Army Educational Outreach Program

Summative Report: FY12 Evaluation

ARMY EDUCATIONAL OUTREACH PROGRAM

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EXECUTIVE SUMMARY

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

In 2012, the AEOP provided outreach to 53,408 participants.

Table 1. 2012 AEOP Participation Numbers

AEOP Element		2012 Participants
AAP	Army Awards Program	1,209
CQL	College Qualified Leaders	274
eCM	eCYBERMISSION	16,096
GEMS	Gains in the Education of Mathematics & Science	1,722
HSAP/ URAP	High School Apprenticeship Program / Undergraduate Research Apprenticeship Program	97
JSHS	Junior Science & Humanities Symposium	8,448
JSS	Junior Solar Sprint	N/A*
REAP	Research & Engineering Apprenticeship Program	131
SEAP	Science & Engineering Apprentice Program	154
STPI	STEM Teacher Program Initiatives	52
UNITE	UNITE	193
WPBC	West Point Bridge Design Contest	25,032
	Total 2012 AEOP Participants	**53,408**

* 2012 was a transitional year for Junior Solar Sprint.

The 2012 AEOP portfolio was assessed by Virginia Tech, Lead Organization in the AEOP CA. Evaluations were performed on the GEMS, HSAP/URAP, REAP, SEAP, and UNITE programs as well as both the JSHS Regional Symposia and the JSHS National Event. The evaluation of STPI focused on its 2012 STEM Teacher Academy (STA). Most evaluations utilized participant questionnaires. Both the GEMS and UNITE assessments involved pre-program and post-program participant questionnaires to enable the measurement of participant growth through the program. Assessments of the AEOP apprenticeship programs (HSAP/URAP, REAP, and SEAP) incorporated mentor questionnaires and rubrics used by mentors to measure participant knowledge and ability levels. The assessment of the JSHS Regional Symposia was based on data obtained through the structured interviews and survey of JSHS Regional Directors.

The 2012 assessment outcomes have been organized according to the three AEOP goals: STEM literate citizenry, STEM savvy educators, and sustainable infrastructure.

Table 2. 2012 AEOP Outcomes	
GOAL ONE: STEM Literate Citizenry	
Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base[1].	
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.	
Outcomes	
The AEOP provided outreach to approximately 53,408 participants in 2012.	• 52,573 students participated in the 2012 AEOP.
	• 835 teachers participated in the 2012 AEOP.
	• 17 Army laboratories or installations and 111 American universities or colleges hosted AEOP participants in 2012.
	• The AEOP received applications from many more qualified participants than it could serve in 2012: GEMS received 2,755 applications for 1,614 positions; SEAP received 796 applications for 154 positions; CQL received 373 applications for 274 positions; and REAP received more than 1500 applications for 131 positions.
AEOP participants have education and career aspirations in STEM.	• 99.4% of AEOP high school participants intend to pursue post-secondary education; 74.1% intend to pursue an undergraduate degree in STEM; and 64.3% intend to pursue a graduate degree in STEM.
	• GEMS increases participants intent to go to college to study STEM (9.7% increase) and intent to take a future internship or apprenticeship in STEM (11% increase).
2,246 AEOP participants were exposed to or participated directly in ongoing DoD research in 2012.	• 525 high school and college students served as apprentices on DoD research projects through SEAP, CQL, and HSAP/URAP.
	• 1614 middle school and high school students as well as 107 near peer mentors and instructors were exposed to DoD research through GEMS.
The AEOP provides participants with frequent exposure to Army S&T and research through hands-on activities that they do not have access to in their regular schools.	• GEMS participants report that they get to participate in hands-on research activities more than once per day during the GEMS program as compared to less than once per week during their regular classes at school.
	• HSAP/URAP, REAP, and SEAP participants report that they participate in hands-on research activities multiple times per week during their AEOP apprenticeship as compared to 2-3 times per month in their regular schools.

[1] *Defense Industry Base (DIB)* – also known as the defense industrial and technological base, refers to a government's academic and industrial assets that are of direct or indirect importance for the production of equipment for a country's armed forces.

AEOP mentors are effective in teaching STEM concepts and motivating participants to pursue STEM research and education.	• 81.4% of HSAP/URAP, REAP, and SEAP participants and 68.5% of National JSHS participants credit their mentors for teaching them concepts fundamental to STEM research.
	• 78.1% of National JSHS participants agree that their mentor helped motive them to pursue STEM research.
	• 72.8% of HSAP/URAP, REAP, and SEAP participants agree that their mentor helped them to formulate their educational goals.
The AEOP provides students from underrepresented groups with tools to achieve their educational goals in STEM.	• 193 high school youth from populations that are historically underrepresented and underserved in STEM participated in UNITE, a pre-collegiate engineering summer initiative that took place at nine universities.
	• UNITE participants agree that they learned about new STEM careers (79.3%) and educational pathways to STEM careers (74.9%).
	• UNITE increases participants confidence in their ability to apply engineering principles to solve real world problems (7.1% increase).
AEOP participants are exposed to Army and DoD STEM careers	• 92.2% of UNITE participants reported that they learned about at least one STEM career in the DoD/Army during their summer program. 74.5% of GEMS participants reported the same.
	• 59.3% of HSAP/URAP, REAP, and SEAP participants report that they learned about new STEM careers within the DoD/Army during their apprenticeship.
	• 82.0% of SEAP apprentices would feel very comfortable taking a civilian job with the DoD because the research is valuable to society.
GOAL 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.	
Outcomes	
• 835 teachers participated in the 2012 AEOP.	
• The AEOP provided online resources to teachers through the eCM and STPI programs.	
• JSS was restructured so that it will be an online resource center for teachers and mentors in 2013.	
• 52 teachers who participated in the STEM Teachers Academy (a program of STPI) received instruction from Army scientists and engineers.	
• The AEOP developed 107 future science educators as near-peer mentors, giving them a firsthand experience implementing inquiry-based teaching methods in the GEMS program	

GOAL 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.
Outcomes
• Virginia Tech provided assessment and evaluation for seven of the AEOP elements in 2012 (JSHS, SEAP, GEMS, REAP, UNITE, STPI, and HSAP/URAP).
• The 2012 AEOP provided outreach to youth in grades 4-12, college students, and teachers.
• The AEOP developed a logo and branding campaign that will be implemented in a comprehensive marketing strategy in 2013.
• The AEOP leveraged millions of dollars in research funding and in-kind support to build a sustainable program infrastructure and implement STEM education programs for students of all ages. Over $3.7 Million in research funding was contributed by Army labs to support SEAP and CQL interns in 2012.
• The AEOP leveraged existing networks of outreach partners to access over 60,000 science educators/administrators/partners through the National Science Teacher Association (NSTA) and 180,000 STEM-interested middle and high school students through the Technology Student Association (TSA).

