STEM majors and careers (68% 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 63% of apprentices reported that their mentors never discussed STEM career opportunities with the DoD.
The REAP experience is greatly valued by apprentices and mentors.	• All responding apprentices indicated being satisfied with their 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.
	• The vast majority of responding mentors indicated having a positive experience. Further, many commented on the benefits the program provides apprentices, including hands-on research experience and increases in STEM content knowledge.
Outcomes Evaluation	
REAP had positive impacts on apprentices' STEM knowledge and competencies.	• A majority of 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.
	• Many apprentices also 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 had positive impacts on apprentices' 21st Century Skills	• A large majority of 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 positively impacted apprentices' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many apprentices reported a large or extreme gain on their confidence to do well in future STEM courses (78%), their ability to contribute to STEM (76%), preparedness for more challenging STEM activities (74%), and building academic or professional STEM credentials (73%). In addition, 72% reported an increase in their sense of accomplishing something in STEM, 70% reported feeling like part of a STEM community, and 69% reported feeling responsible for a STEM project or activity.
	• Apprentices also reported on the likelihood that they would engage in additional STEM activities outside of school. 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 succeeded in raising apprentices' education aspirations, but did not	• 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 (74% before REAP, 96% after).

change their career aspirations	• 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; however, there was not a statistically significant difference from before REAP to after. This result is likely due to the requirement for apprentices to demonstrate interest in STEM in order to be selected for the program.
Although many REAP apprentices were largely unaware of other AEOP initiatives, a substantial portion expressed interest in future AEOP opportunities.	• At the end of their apprenticeship, many apprentices reported that they had never heard of any of the AEOPs except for REAP (43-68% of apprentices, depending on the program). However, after participating in REAP, a large proportion of apprentices were somewhat to very interested in participating in other AEOP initiatives in the future (38-72% of apprentices, depending on the program).
REAP raised apprentice awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of apprentices reported that they had a greater appreciation (64%) and awareness (63%) of DoD STEM research and careers. In addition, 49% indicated that REAP raised their interest in pursuing a STEM career with the DoD. Apprentices cited their participation in REAP (53%), their REAP mentor (40%), and the AEOP instructional supplies (30%) as having the most impact on their awareness of DoD STEM careers.

Recommendations

1. 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 under-represented and underserved in these fields. The bridge between UNITE and REAP has shown early signs of efficacy in helping REAP attract students from under-represented and underserved groups; 18 students from UNITE received REAP apprenticeships in 2014. However, on the questionnaires, apprentices and mentors reported that they are largely unaware of UNITE, which indicates that more emphasis should be given to the UNITE-REAP pipeline so that it can be sustained, if not expanded, in the future. It will also be important for evaluation efforts to be focused on the UNITE-REAP bridge to determine if it has a lasting effect on participants' STEM persistence and to collect information about how the bridge program may be improved in subsequent years. Still, the program may want to consider doing more to increase the likelihood that the program has a long-term impact on the number of students who pursue STEM. Strategies that have been shown to be effective in this area 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. Although many mentors reported using a number of these strategies (e.g., highlighting the under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM), substantive proportions did not. The program should consider ways to ensure that these areas are addressed systematically. For example, the program may want to work

with each site to see how these areas could be built into their schedules, or provide more guidance to mentors for how and when to address these issues. Additionally, the program should consider recruiting a more diverse pool of mentors that reflects the gender and race/ethnicity of the apprentices to serve as strong role models for the apprentices. The use of an RFP for to identify sites for the program resulted in 18 host sites that are identified as historically black colleges and universities (HBCUs) or minority serving institutions (MSIs). The program should continue these efforts to create more apprenticeships at HBCUs and MSIs.

2. As was found in 2013, 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 work with sites to increase apprentices' exposure to AEOP. Only 63% of mentors recommended other AEOPs to apprentices, typically SMART and URAP, both undergraduate initiatives. Further, although many apprentices expressed interest in participating in other AEOP programs, a substantial proportion indicated having little or no interest. Many of the apprentices reported learning about other AEOPs through their participation in REAP, their mentor, or the instructional resources provided to them; however, the program may want to 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. In addition, given the limited use of the program website, print materials, and social media, the program should consider how these materials could be adjusted to provide apprentices with more information and facilitate their enrollment in other AEOPs.