WHAT AEOP PARTICIPANTS ARE SAYING

- "This GEMS experience was a truly phenomenal experience that helped me decide to pursue a career as, hopefully, an Army research engineer." ~ GEMS Participant, 2012

- "Biomedical mechanical engineering was my favorite topic during UNITE. I enjoyed learning about how math and science can be turned into devices to help the human body. I am pretty positive I want to pursue a career in this field." ~ UNITE Participant, 2012

- "I am so blessed that I had the chance to participate in JSHS at the Regional and National levels this year. The experience was absolutely life-changing, and has reaffirmed my interest in majoring in a STEM field in college. The friends I have made will definitely be a large part of my life now, as I learn about what kinds of research they are working on and the facilities they have access to. It is incredibly encouraging to see adults today from all parts of the country care to such an amazing extent to better help this generation of students in the pursuit of science. I am so grateful I had this opportunity, and thank you again for all of your hard work in putting this event on each year - it means more to me than I can express in words." ~ JSHS Participant, 2012

- "My favorite activity[at the National Judging & Educational Event] was the STEM Tech Expo because it gave me a chance to see all different ways that science is applied to everyday lives of soldiers in our Army, and it also had stations using Biology and Chemistry, my two favorite parts of science." ~eCYBERMISSION Participant, 2012

- "The experience was inspiring. I am now confident that I will enjoy and do well in a research field. SEAP revealed what it was like to work in a lab and to be faced with a problem that you must solve: something I don't think I could have learned anywhere else." ~ SEAP Participant, 2012

- "[My apprentice] is an exceptional student. He is very intelligent and motivated. Importantly, he is curious and has a true thirst for knowledge. He will be a tremendous asset to the US science and engineering enterprise. I recommend this highly gifted student for academic and research fellowships in the future." ~ REAP Mentor, 2012

RECOMMENDATIONS

Evidence collected during the assessment of the 2012 AEOP informs the following recommendations for the future development of the AEOP:

- Assessment data indicates that the AEOP provides participants with hands-on STEM experiences that they do not have access to in their regular schooling environment and that the AEOP is effective at motivating participants to pursue future research and education in STEM. The AEOP provides extracurricular education and support to participants that sparks interest in STEM and identifies pathways through which participants can achieve their STEM education and career goals. Efforts should be made to capture and further replicate and institutionalize the best practices that contribute to this significant achievement.

- There is a considerable differential between the number of applications being considered for AEOP programs and the number of spaces available for participants indicating significant unmet need. In light of the evidence of program success, it is recommended that the Army expand the GEMS, SEAP, REAP, HSAP/URAP, and UNITE initiatives.

  In particular, efforts should be made to ensure that alumni of AEOP initiatives have the opportunity to participate in the next-level AEOP initiative that is available to them. For example, 79% of 2012 GEMs participants expressed interest in participating in advanced levels of the GEMS program. Ideally, space in a GEMS program will exist for all past participants who are interested and qualified. However, based on the number of GEMS applicants that were turned away in 2012 and the fact that advanced GEMS programs do not exist at all laboratory sites, this may be impossible. SEAP and CQL also provide an opportunity for GEMS participants to continue their work in STEM at the Army laboratories (localized STEM pipelines) but the number of available positions in these programs is small relative to the number of GEMS participants. In 2012 there were 796 applicants for 154 SEAP positions and 373 applicants for 274 CQL positions.

  In addition to the high demand for positions in the apprenticeship programs and the GEMS-SEAP-CQL pipeline, it is significant to note that 60 proposals were received in response to the RFP that solicited the 9 UNITE host sites. Institutions as well as individual students and mentors are interested in taking part in the AEOP's STEM outreach efforts.

- One of the AEOP objectives, under the goal of STEM literate citizenry, is to provide students from underserved groups[2] with tools to achieve their educational goals in STEM. What does this mean for the AEOP? In 2012 the UNITE program was dedicated to providing a pre-engineering experience to high school youth from historically underrepresented and underserved groups in STEM (100% of 193

[2] The following populations are considered historically underrepresented and underserved in STEM: African American/ Black, Hispanic, or Native American/Alaskan Native students; students who qualify for free or reduced lunch, attend a Title I school, or be low-income according to Federal TRIO criteria; and women and girls in physical science, computer science, mathematics or engineering.

participants). In 2013, REAP will be realigned with its original intent of providing a nationwide apprenticeship program to students from underrepresented groups[3]. Aside from UNITE and REAP, how do the other AEOP initiatives provide access to participants from underrepresented groups?

According to 2012 assessment data, the AEOP element with the biggest challenge in this area is JSHS. Only 1% of participants in National JSHS identified as being from an underrepresented population. While a common response to this fact is often that the competition process is objective and that we simply do not have participants from underserved populations presenting the best research, we recommend looking beyond this perspective[4]. Factors that may be prohibitive to participation of students from underrepresented populations in the AEOP include: limited access to resources including mentorship, a participant selection or judging process that does not consider resource inequities, and environments in which participants from minority groups do not feel welcome or supported (including lack of role-models).

It is recommended that Army leadership provide guidance to the Consortium on how to interpret the objective of providing outreach to underserved populations amongst the various AEOP elements. Some AEOP initiatives, including the apprenticeship programs, are specifically designed to engage the most talented STEM students. Should administrators charged with selecting participants pay attention to inequities in access to resources and offer acceptance to students who may have the interest but not yet had the opportunity to succeed in STEM? Would the need to provide such students with more instruction, as compared to students with prior access to more resources, take away from mentor interest in participating in the AEOP programs? It may prove a difficult balance to strike.

- 2012 assessment data indicates that AEOP participants intend to pursue careers in STEM. While the AEOP provides participants with information about STEM careers and educational pathways, it is less successful in providing information about STEM careers with the Army. It is recommended that a resource on STEM careers with the Army be created and that it be for use within all AEOP elements. The resource may also serve as a useful electronic resource for teachers to incorporate into their classrooms.

- The cross-promotion of other AEOP initiatives, under the goal of building a sustainable infrastructure for STEM outreach across the Army, has become a recognized priority of all of the AEOP elements. 2012 assessment data indicates that many AEOP participants are largely unaware of other opportunities available to them in the AEOP. Efforts should be made to significantly increase the exposure of participants, local program administrators, and mentors to information about other opportunities in the AEOP portfolio. Specifically, at the culmination of each AEOP experience participants should know what their next-step options are for continued participation in the AEOP.

- The assessment tools utilized in 2012 did not collect evidence to support conclusions about the achievement of the AEOPs goals of STEM savvy educators and a sustainable infrastructure. Consortium members should review program objectives to ensure that these goals and the affiliated objectives are being addressed by in 2013. The 2013 assessment strategy should incorporate measures that will yield measurable outcomes toward goal achievement.

  Notably the AEOP currently does not include outreach to youth in grades K-3 and there is no current competitive application process for new initiatives. The Consortium should engage with Army leadership to investigate the possibility of establishing programs and procedures to meet these AEOP objectives.

[3] 21% of 2012 REAP participants who responded to the assessment questionnaire identified as being a member of a historically underserved or underrepresented population in STEM.
[4] See the 2012 National JSHS Evaluation Report for a full list of recommendations specific to that program.

FY12 EVALUATION

This report summarizes the FY12 evaluation of the AEOP elements. Eight individual program reports[5] are available under separate cover. The executive summaries for these reports are contained in the appendices of this document.

The evaluation was performed by Virginia Tech, the Lead Organization (LO) in the AEOP CA consortium. This report includes a program overview, the assessment strategy, and outcomes. The final section offers evidence-based recommendations intended to inform decision-making regarding future program development.

2012 AEOP OVERVIEW

The 2012 portfolio of AEOP initiatives is outlined in Table 3 below. The table includes the number of 2012 applicants and participants organized by program. There were 53,408 participants in the 2012 AEOP. Participation numbers are summarized in Table 4.

Table 3. 2012 AEOP Initiatives	
Army Awards Program (AAP)	
Description	Provides awards and judges at local, state, and ISEF science fairs.
Population	High School
No. of 2012 Awards	1,209
College Qualified Leaders (CQL)	
Description	Apprentice program at Army and DoD laboratories.
Population	College Undergraduate
No. of 2012 Applicants	373
No. of 2012 Participants	274
Placement Rate	73%
eCYBERMISSION (eCM)	
Description	Web-based STEM competition.
Population	6th-9th Grades
No. of 2012 Participants	16,096 Total (15,406 Students, 690 Advisors)
No. of 2012 Volunteers	1,773
Gains in the Education of Mathematics & Science (GEMS)	
Description	Hands-on summer program in Army laboratories.
Population	5th-12th Grade Students and College Undergraduate Near-Peer Mentors
No. of 2012 Applicants	2,755 Students
No. of 2012 Participants	1,722 Total (1,614 Students, 63 Near-Peer Mentors, 45 Teachers)
Placement Rate	56%

[5] FY12 assessment efforts included the evaluation of the following AEOP elements: Gains in the Education of Mathematics & Science (GEMS, Appendix A), the High School Apprenticeship Program / Undergraduate Research Apprenticeship Program (HSAP/URAP, Appendix B), the Junior Science & Humanities Symposium (JSHS) Regional Symposia (Appendix C), the Junior Science & Humanities Symposium (JSHS) National Event (Appendix D), the Research & Engineering Apprenticeship Program (REAP, Appendix E), the Science & Engineering Apprenticeship Program (SEAP, Appendix F), the Science Teachers Program Initiatives (STPI, Appendix G), and UNITE (Appendix H).

High School Apprenticeship Program (HSAP)/ Undergraduate Research Apprenticeship Program (URAP)	
Description	Apprentice program in Army-funded labs at colleges or universities nationwide.
Population	High School and College Undergraduate
No. of 2012 Applicants	290
No. of 2012 Participants	97 Total (28 HSAP, 69 URAP)
Placement Rate	33%
Junior Science & Humanities Symposium (JSHS)	
Description	Nationwide research competition that includes 48 regional events.
Population	High School
No. of 2012 Participants	8,448 Total (8,400 Students, 48 Teacher Awards)
Junior Solar Sprint (JSS)	
Description	Online resource center for teachers/mentors that supports an online solar car competition for 4th-8th grade students.
Population	Teachers, Mentors, 4th-8th Grade Students
No. of 2012 Participants	Transitional year for program. Provided honorariums to support 9 races in the NE.
Research & Engineering Apprenticeship Program (REAP)	
Description	Apprentice program at colleges or universities.
Population	High School
No. of 2012 Applicants	1,500+
No. of 2012 Participants	131
Placement Rate	9%
Science & Engineering Apprentice Program (SEAP)	
Description	Apprentice program at Army and DoD laboratories.
Population	High School
No. of 2012 Applicants	796
No. of 2012 Participants	154
Placement Rate	19%
STEM Teacher Program Initiatives (STPI)	
Description	STEM professional development initiatives for teachers.
Population	Teachers (Harford and Cecil Counties, Maryland)
No. of 2012 Participants	52

UNITE	
Description	Pre-collegiate, engineering summer program at university host sites for students from groups historically underserved and under-represented in STEM.
Population	High School
No. of 2012 Applicants	420
No. of 2012 Participants	193
Placement Rate	46%
West Point Bridge Design Contest (WPBDC)	
Description	Online bridge design competition and engineering experience.
Population	Age 13 - Grade 12
No. of 2012 Participants	25,032

Table 4. 2012 AEOP Participation

AEOP Element		2012 Participants
AAP	Army Awards Program	1,209
CQL	College Qualified Leaders	274
eCM	eCYBERMISSION	16,096
GEMS	Gains in the Education of Mathematics & Science	1,722
HSAP/ URAP	High School Apprenticeship Program / Undergraduate Research Apprenticeship Program	97
JSHS	Junior Science & Humanities Symposium	8,448
JSS	Junior Solar Sprint	N/A*
REAP	Research & Engineering Apprenticeship Program	131
SEAP	Science & Engineering Apprentice Program	154
STPI	STEM Teacher Program Initiatives	52
UNITE	UNITE	193
WPBC	West Point Bridge Design Contest	25,032
	Total 2012 AEOP Participants	**53,408**

* 2012 was a transitional year for Junior Solar Sprint.

In 2012, the Army's vision for the AEOP was revised to include the goals and objectives presented in Table 5. The 2012 evaluation focused on AEOP's first goal of STEM Literate Citizenry.

Table 5. AEOP Goals and Objectives

GOAL 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.

GOAL 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.
GOAL 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.

ASSESSMENT STRATEGY

Virginia Tech assessed seven[6] of the 2012 AEOP elements in collaboration with AEOP CA consortium members[7], individual program administrators (IPAs), the Army Cooperative Agreement Managers (CAMs), Army Subject Matter Experts (ASMEs), and personnel responsible for implementing programs at specific sites (Lab Coordinators, etc.) The 2012 assessment strategy established baseline evaluations for some AEOP elements and built on assessments performed in 2011 for others. All assessments were approved by Virginia Tech's Internal Review Board (IRB) for the protection of human research subjects.

The 2012 AEOP assessment strategy is summarized in Table 6. Evaluations were performed on the GEMS, HSAP/URAP, REAP, SEAP, and UNITE programs as well as both the JSHS Regional Symposia and the JSHS National Event. The evaluation of STPI focused on its 2012 STEM Teacher Academy (STA). Most evaluations utilized participant questionnaires. Both the GEMS and UNITE assessments involved pre-program and post-program participant questionnaires to enable the measurement of participant growth through the program. Assessments of the AEOP apprenticeship programs (HSAP/URAP, REAP, and SEAP) incorporated mentor questionnaires and rubrics used by mentors to measure participant knowledge and ability levels. The assessment of the JSHS Regional Symposia was based on data obtained through the structured interviews and survey of JSHS Regional Directors.