3. Similar to recommendation 2, efforts should be made to help mentors and apprentices become more aware of DoD STEM research and careers. Sixty-four 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. Consistent with the recommendation from 2013, 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.

4. A number of apprentices suggested that the REAP program could be improved by extending the length of the experience. Many apprentices 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.

5. 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. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In

particular, consideration should be given to whether the parallel nature of the apprentice and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

Appendix I: 2014 Science & Engineering Apprenticeship Program (SEAP) Evaluation Executive Summary

The Science & Engineering Apprenticeship Program (SEAP), managed by the American Society for Engineering Education (ASEE), 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 2014, SEAP provided outreach to 92 apprentices and 86 Army S&Es (all adults who acted as mentors) at nine Army laboratory sites (herein called SEAP sites). The number of apprentices represents a 9% decrease from the 101 participants in 2013; the number of applicants was essentially unchanged (810 in 2014 vs. 814 in 2013).

This report documents the evaluation of the 2014 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, 4 focus groups with apprentices, 4 focus groups with mentors, and an annual program report compiled by ASEE.

2014 SEAP Fast Facts	
Description	STEM Apprenticeship Program – Summer, at Army laboratories with Army S&E mentors
Participant Population	9th-12th grade students
No. of Applicants	810
No. of Students (Apprentices)	92
Placement Rate	11%
No. of Adults (Mentors)	86
No. of Army S&Es	86
No. of Army Research Laboratories	9
No. of K-12 Schools	58
No. of K-12 Schools – Title I	N/A
Total Cost	$259,719
Stipend Cost (paid by participating labs)	$220,966
Administrative Cost to ASEE	$38,753
Cost Per Student Participant	$2,823

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[28] 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 FY14 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.

2014 SEAP Evaluation Findings	
Participant Profiles	
SEAP had some success in providing outreach to participants from historically under-represented and underserved populations.	• SEAP has been somewhat successful in attracting participation of female students; 40% of FY14 participants were female—a population that is historically under-represented in engineering fields.
	• SEAP has had limited success in providing outreach to students from historically under-represented and underserved race/ethnic groups. Of enrolled apprentices in FY14, 13% identify as Black or African American, 5% as Native American or Alaskan Native, and 2% as Native Hawaiian or Other Pacific Islander.
SEAP appears to have had limited success in engaging a diverse group of adult participants as STEM mentors.	• Of the 17 respondents to the mentor questionnaire, two-thirds (65%) were males and the large majority identified themselves at White (82%). Because of the nature of the SEAP program, nearly all responding mentors were scientists, engineers, or mathematics professionals (94%). However, because of the low response rate to the questionnaire, the respondents may not be representative of the population of SEAP mentors.
Actionable Program Evaluation	
Some efforts were made by ASEE to market SEAP to under-represented and underserved populations. The impact of these efforts is unclear as most apprentices report learning about the program from alternative sources.	• A number of strategies were used by ASEE to market SEAP and recruit students from schools and school networks identified as serving large populations of traditionally under-represented and underserved students. These efforts included sending email blasts to teachers, guidance counselors, and principals in areas nearby participating SEAP labs; mailing promotional materials when requested by teachers (e.g., AEOP brochures); and sharing information at events such as "Hispanic Association for Colleges and Universities Conference" and "Invent it. Build it. Career Expo at the Society of Women Engineers Conference."
	• Similar to FY13, FY14 apprentices frequently learned about the SEAP program from an immediate family member (43%), a teacher or professor (21%), or a past participant of SEAP (19%).

[28] "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.