[6] The following AEOP initiatives were included in Virginia Tech's 2012 evaluation plan: GEMS, HSAP/URAP, JSHS (National Event and Regional Symposia), REAP, SEAP, STPI, and UNITE. An evaluative report on 2012 eCYBERMISSION was prepared by Booz Allen Hamilton for the Army in 2012.

[7] The 2012 AEOP CA consortium members included the Academy of Applied Science (AAP, JSHS, REAP), George Washington University (CQL, GEMS, SEAP), the Technology Student Association (JSS, UNITE), and the University of New Hampshire (STPI). The National Science Teachers Association (NSTA) and the American Society for Engineering Education (ASEE) were identified through competitive RFP processes and joined the Consortium as the new program administrators of eCYBERMISSION (NSTA) and CQL, GEMS, and SEAP (ASEE) beginning in FY2013. HSAP/URAP is managed by the Army Research Office.

Table 6. 2012 AEOP Assessment Strategy		
AEOP Element	**Assessment Tools**	**Program-Level Outcomes**
GEMS	<u>Program Evaluation:</u> • Pre-program participant questionnaire • Post-program participant questionnaire	• GEMS nurtures interest and excitement in STEM for middle and high school participants. • GEMS nurtures interest and excitement in STEM for mentor and teacher participants. • GEMS successfully implements STEM enrichment experiences that are hands-on, inquiry-based educational modules that enhance in-school learning. • GEMS increases participant knowledge in targeted STEM areas and laboratory skills. • GEMS provides STEM outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM. • GEMS encourages participants to pursue secondary and post-secondary education in STEM. • GEMS educates participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories • GEMS provides information to participants about opportunities for STEM enrichment through advancing levels of GEMS. The program is not as successful in providing information about other AEOP initiatives
HSAP/URAP	<u>Program Evaluation:</u> • Participant questionnaire • Mentor questionnaire and rubrics	• HSAP/URAP provides hands-on research experiences to high school and undergraduate participants. • The assessment was inconclusive in determining if HSAP/URAP is successful at educating participants about the Army's interest and investment in science. • HSAP/URAP fosters mentorship by a university researcher. • HSAP/URAP inspires participants to continue pursuit of STEM interests.

JSHS	<u>Regional Symposia Evaluation:</u> • Regional Director structured interview • Regional Director questionnaire	• Critical resources for administration of regional JSHS symposia include: funding from the Army, Navy & Air Force, support from a university partner, and strategic partnerships with non-university organizations. • JSHS has limited success at achieving diversity at regional events. • Participants in Regional JSHS receive value from the experience even if they do not advance to the JSHS National Event.
	<u>National Symposium Evaluation:</u> • Post-symposium participant questionnaire	• National JSHS is successful in providing outreach to an even distribution of males and females. It does not provide outreach to a representative population from groups historically underserved and underrepresented in STEM. • National JSHS provides outreach to the Nation's future STEM workforce. • National JSHS is successful at fostering development in critical skills for STEM research among participants. • National JSHS expands the horizons of research-oriented students by exposing them to opportunities in the academic, industrial, and governmental communities. • Participants value and are motivated by interactions with like-minded peers at National JSHS. • National JSHS participants receive a high level of support and motivation from their research mentors. • Participants express a high level of satisfaction with National JSHS.
REAP	<u>Program Evaluation:</u> • Participant questionnaire • Mentor questionnaire and rubric	• REAP motivates participants towards a career in STEM. • REAP expands participants' background and understanding of STEM research. • REAP engages participants in the philosophy and objectives of scientific research. • REAP exposes participants to science experiences not readily available in high school. • REAP introduces participants to the real world of research in STEM. • REAP partners participants with faculty mentors to support current and future professional growth and development.

SEAP	<u>Program Evaluation:</u> • Participant questionnaire • Mentor questionnaire and rubric	• SEAP nurtures interest and excitement in STEM for high school participants. • SEAP provides STEM outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM. • SEAP increases participant knowledge in targeted STEM areas and develops participant research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research (poster, paper, oral presentation, etc.). • SEAP encourages participants to pursue post-secondary education in STEM. • SEAP educates participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories. • SEAP acquaints participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community. • SEAP has limited success in providing information to participants about opportunities for STEM enrichment through the Junior Science & Humanities Symposium (JSHS), College Qualified Leaders (CQL), and other AEOP opportunities.
STPI	<u>STEM Teacher's Academy (STA) Evaluation:</u> • Post-program participant questionnaire	• STA content, activities, and presentations will be adapted to lesson plans and teaching in participant classrooms. • STA encouraged participants to seek out collaborations with other teachers and STEM professionals. • STA provided participants with the content and confidence to develop professional development activities for their schools. • STA participants intend to use STA content to lead energy and environmental literacy initiatives within their schools. • STA increased the energy and environmental literacy of participants. • STA had limited success in increasing the visibility of AEOPs to participants.

UNITE	Program Evaluation: • Pre-program participant questionnaire • Post-program participant questionnaire	• UNITE effectively shows participants the real-world applications of math and science. • UNITE raises participant confidence in the ability to participate in engineering activities. • UNITE inspires participants to consider engineering majors in college by providing participants with an understanding of what it means to work as an engineer, illustrating pathways to engineering, and establishing support systems. • UNITE works to remove social barriers and negative attitudes about engineering. While students experience an increase in motivation they also experience an increase in disengagement. • UNITE promotes collaboration and problem-solving in a team environment. • UNITE works to increase the number of STEM graduates to fill the projected shortfall of scientists and engineers in national and Department of Defense (DoD) careers. • UNITE exposes participants to STEM careers in the Army and DoD.

Participant, mentor, and Regional Director questionnaires were provided in paper-and-pencil and/or electronic format utilizing the Qualtrics© survey software system hosted by Virginia Tech. The structured interviews of JSHS Regional Directors took place at the 2012 National JSHS event. All data entry and analysis was performed by the Virginia Tech AEOP evaluation team.

OUTCOMES

The outcomes from the 2012 evaluations of the selected AEOP elements are grouped according to AEOP goal and objective.

GOAL ONE: STEM LITERATE CITIZENRY

Most program outcomes in 2012 provided evidence of the AEOPs success at contributing to the first goal, a STEM literate citizenry. Specific outcomes to support the achievement of this AEOP goal along with the evidence that informs the outcomes are presented in Table 7.

Table 7. 2012 Outcomes - STEM Literate Citizenry

The AEOP provided outreach to approximately 53,408 participants in 2012.	
AEOP Element	**Evidence Supporting the AEOP-Level Outcome**
AEOP-Wide	• 52,573 students participated in the 2012 AEOP.
	• 835 teachers and mentors participated in the 2012 AEOP.
	• 17 Army laboratories or installations and 111 American universities or colleges hosted AEOP participants in 2012.
	• The AEOP received applications from many more qualified participants than it could serve in 2012: GEMS - 2,755 applications received for 1,614 positions; SEAP-796 applications received for 154 positions; CQL -373 applications received for 274 positions; and REAP received more than 1500 applications for 131 positions.

AEOP participants have education and career aspirations in STEM.	
AEOP- Wide	• 99.4% of AEOP high school participants intend to pursue post-secondary education; 74.1% intend to pursue an undergraduate degree in STEM; and 64.3% intend to pursue a graduate degree in STEM.
GEMS	• GEMS increases participant intent to pursue further STEM education, activities, and careers (pre-program avg. 4.84/6.00, post-program avg. 5.00/6.00; difference of 0.16). • GEMS increases participants' intent to go to college to study STEM (9.7% increase) and intent to take a future internship or apprenticeship in STEM (11% increase).
HSAP/ URAP	• 100% of participants intend to pursue a college degree in a STEM field, 96% intend to pursue an advanced STEM. • 100% of URAP participants were enrolled as STEM majors in college. • HSAP participants are confident that they will attend college to pursue their degree of choice (avg. 5.83/6.00) and that they will overcome any obstacles between themselves and their desired degree (avg. 5.48/6.00). • Participants are highly certain that they will apply for (avg. 5.65/6.00), get jobs (avg. 5.57/6.00), and build careers (avg. 5.61/6.00) around STEM.
JSHS	• 89% of National JSHS participants intend to pursue a college degree in a STEM field and 84% plan to pursue an advanced STEM degree. • 92% of National JSHS participants intend to pursue a career in a STEM field. Careers in medicine/health (36%), life science (19%), and engineering (16%) were chosen most frequently.
REAP	• 79% of REAP participants plan to pursue at least a bachelor's degree in STEM and 71% intend to complete an advanced degree in a STEM field. • Participants are confident that they will attend college to pursue their desired degree (avg. 5.71/6.00) and that they will finish their desired degree (avg. 5.43/6.00). • REAP participants intend to pursue STEM careers (avg. 5.29/6.00). • REAP mentors believe that participants are interested in pursuing STEM careers (avg. 5.25/6.00) and that participants have the motivation necessary to be successful in STEM careers (avg. 5.79/6.00).
SEAP	• 92% of SEAP participants intend to pursue bachelor's-or higher-level, degrees within STEM fields while 68% intend to pursue a graduate degree in STEM. • Participants are confident that they will achieve their educational goals; attend college to pursue their desired degree (avg. 5.71/6.00), finish their desired degree (avg. 5.43/6.00), get good grades in class (avg. 5.36/6.00). • Participants report interest in the STEM & DoD-STEM jobs/careers that they learned about (avg. 3.90/6.00 and 4.02/6.00, respectively). • SEAP mentors report that participants were interested in pursuing STEM careers (avg. 4.59/6.00) and, to a lesser extent, DoD STEM careers (avg. 3.85/6.00). • 79% of participants report being interested in applied research fields (i.e., chemistry, engineering, technology, medical) while others report being interested in academic research (12%) or service careers (9%).
UNITE	• More UNITE participants plan to major in engineering in college (pre-program avg. 3.89/6.00; post-program avg. 4.04/6.00), and work in engineering for their career (pre-UNITE avg. 3.79/6.00; post-UNITE avg. 3.96/6.00) after participating in UNITE. • Participants intend to pursue a bachelor's degree (93%) and many intend to pursue advanced degrees (77%). The majority of UNITE participants intend to pursue their degrees in STEM fields (57%)

2,246 AEOP participants were exposed to or participated directly in ongoing DoD research in 2012.	
AEOP- Wide	• 525 high school and college students served as apprentices on DoD research projects through SEAP, CQL, and HSAP/URAP.
	• 1,614 middle school and high school students as well as 107 near peer mentors and instructors were exposed to DoD research through GEMS.
The AEOP provides participants with frequent exposure to hands-on research activities that they do not have access to in their regular schools.	
GEMS	• GEMS participants report that they get to participate in hands-on research activities more than once per day during the GEMS program as compared to less than once per week during their regular classes at school. • GEMS engages participants in the following activities 4-5 times per week: observe teachers performing an experiment and take notes; go through the procedure of a pre-determined experiment or activity and then use a workbook to answer questions; and conduct an experiment from a set of instructions but get to create a hypothesis and independently draw conclusions. Participants report that they experience the same activities once every two weeks in their schools
HSAP/ URAP	• Participants engaged in scientific reasoning activities and in laboratory research activities more than once every two weeks. Participants reported using proper safety procedures, cleaning and caring for lab equipment, and using advanced science or engineering equipment multiple times per week or more. • HSAP participants engaged in critical research activities during HSAP (avg. 4.62/6.00) much more frequently than in their high school classes (avg. 3.29/6.00, difference of 1.34). • Participants were exposed to critical university research experiences including advanced scientific projects (avg. 5.30/6.00) and scientific research that will have a real-world impact (avg. 5.26/6.00).
REAP	• According to mentors, REAP participants engaged in the following STEM research activities more than three times per week: organized and handled data, observed an experiment, analyzed experimental data, used advanced laboratory equipment, designed their own experiments, and created their own hypotheses and conclusions. • Participants engaged in team research, academic research activities, synthesizing academic information, and evaluating academic information more than once per week during REAP. • Participants used advanced science/engineering equipment, cared for equipment, used proper safety procedures, and employed advanced measurement techniques more than once per week during REAP
SEAP	• Participants engaged in scientific reasoning activities more than 2-3 times per month (avg. 3.64/6.00) and engaged in hands-on research activities more than once per week (avg. 4.17/6.00). Participants engage in the same activities less often during their regular school experiences (avg. 2.99/6.00 and 3.22/6.00 respectively).