SEAP apprentices are motivated by opportunities to learn about STEM, typically in ways not possible in school.	• Apprentices were motivated to participate in SEAP because of their interest in STEM (88%), the opportunity to learn in ways that are not possible in school (82%), the desire to learn something new or interesting (79%), and the desire to expand laboratory or research skills (68%).
SEAP engages apprentices in meaningful STEM learning, through team-based and authentic STEM experiences.	• Most apprentices (70-86%) report interacting with STEM professionals, applying STEM to real-life situations, learning about STEM topics, learning about cutting-edge STEM research, and learning about different STEM careers on most days or every day of their SEAP experience.
	• Apprentices had opportunities to engage in a variety of STEM practices during their SEAP experience. For example, 79% reported participating in hands-on activities; 73% communicating with other students about STEM; and 73% practicing using laboratory or field techniques, procedures, and tools on most days or every day.
	• Similar to FY13, apprentices in FY14 reported greater opportunities to learn about STEM and greater engagement in STEM practices in their SEAP experience than they typically have in school.
	• Large proportions of mentors report using 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.
SEAP promotes DoD STEM research and careers but can improve marketing of other AEOP opportunities.	• The vast majority of responding apprentices have favorable opinions of what DoD researchers do and the value of DoD research more broadly.
	• Most apprentices (83%) reported learning about multiple DoD STEM careers during their participation in SEAP. Mentors were most likely to rate participation in SEAP, administrators or site coordinators, and invited speakers or career events as "very much" useful in their efforts to expose their apprentices to different DoD STEM careers.
	• As in FY13, the vast majority of FY14 apprentices reported never hearing about or never participating in AEOP programs beyond SEAP. Similarly, responding mentors generally had no awareness of or past participation in other AEOP programs.
The SEAP experience is valued by apprentices and mentors.	• In general, responding apprentices indicated being satisfied with their SEAP experience, highlighting the instruction and mentorship they received during program activities.
	• The vast majority of responding mentors indicated having a positive experience. Further, many commented on the benefits the program provides apprentices, including opportunities for apprentices to have hands-on/real-life research experiences and the introduction of STEM at an early age.
Outcomes Evaluation	
SEAP had positive impacts on apprentices' STEM knowledge and competencies.	• A vast majority of apprentices reported large or extreme gains on 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; a STEM topic or field in depth; and the research processes, ethics, and rules for

	conduct in STEM. These impacts were identified across all demographic subgroups examined. • Many apprentices reported large or extreme gains in their abilities to do STEM, including such things as communicating information about their design processes and/or solutions in different formats, carrying out procedures for an investigation, supporting a proposed explanation with data from investigations, and displaying numeric data from an investigation in charts or graphs to identify patterns and relationships.
SEAP had positive impacts on apprentices' 21st Century Skills.	• A large majority of apprentices reported large or extreme gains on their ability to build relationships with professionals in the field, make changes when things do not go as planned, stick with a task until it is complete, and communicate effectively with others.
SEAP positively impacted apprentices' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many apprentices reported a large or extreme gain on their preparedness for more challenging STEM activities (77%), confidence to do well in future STEM courses (75%), and ability to think creatively about a STEM project or activity (74%). In addition, 63% reported increased confidence in their ability to contribute to STEM (73%) and increased sense of belonging to a STEM community (65%). • A majority of apprentices indicated that as a result of SEAP, they were more likely to work on a STEM project or experiment in a university or professional setting, look up STEM information at a library or on the internet, mentor or teach other students about STEM, and take an elective STEM class.
SEAP did not impact apprentices' education or career aspirations, likely because of the entry requirements of the program.	• Both before and after participating in SEAP, most apprentices indicated wanting to pursue an advanced degree after college. • A substantial proportion of apprentices expressed uncertainty about their career aspirations, both before and after participating in SEAP. The remaining apprentices generally indicating a desire to pursue a STEM-related career, both before and after participating in SEAP.
Apprentices show interest in future AEOP opportunities.	• Consistent with FY13, FY14 apprentices indicated being "very much" interested in participating in future AEOP programs, including SEAP (61%), CQL (47%), and SMART (45%).
SEAP raised apprentice awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of apprentices reported that they had a greater awareness (78%) and appreciation (88%) of DoD STEM research and careers. In addition, 68% indicated that SEAP raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. Although it is not an objective of SEAP in particular, the AEOP portfolio has the goal of attracting students from groups historically under-represented and underserved in STEM. SEAP has had limited success in this area—a finding that is fairly consistent with previous years, indicating that this area is one in which SEAP can continue to improve. Although

ASEE made some efforts to reach out to minority-serving schools and networks, the majority of apprentice survey respondents indicated learning about SEAP through other means (most frequently through an immediate family member (48%)). Many responding mentors indicted recruiting their apprentices through personal networks (e.g., workplace colleagues, personal acquaintances, university faculty). The lack of success in recruiting students from groups historically under-represented and underserved in STEM to SEAP is shaped by multiple factors including the recruitment and selection process that is used by mentors and the marketing of SEAP to target groups by ASEE. Improvements can be made in all areas. The program may want to consider additional/alternate means of recruiting and selecting apprentices and mentors to ensure that SEAP includes diverse groups of highly talented participants. For example, the IPA may need to look at each site and compare its geographical reach to the target population. In addition, each site may want to compare the population of potential apprentices in its area to the applicant pool to identify gaps in its outreach to historically under-represented and underserved populations.

2. Given the goal of having apprentices progress from SEAP into other AEOP programs, the program may want to work with sites to increase apprentices' exposure to AEOP. Small percentages of mentors explicitly discussed other AEOPs with their apprentices, typically GEMS (35%), SMART (24%), and GEMS Near Peers (24%). Further, although many apprentices expressed interest in participating in other AEOP programs, a substantial proportion indicated having no interest. The program may want to work with each site to ensure that all apprentices have access to structured opportunities that both describe the other AEOPs and provide information to apprentices on how they can apply to them. To this end, SEAP should ensure that mentors: (1) are aware of the intended focus on exposing apprentices to AEOP/DoD programs, (2) have the resources to educate themselves and their apprentices about these programs, and (3) are equipped to help apprentices apply to other AEOP/DoD programs. In addition, given the limited use of the program website, print materials, and social media, the program should consider how these resources could be modified or leveraged to provide mentors and apprentices with more information about AEOP initiatives and facilitate increased enrollment.

3. 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. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the apprentice and mentor questionnaires is necessary, with items being asked only of the most appropriate data source. In addition, items that are collected through the new, centralized registration (e.g., demographics) and those that may provide difficult-to-interpret data should be considered for removal.

4. The number of applications for SEAP apprenticeships (810 applications for 92 funded apprenticeships) is indicative of a substantial unmet need. Although 14 Army research laboratories were designated as SEAP sites in FY14, 5 of these locations did not host apprentices, despite receiving applications. In order to sustain, and potentially increase, student participation, the program will likely need to intensify its efforts to recruit Army S&Es to serve as mentors. These

efforts may require examining and modifying program- and site-level structures, processes, and resources that both enable and discourage Army S&Es' participation.

5. A small number of apprentices (2%) reported that they did not have a research project to work on during their SEAP experience. In addition, 9% indicated that they were not at all satisfied with the amount of time spent doing meaningful research, and 14% indicated that their research mentor was available only half of the time or less often. Given that the goal of SEAP is for students to gain exposure to the real world of research, it is important that the project monitors the quality of apprentices' research experiences. Apprentices who do not have positive experiences in the program are unlikely to continue their association with their original laboratory and mentor in future summers, unlikely to enroll in future AEOP programs, and unlikely to recommend AEOP programs to other students.

Appendix J: 2014 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 under-represented 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, 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 FY14 UNITE 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 UNITE included questionnaires for students and mentors, 3 focus groups with students and 1 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).

2014 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	Rising 10th and 11th grade students from groups historically underserved and under-represented in STEM
No. of Applicants	437
No. of Students	280
Placement Rate	64%
No. of Adults	162
No. of Army S&Es	20
No. of Army Agencies	12
No. of K-12 Teachers	48
No. of K-12 Schools	121
No. of K-12 Schools – Title I	53[‡]
No. of College/Universities	10
No. of HBCU/MSIs	7
Total Cost	$359,940
Stipend Cost	$80,400
Administrative Cost to TSA	$102,200
Administrative Cost to Host Sites	$177,340
Cost Per Student Participant	$1,286

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

Summary of Findings

The FY14 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.