AEOP mentors are effective in teaching STEM concepts and motivating participants to pursue STEM research and education.	
GEMS	• Participants believe that GEMS instructors take a real interest in participant learning (avg. 5.40/6.00), are easy to learn from (avg. 5.28/6.00), encourage participants to ask questions (avg. 5.25/6.00), and explain difficult concepts very well (avg. 5.16/6.00). • Participants believe that GEMS instructors are excited to do hands-on activities (avg. 5.42/6.00), enjoy hands-on activities as much or more than participants (avg. 4.98/6.00). • Participants like to learn from instructors because the instructors are just as interested and excited as the students (avg. 5.27/6.00)
HSAP/ URAP	• Participants believe that their mentors motivated them to pursue careers in STEM (avg. 5.39/6.00) and spoke with them about their future education and career goals (avg. 5.30/6.00). • Mentors provided participants with professional development by helping them clarify goals (avg. 4.91/6.00) and advising them on the necessary steps to achieve them (avg. 4.91/6.00). • Mentors taught participants about professional and educational networks (avg. 4.57/6.00) and exposed them to professional organizations (avg. 4.09/6.00). • Participants reported that their mentor will either write or help them obtain letters of reference (avg. 4.91/6.00) and that their mentor helped them craft their résumé (avg. 3.96/6.00). • Mentors helped participants develop scientific research skills and abilities by encouraging them to perform a variety of tasks in the lab (avg. 5.30/6.00), to perform research (avg. 5.30/6.00), teaching them to work more effectively in the lab (avg. 5.13/6.00), and helping them become better writers of scientific research (avg. 5.04/6.00). • 83% of HSAP/URAP respondents “somewhat agree”, “agree”, or “strongly agree” that they frequently worked with their mentor in the laboratory.
JSHS	• National JSHS participants perceived a uniformly high level of support from their mentors. Participants reported that their mentors helped motivate them (avg. 5.12/6.00), they learned more from their mentors than they did from their high school experience (avg. 5.10/6.00), and their mentors were critical to their success at JSHS (avg. 4.75/6.00). • 78% of National JSHS participants agree that their mentor helped motive them to pursue STEM research. • National JSHS participants indicated that their mentors provided them with tangible support in the form of access to equipment or letters of reference, non-tangible support in the form of guidance, inspiration, and motivation, and valuable knowledge and clarification with scientific reasoning. • 93% of Regional Directors agree that mentorship and/or adult support is critical to the success of JSHS participants. • Regional Directors help to facilitate mentorship for participants by cultivating relationships with available mentors and/or creating a mentor database, forming strategic partnerships with organizations that provide mentorship, and/or providing participants with electronic access to volunteer graduate students or researchers.

REAP	• REAP participants believe their mentors motivated them to pursue a STEM career (avg. 5.29/6.00). • REAP mentors report that they came to know about participant career and educational goals (avg. 4.92/6.00) that they attempted to educate participants about STEM career pathways (avg. 4.79/6.00), but agreed less that they provided participants with information on STEM careers with the Army (avg. 2.77/6.00). • Participants report that their mentors encouraged them to perform lab tasks (avg. 5.14/6.00), taught them to work effectively in a laboratory (avg. 5.07/6.00), helped them formulate their educational goals (avg. 5.00/6.00), helped them become a better writer or scientific research (avg. 4.86/6.00), and frequently worked with them in the laboratory (avg. 4.79/6.00).
SEAP	• Participants report that their mentors helped them become better researchers, encouraged and/or inspired them to pursue future research, education, and careers in STEM (avg. 4.89/6.00).
The AEOP provides students from underrepresented groups with tools to achieve their educational goals in STEM. Some AEOP elements are more effective at this than others.	
GEMS	• The 2012 GEMS program provided outreach to a diverse population. 25% of participants were from racial/ethnic groups that have been historically underrepresented and underserved in STEM. 11% of participants qualify for free or reduced lunch - another population that is underrepresented and underserved in STEM
HSAP/ URAP	• 17% of participants in 2012 HSAP/URAP identified as being from groups that are historically underrepresented and underserved in STEM.
JSHS	• 1% of National JSHS participants are from groups that are historically underrrepresented and underserved in STEM. • 45% of Regional Directors report successfully achieving race/ethnic diversity among participants, 33% report successfully achieving geographic diversity, and 23% report successfully achieving socio-economic status (SES) diversity.
REAP	• 21% of REAP participants report that they are from groups that are historically underrepresented and underserved in STEM. 14% report that they qualify for free or reduced lunch at school
SEAP	• 10% of SEAP participants 16% of mentors are from groups that are historically underrrepresented and underserved in STEM.
UNITE	• 193 high school youth (100% of program participants) from populations that are historically underrepresented and underserved in STEM participated in UNITE, a pre-collegiate engineering summer initiative that took place at 9 host sites. • UNITE participants agree that they learned about new STEM careers (79%) and educational pathways to STEM careers (75%). • UNITE increases participants confidence in their ability to apply engineering principles to solve real world problems (7% increase).
AEOP participants are exposed to Army and DoD STEM careers	
eCM	• Throughout the eCM competition cycle, eCM provides an opportunity for students and teachers to engage with Army scientists and engineers as virtual CyberGuides (technical consultants) to assist with questions relative to their projects. • The eCM National Judging and Education Event (NJ&EE) included a STEM Tech Expo which provided participants with insight into a variety of Army STEM careers and opportunities.

GEMS	• Participants learn about 3.79 STEM careers and 2.61 careers with the Army laboratories during the GEMS program. • 75% of GEMS participants reported that they learned about at least one STEM career in the DoD/Army during their summer program. • Participants at sites hosted by Army-affiliated installations report more frequent exposure to both STEM careers (onsite avg. 4.09, off-site avg. 3.08) and Army laboratory careers (on-site avg. 3.30, off-site avg. 0.97) than do those who attend programs hosted outside of the sponsoring Army installation
HSAP/ URAP	• Participants report that their mentors educated them about STEM careers (avg. 4.96/6.00) and taught them about STEM careers that are sponsored by the Army (avg. 4.30/6.00). • Participants express great certainty that they will build their career around their STEM skills (avg. 5.61/6.00) but only moderate levels of certainty that they will pursue a STEM job with the Army (avg. 3.04/6.00) or build a STEM career with the Army (avg. 2.87/6.00).
JSHS	• National JSHS participants report that the invited speakers taught them the value of pursuing DoD or service careers in STEM (avg. 4.16/6.00). • National JSHS participants report that lab showcases and DoD exhibits challenged their previous assumptions about DoD/government work (avg. 4.55/6.00), motivated them to explore DoD career options (avg. 4.01/6.00), and educated them about educational opportunities offered by the DoD (avg. 4.84/6.00)
REAP	• Participants intend to pursue STEM careers (avg. 5.29/6.00) but they are uncertain if they will pursue STEM jobs (avg. 2.86/6.00) or STEM careers with the Army or DoD (avg. 2.79/6.00). • Mentors agree that they attempted to educate participants on STEM career pathways (avg. 4.79/6.00) but agreed less that they provided participants with information on STEM careers with the Army (avg. 2.77/6.00). Participants echoed that sentiment, agreeing at a low rate that their mentor taught them about STEM careers sponsored by the Army (avg. 3.43/6.00)
SEAP	• Participants report that they learned about STEM careers (avg. 4.76/6.00) and DoD STEM careers (avg. 4.68/6.00) during SEAP. • Participants report interest in the STEM careers (avg. 3.90/6.00) and DoD careers (avg. 4.02/6.00) that they learned about during SEAP. Mentors also report that participants were interested in pursuing STEM careers (avg. 4.59/6.00) and, to a lesser extent, DoD STEM careers (avg. 3.85/6.00). • 82% of SEAP apprentices would feel very comfortable taking a civilian job with the DoD because the research is valuable to society. • 80% of mentors affirmed that they educated their apprentice about different STEM careers within the DoD and 70% affirmed that they provided information to their apprentice about civilian research programs within the DoD.
UNITE	• On average, participants indicated that they learned about 4.28 STEM careers in the Army and DoD during UNITE. • 92% of UNITE participants reported that they learned about at least one STEM career in the DoD/Army during their summer program.