2014 UNITE Evaluation Findings	
Participant Profiles	
UNITE continues to have success at serving students of historically under-represented and underserved populations.	• UNITE was successful in attracting female participants—a population that is historically under-represented in engineering fields. Enrollment data indicate that 65% of participants were female.
	• UNITE had success in providing outreach to students from historically under-represented and underserved minority race/ethnicity and low-income groups. Enrollment data indicate that 55% of participating students identified as Native American or Alaskan Native, 22% as Black or African American, and 17% as Hispanic or Latino. A majority of students responding to the questionnaire reported qualifying for free or reduced-price lunch (53%).
	• UNITE served students across a range of school contexts. Most student questionnaire respondents attended public schools (78%) and schools in urban settings (55%) or frontier/tribal schools (16%), which tend to have higher numbers or proportions of underserved groups.
UNITE engages a diverse group of adult participants as STEM mentors.	• In total, 162 adults, including university faculty, high school and university students, local teachers, and industry STEM professionals served as program mentors. Additional STEM professionals from a range of business sectors participated in career day activities.
Actionable Program Evaluation	
UNITE is strongly marketed to schools and teachers serving historically under-represented and underserved groups.	• Many UNITE sites employed multi-pronged efforts to market programs to and recruit students from schools and school networks identified as serving large populations of traditionally under-represented and underserved students. These efforts included university press releases distributed to area media, printed promotional materials, university websites, social media (Facebook), and marketing at existing programs at the site (e.g., Upward Bound).
	• Students most frequently learned about the local UNITE program from school or university newsletters, emails, or websites (34%); teachers/professors (21%); mentors from the UNITE program (21%); immediate family members (16%); and the AEOP website (16%).
UNITE students are motivated by opportunities to learn about STEM in ways not possible in school.	• Students were most frequently motivated to participate in UNITE by the desire to learn something new or interesting (66%), because of their interest in STEM (62%), to have fun (62%), and to learn in ways not possible in school (61%).

UNITE engages students in meaningful STEM learning, through team-based and hands-on activities.	• Most students (54-83%) report learning about STEM topics, applications of STEM to real-life situations, STEM careers, and cutting-edge STEM research on most days or every day of their UNITE experience.
	• Most students had opportunities to engage in a variety of STEM practices during their UNITE experience. For example, 85% reported working as part of a team, 76% participating in hands-on activities, 70% building or simulating something, and 67% coming up with creative explanations/solutions on most days or every day.
	• Students reported greater opportunities to learn about STEM and greater engagement in STEM practices in their UNITE experience than they typically have in school.
	• Large proportions of mentors report 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.
UNITE promotes DoD STEM research and careers but can improve marketing of other AEOP opportunities.	• Most mentors had no awareness of or past participation in an AEOP initiative beyond UNITE. In addition, although most students reported an increase in awareness of other AEOPs, a substantial proportion reported never hearing about any of the other programs. However, a substantial portion of students were made aware of, and expressed interest in the REAP program, indicating that the effort to cross-market these programs is having the desired results.
	• 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. Six of the 10 UNITE sites engaged Army engineers as speakers, or went to Army facilities in career day events.
The UNITE experience is greatly valued by students and mentors.	• All responding students indicated being satisfied with their UNITE experience, highlighting the opportunity to learn about STEM fields and career opportunities. Students also commented on how UNITE provided opportunities they do not get in school and would not otherwise have.
	• The vast majority of responding mentors indicated having a positive experience. Further, many commented on the benefits the program provides students, including deepening their knowledge about and confidence in STEM.
Outcomes Evaluation	
UNITE had positive impacts on students' STEM knowledge and competencies.	• A majority of 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. These impacts were identified across all student groups.
	• Many students 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.

UNITE had positive impacts on students' 21st Century Skills.	• A large majority of students reported large or extreme gains on their ability to work collaboratively with a team, communicate effectively with others, include others' perspectives when making decisions, sticking with a task until it is complete, and connecting a topic or field and their personal values.
UNITE positively impacted students' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many students reported a large or extreme gain on their confidence to do well in future STEM courses (71%), ability to think creatively about a STEM project or activity (67%), academic credentials in STEM (63%), and preparedness for more challenging STEM activities (66%). In addition, 63% reported increased confidence in their ability to contribute to STEM, 61% reported clarifying a STEM career path, and 54% increased interest in a new STEM topic or field.
	• Students also reported on the likelihood that they would engage in additional STEM activities outside of school. A majority of students indicated that as a result of UNITE, they were more likely to tinker with mechanical or electrical devices, participate in a STEM camp, fair, or competition, work on a STEM project in a university or professional setting, help with a community service project related to STEM, or mentor other students about STEM.
UNITE succeeded in raising students education aspirations, but did not change their career aspirations.	• 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 (44% before UNITE, 59% 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. Although many students indicated interest in a STEM-related career, there was not a statistically significant difference from before UNITE to after. This result is likely due to the requirement for students to demonstrate interest in STEM in order to be selected for the program.
UNITE students are largely unaware of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• With the exception of REAP, students and mentors were largely unaware of other AEOP initiatives. However, 79% of students indicated that UNITE made them more aware of other AEOPs, and 75% credited UNITE with increasing their interest in participating in other programs.
UNITE raised student awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of students reported that they had a greater awareness (77%) and appreciation (76%) of DoD STEM research and careers. In addition, 62% indicated that UNITE raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. The UNITE 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 under-represented and underserved in these fields. However, the program may want to consider doing more to increase the likelihood that the program has a long-term

impact on the number of students who pursue STEM. Strategies that have been shown to be effective in this area 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. Although many mentors reported using a number of these strategies (e.g., highlighting the under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM), substantive proportions did not. The program should consider ways to ensure that these areas are addressed systematically. For example, the program may want to work with each site to see how these areas could be built into their schedules, or provide more guidance to mentors for how and when to address these issues.

2. Similarly, given the goal of having students progress from UNITE into other AEOP programs, particularly REAP and JSHS, the program may want to work with sites to increase students' exposure to AEOP. Only about half of mentors recommended other AEOPs to students, typically REAP. Further, although many students expressed interest in participating in other AEOP programs, a substantial proportion indicated having no interest. Given the proportion of students who reported learning about other AEOPs from invited speakers, career events, or their mentors, 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. In addition, given the limited use of the program website, print materials, and social media, the program should consider how these materials could be adjusted to provide students with more information and facilitate their enrollment in other AEOPs.

3. A number of students suggested the UNITE program could be improved by changes to the content. For example, some students wanted opportunities to engage in a broader range of STEM topics, others wanted more field experiences. Mentors also expressed a need for more resources for engaging students in hands-on, authentic STEM experiences. To help ensure a high-quality experience across sites, the program should consider creating a "library" of activities and resources for individual sites and mentors to draw upon. These resources could range from suggested curricula for the entire UNITE experience to specific activities in different topic areas that mentors could use with their students. To start building this library, sites and mentors could be asked to submit their most successful activities, which could be vetted, edited as necessary, and then made available to all sites and mentors.

4. For a number of outcomes (impacts on students' STEM abilities and STEM identity), there were significant differences in reported impacts between female and male students; in each case, males reported greater impacts. These types of results might raise concerns about whether there were inequities in how males and females were being served by the program. However, the majority of survey respondents identified themselves as Black or African American, and previous research has shown that males from this group often have worse education outcomes than other students, including their female counterparts.[29] Thus, it will be important to monitor this issue in future years, and if sample

[29] Pollard, D.S. (1993). Gender, achievement and African American students' perceptions of their school experience. Education Psychologist, 28(4), 341-356.

sizes allow, disaggregate results into more specific subgroups (e.g., Black/African-American males, Black/African-American females, White males, White females) to ensure the program is serving all students equitably.

5. Efforts should be undertaken to improve participation in evaluation activities, as the low response rates for both the student and mentor questionnaires raise questions about the representativeness of the results. Improved communication with the individual program sites about expectations for the evaluation may help. In addition, the evaluation instruments may need to be streamlined as perceived response burden can affect participation. In particular, consideration should be given to whether the parallel nature of the student and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

Appendix K: 2014 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 final reports for submission to the US Army Research Office Youth Science programs office.

In 2014, URAP provided outreach to 59 apprentices and their mentors at 27 Army-sponsored university or college laboratory sites (herein called URAP sites).

This report documents the evaluation of the 2014 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 focus groups with apprentices and mentors (conducted online or over the telephone) and online post-program questionnaires distributed to all apprentices and mentors.

2014 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
No. of Applicants	90
No. of Students (Apprentices)	59
Placement Rate	66%
No. of Adults (Mentors)	31
No. of College/University S&Es	31
No. of College/Universities	27
No. of Army-Funded College/University Laboratories	27
No. of HBCU/MSIs	10
Total Cost	$210,185
Admin/Overhead Costs (Host Sites)	$30,719
Stipend Cost (paid by AEOP and ARO)	$179,466

Cost Per Student Participant	$3,562

Summary of Findings

The 2014 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.