GOAL TWO: STEM SAVVY EDUCATORS

Several AEOP initiatives engage and/or provide resources to teachers. Specific outcomes to support the achievement of the AEOP goal, STEM Savvy Educators, along with the evidence that informs the outcomes are presented in Table 8.

Table 8. 2012 Outcomes - STEM Savvy Educators	
835 teachers participated in the 2012 AEOP	
AEOP Element	**Evidence Supporting the AEOP-Level Outcome**
AEOP-Wide	• Teachers participated in the following 2012 AEOP initiatives: eCM (690 teacher-participants), GEMS (45 teacher-participants), JSHS (48 teacher awards), and STPI (52 teacher-participants). Many addition teachers participated in AEOP initiatives as student research mentors and volunteers.
eCM	• 690 Team Advisors, consisting mostly of school teachers, registered and participated in the 2012 eCM program. 50% of the previous year's Team Advisors participated in the 2012 program.
STPI	• 52 teachers who participated in the STEM Teacher Academy (a program of STPI) received professional development credits for participation in the program.
The AEOP provides online STEM resources to support teachers.	
eCM	• Online resources were provided to Team Advisors in the form of Mission Folder Tips and Interactive Webinars. Subjects included investigative techniques, constructing hypotheses, writing a scientific survey, and the engineering design process.
JSS	• JSS was restructured to be an online resource center for teachers and mentors in 2013.
STPI	• Participants in the 2012 STEM Teacher Academy received access to ongoing online support and teaching resources.
The AEOP provides professional development for teachers through direct instruction from Army scientists and engineers.	
STPI	• Participants in the STEM Teacher Academy received instruction in STEM from Army scientists and engineers, intended for transfer to future classroom application.
The AEOP develops future science educators.	
GEMS	• 63 Near-Peer mentors and 45 instructors were developed as science educators through first-hand experience implementing inquiry-based teaching methods in the GEMS program.
The 2012 AEOP provided direct mentorship to 382 participants.	
CQL	• Army scientists provided mentorship to 274 CQL apprentices in 2012.
HSAP/URAP	• HSAP/URAP mentors from 53 Army-funded university laboratories hosted 97 participants for a summer research apprenticeship.
REAP	• REAP mentors from 52 universities hosted 131 participants for a summer research apprenticeship.
SEAP	• Army scientists within 12 laboratory sites provided mentorship to 154 SEAP apprentices.

GOAL THREE: SUSTAINABLE INFRASTRUCTURE

While efforts have been made in the Consortium to support the development of a sustainable infrastructure for STEM outreach across the Army, the evaluation of such efforts was not the focus of the 2012 assessment strategy. Table 9 provides a brief overview of achievements that have been made within the Consortium in 2012 in support of sustainable infrastructure.

Table 9. 2012 Outcomes - Sustainable Infrastructure	
Seven of the AEOP elements were evaluated in 2012	
AEOP Element	**Evidence Supporting the AEOP-Level Outcome**
AEOP-Wide	• Virginia Tech provided assessment and evaluation for seven of the AEOP elements in 2012 (JSHS, SEAP, GEMS, REAP, UNITE, STPI, and HSAP/URAP).
The 2012 AEOP provided outreach to youth in grades 4-12, college students, and teachers.	
The AEOP developed a logo and branding campaign that will be implemented in a comprehensive marketing strategy in 2013.	

DISCUSSION & RECOMMENDATIONS

The assessment of the 2012 AEOP yielded significant evidence to support the achievement AEOP goal of a STEM literate citizenry and its objectives. While the AEOP portfolio provided engagement for teachers in 2012, insufficient evidence, beyond the number of teachers served and the detailed evaluation of STPI's STEM Teacher Academy, is available to draw meaningful conclusions about the achievement of the second AEOP goal, STEM savvy educators. The third AEOP goal, the development of sustainable infrastructure for STEM outreach across the Army, was not a focus of the 2012 assessment strategy. No conclusions about its achievement can be drawn based on the available data set.

The findings of the 2012 AEOP evaluation point to the importance of formulating an assessment strategy and designing assessment tools that will yield data that speaks to the achievement of AEOP as well as individual program objectives. This was a particular challenge in 2012 because the AEOP goals and objectives were revised and clarified after evaluation efforts were in place. The 2013 AEOP assessment effort will yield data that will enable conclusions to be drawn about all three AEOP goals as the strategy and tools (focus groups, questionnaires, interviews, etc.) will be designed around them.

The reader is encouraged to review the eight individual evaluation reports that have been prepared on the 2012 AEOP elements. The executive summaries of these reports, which include program-level outcomes and recommendations, are included in Appendices A through H of this document. In general, assessments revealed a high level of success with each of the programs.

The recommendations that follow are in response to the summative outcomes presented in this report and should be considered as applying to the AEOP portfolio at large.

- Assessment data indicates that the AEOP provides participants with hands-on STEM experiences that they do not have access to in their regular schooling environment and that the AEOP is effective at motivating participants to pursue future research and education in STEM. The AEOP provides extracurricular education and support to participants that sparks interest in STEM and identifies pathways through which participants can achieve their STEM education and career goals. Efforts should be made to capture and further replicate and institutionalize the best practices that contribute to this significant achievement.

- There is a considerable differential between the number of applications being considered for AEOP programs and the number of spaces available for participants indicating significant unmet need. In light of the evidence of program success, it is recommended that the Army expand the GEMS, SEAP, REAP, HSAP/URAP, and UNITE initiatives.

  In particular, efforts should be made to ensure that alumni of AEOP initiatives have the opportunity to participate in the next-level AEOP initiative that is available to them. For example, 79% of 2012 GEMS participants expressed interest in participating in advanced levels of the GEMS program. Ideally, space in

a GEMS program will exist for all past participants who are interested and qualified. However, based on the number of GEMS applicants that were turned away in 2012 and the fact that advanced GEMS programs do not exist at all laboratory sites, this may be impossible. SEAP and CQL also provide an opportunity for GEMS participants to continue their work in STEM at the Army laboratories (localized STEM pipelines) but the number of available positions in these programs is small relative to the number of GEMS participants. In 2012 there were 796 applicants for 154 SEAP positions and 373 applicants for 274 CQL positions.

In addition to the high demand for positions in the apprenticeship programs and the GEMS-SEAP-CQL pipeline, it is significant to note that 60 proposals were received in response to the RFP that solicited the 9 UNITE host sites. Institutions as well as individual students and mentors are interested in taking part in the AEOP's STEM outreach efforts.