2014 URAP Evaluation Findings	
Participant Profiles	
URAP continues to have difficulty providing outreach to participants from historically under-represented and underserved populations.	• URAP had difficulty attracting participation from female apprentices—a population that is historically under-represented and underserved in specific STEM fields. URAP apprentices included far more males (71%) than females (27%).
	• URAP had difficulty providing outreach to apprentices from historically under-represented and underserved race/ethnicity groups (15%). Low proportions of apprentices identify as Native American or Alaskan Native (0%), Native Hawaiian (0%), Hispanic or Latino (7%), and Black or African American (8%).
URAP STEM mentors were lacking in diversity as well.	• Although there were more female than male (69% and 31%, respectively) mentors among questionnaire respondents, the majority identified as either Asian (56%) or White (38%). Only one responding mentor identified as Hispanic or Latino and none identified as Black or African American.
Actionable Program Evaluation	
Marketing and recruitment of URAP apprentices and mentors depends almost entirely on the universities or colleges that host URAP	• ARO marketed and recruited 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. • Apprentices learned about URAP through university personnel, advertisements, classes, or other acquaintances associated with URAP site. Many apprentices had existing associations with their mentor prior to working as a URAP apprentice. 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, 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. • Most mentors reported recruiting apprentices within the university or college context. Some mentors had a previous association with the apprentice prior to URAP through a course or previous research.

	• In both 2013 and 2014, many apprentices and mentors had existing associations prior to URAP, though most mentors reported selecting apprentices from the AEOP applicant pool. This pattern of responses suggests that apprentices are first recruited within universities and colleges and subsequently directed to the AEOP application as a formality. The program may want to collect additional information about previous relationships between mentors and apprentices as part of their application process to help ensure it is meeting its goal of involving new students in the URAP research experience.
URAP apprentices are motivated by opportunities to learn about STEM in ways not possible in school.	• Apprentices were most frequently motivated to participate in URAP by the desire to expand laboratory or research skills (98%), because of their interest in STEM (97%), to learn in ways not possible in school (88%), and by the opportunity to use advanced laboratory technology (87%).
URAP engages apprentices in meaningful STEM learning, through team-based and hands-on activities.	• Most apprentices (71-91%) report learning about STEM topics, applications of STEM to real-life situations, and communicating with other students about STEM on most days or every day of their URAP experience.
	• Most apprentices had opportunities to engage in a variety of STEM practices during their URAP experience. For example, 86% reported practicing using laboratory or field techniques, procedures, or tools; 86% participating in hands-on activities; 83% reported working as part of a team; 83% building or simulating something; and 83% analyzing or interpreting data on most days or every day.
	• Apprentices reported greater opportunities to learn about STEM and greater engagement in STEM practices in their URAP experience than they typically have in school.
	• Large proportions of mentors report using 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.
URAP promotes DoD STEM research and careers but can improve marketing of other AEOP opportunities.	• More than half of mentors (53%) indicated discussing DoD STEM career opportunities with their apprentices. As a result, more than 60% of apprentices reported that they had a greater awareness and appreciation of DoD STEM careers.
	• Most mentors had no awareness of or past participation in an AEOP initiative beyond URAP. Similarly, a substantial proportion of apprentices, when asked what AEOPs they had participated in, indicated never hearing of most of the AEOP programs. However, when asked about their awareness of other AEOPs, most apprentices reported an increase in awareness as a result of participating in URAP. This apparent contradiction may be a result of apprentices learning that AEOP offers several other programs, but not receiving specific information about the various other offerings.
The URAP experience is greatly valued by apprentices and mentors.	• All responding apprentices indicated being satisfied with their URAP experience, highlighting the opportunity to learn about STEM fields and career opportunities. Apprentices also commented on how URAP provided opportunities they do not get in school and would not have otherwise.

	• The vast majority of responding mentors indicated having a positive experience. Further, many commented on the benefits the program provides apprentices, including deepening their knowledge about and confidence in STEM.
Outcomes Evaluation	
URAP had positive impacts on apprentices' STEM knowledge and competencies.	• A majority of apprentices reported large or extreme gains in 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.
	• Many 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.
URAP had positive impacts on apprentices' 21st Century Skills.	• A large majority of 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 positively impacted apprentices' confidence and identity in STEM, as well as their interest in future STEM engagement.	• Many apprentices reported a large or extreme gain in feeling responsible for a STEM project or activity (88%), confidence to do well in future STEM courses (79%), ability to build academic or professional credentials in STEM (76%), preparedness for more challenging STEM activities (73%), feeling like a STEM professional (73%), feeling like part of a STEM community (73%) and trying out new ideas or procedures on their own in a STEM project (73%).
	• Apprentices also reported on the 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 (82%), to talk with friends or family about STEM (72%), and to help with a community service project related to STEM (69%).
URAP succeeded in raising apprentices' education aspirations, but did not change their career aspirations.	• After participating in URAP, 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 beyond a Bachelor's degree (79% before URAP, 91% 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. Although many apprentices indicated interest in a STEM-related career, there was not a statistically significant difference from before URAP to after. This result is likely due to the requirement for students to demonstrate interest in STEM in order to be selected for the program.

URAP apprentices are largely unaware of AEOP initiatives, but apprentices show substantial interest in future AEOP opportunities.	• About three-quarters of apprentices indicated that URAP made them more aware of other AEOPs (74%), and credited URAP with increasing their interest in participating in other programs (76%).
URAP raised apprentice awareness and appreciation of DoD STEM research and careers, as well as their interest in pursuing a STEM career with the DoD.	• A majority of apprentices reported that they had a greater awareness (62%) and appreciation (68%) of DoD STEM research and careers. In addition, 59% indicated that URAP raised their interest in pursuing a STEM career with the DoD.

Recommendations

1. AEOP objectives include expanding participation of historically under-represented and underserved populations. Similar to past years, in URAP, recruitment of apprentices is largely a bottom-up phenomenon that occurs at the site-level using connections or mechanisms available to the university or college site. As a result, the ability of URAP to recruit underserved or under-represented populations of students depends upon the diversity of the universities or colleges in which recruitment takes place. Indications are that many URAP apprentices are informally selected by mentors and subsequently sent to the AEOP application site as a mere formality. Guidance ensuring that "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who apply through the AEOP website is likely to help in recruitment efforts. 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.

2. Given the goal of exposing apprentices to other AEOP initiatives and encouraging continued participation (including as a mentor or volunteer) in programs which are available, URAP may want to work with sites to increase both mentors' and apprentices' exposure to AEOP. Evaluation data suggests that URAP apprentices and mentors were largely unaware of other AEOP initiatives and that URAP served as an entry point into the AEOP for students who have not yet been exposed the Army STEM outreach. Yet, substantial apprentice interest exists in participating in AEOPs moving forward. This interest could be cultivated with more attention by ARO and mentors during URAP program activities. Continued guidance by ARO is needed to educate mentors about AEOP opportunities nationwide. Adequate resources and guidance for using resources with apprentices should be provided to mentors such that that all apprentices leave URAP with an idea of their next steps in AEOP and/or the capability to serve as an AEOP ambassador.

3. Similarly, given the goal of exposing apprentices to Army/DoD STEM research and careers, the program may want to build in opportunities to provide this information to their apprentices. More than half of apprentices who completed

the survey (68%) reported that they did not learn about any DoD STEM jobs/careers during URAP. In an effort to increase and standardize the information provided to apprentices, it would be beneficial to create a resource that profiles Army STEM interests and the education, on-the-job training, and related research activities of Army careers. Such a resource could start the conversation about Army STEM careers and motivate further exploration beyond the resource itself. A repository of public, web-based and print resources (e.g., Army and directorate STEM career webpages, online magazines, federal application guidelines) could also be disseminated to each mentor and/or apprentice to help guide their exploration of Army/DoD STEM interests, careers, and available positions.

4. Additional 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 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[30]) and response burden can affect participation.[31] In particular, consideration should be given to whether the parallel nature of the apprentice and mentor questionnaires is necessary, with items being asked only of the most appropriate data source.

[30] 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.

[31] 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."