- One of the AEOP objectives, under the goal of STEM literate citizenry, is to provide students from underserved groups[8] with tools to achieve their educational goals in STEM. What does this mean for the AEOP? In 2012 the UNITE program was dedicated to providing a pre-engineering experience to high school youth from historically underrepresented and underserved groups in STEM (100% of 193 participants). In 2013, REAP will be realigned with its original intent of providing a nationwide apprenticeship program to students from underrepresented groups[9]. Aside from UNITE and REAP, how do the other AEOP initiatives provide access to participants from underrepresented groups?

  According to 2012 assessment data, the AEOP element with the biggest challenge in this area is JSHS. Only 1% of participants in National JSHS identified as being from an underrepresented population. While a common response to this fact is often that the competition process is objective and that we simply do not have participants from underserved populations presenting the best research, we recommend looking beyond this perspective[10]. Factors that may be prohibitive to participation of students from underrepresented populations in the AEOP include: limited access to resources including mentorship, a participant selection or judging process that does not consider resource inequities, and environments in which participants from minority groups do not feel welcome or supported (including lack of role-models).

  It is recommended that Army leadership provide guidance to the Consortium on how to interpret the objective of providing outreach to underserved populations amongst the various AEOP elements. Some AEOP initiatives, including the apprenticeship programs, are specifically designed to engage the most talented STEM students. Should administrators charged with selecting participants pay attention to inequities in access to resources and offer acceptance to students who may have the interest but not yet had the opportunity to succeed in STEM? Would the need to provide such students with more instruction, as compared to students with prior access to more resources, take away from mentor interest in participating in the AEOP programs? It may prove a difficult balance to strike.

- Assessment data indicates that AEOP participants intend to pursue careers in STEM. While the AEOP provides participants with information about STEM careers and educational pathways, it is less successful in providing information about STEM careers with the Army. It is recommended that a resource on STEM careers with the Army be created and that it be for use within all AEOP elements. The resource may also serve as a useful electronic resource for teachers to incorporate into their classrooms.

[8] The following populations are considered historically underrepresented and underserved in STEM: African American/ Black, Hispanic, or Native American/Alaskan Native students; students who qualify for free or reduced lunch, attend a Title I school, or be low-income according to Federal TRIO criteria; and women and girls in physical science, computer science, mathematics or engineering.

[9] 21% of 2012 REAP participants who responded to the assessment questionnaire identified as being a member of a historically underserved or underrepresented population in STEM.

[10] See the 2012 National JSHS Evaluation Report for a full list of recommendations specific to that program.

- The cross-promotion of other AEOP initiatives, under the goal of building a sustainable infrastructure for STEM outreach across the Army, has become a recognized priority of all of the AEOP elements. 2012 assessment data indicates that many AEOP participants are largely unaware of other opportunities available to them in the AEOP. Efforts should be made to significantly increase the exposure of participants, local program administrators, and mentors to information about other opportunities in the AEOP portfolio. Specifically, at the culmination of each AEOP experience participants should know what their next-step options are for continued participation in the AEOP.

- The assessment tools utilized in 2012 did not collect evidence to support conclusions about the achievement of the AEOPs goals of STEM savvy educators and a sustainable infrastructure. Consortium members should review program objectives to ensure that these goals and the affiliated objectives are being addressed by in 2013. The 2013 assessment strategy should incorporate measures that will yield measurable outcomes toward goal achievement.

  Notably the AEOP currently does not include outreach to youth in grades K-3 and there is no current competitive application process for new initiatives. The Consortium should engage with Army leadership to investigate the possibility of establishing programs and procedures to meet these AEOP objectives.

APPENDICES

Appendix A: Gains in the Education of Mathematics & Science (GEMS) FY12 Evaluation – Executive Summary

Appendix B: High School Apprenticeship Program (HSAP) / Undergraduate Research Apprenticeship Program (URAP) FY12 Evaluation - Executive Summary

Appendix C: Junior Science & Humanities Symposium (JSHS) Regional Symposia FY12 Evaluation – Executive Summary

Appendix D: Junior Science & Humanities Symposium (JSHS) National Event FY12 Evaluation - Executive Summary

Appendix E: Research & Engineering Apprentice Program (REAP) FY12 Evaluation - Executive Summary

Appendix F: Science & Engineering Apprentice Program (SEAP) FY12 Evaluation - Executive Summary

Appendix G: Science Teacher Program Initiatives (STPI) FY12 Evaluation - Executive Summary

Appendix H: UNITE FY12 Evaluation - Executive Summary

Appendix I: Summative Outcomes FY2012 Highlight Sheet

EXECUTIVE SUMMARY

Gains in the Education of Mathematics & Science (GEMS), managed in FY12 by George Washington University (GWU) and in FY13 by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) initiative that enables students in grades 5-12 to experience science, technology, engineering, and mathematics (STEM) in a real laboratory setting. The one- to four-week summer program is based on a multi-disciplinary educational curriculum and is focused on age-appropriate, hands-on, inquiry-centered activities or modules in areas that include engineering, mathematics, biology, biomedical sciences, chemistry, and physics. Many of the GEMS sites utilize near-peer mentors, college students in STEM, as a key element in their instructional model. Near-peer mentors are young scientists and students who translate and communicate complex STEM content and their own STEM experiences to the younger GEMS participant.

In 2012, GEMS provided outreach to 1,614 participants at 14 different sites, each of which was hosted by a participating Army laboratory. More than 2,700 applications were received from students interested in the GEMS program.

The 2012 GEMS program was assessed with pre-program and post-program questionnaires. Data was combined from matched questionnaires to measure participants' perceptions of their change and growth through their GEMS experience. The assessment of the 2012 GEMS indicates achievement of most objectives. In particular, data indicates:

Table 1. GEMS 2012 Outcomes

GEMS nurtures interest and excitement in STEM for middle and high school participants.	• GEMS increases overall participant interest and attitude towards STEM (post-program avg. 5.18 on a 6 point scale, difference of 0.40).
	• GEMS participants report more interest in learning (difference of 0.55), enjoyment in taking STEM lessons (difference of 0.44), and satisfaction with hands-on activities (difference of 0.25) in GEMS as compared to their regular schools.
	• GEMS increases participants' desire to share what they learn in GEMS with their friends and family (difference of 0.59) and desire to learn more about the STEM topics covered in the program (difference of 0.52).
	• GEMS increases participants' interest in joining a STEM club (difference of 0.38), interest in thinking about STEM topics outside of instruction (difference of 0.33), and interest in studying more STEM (difference of 0.13).
GEMS nurtures interest and excitement in STEM for mentor and teacher participants.	• GEMS instructors take a real interest in participant learning (avg. 5.40 on a 6 point scale), are easy to learn from (avg. 5.28), encourage participants to ask questions (avg. 5.25), and explain difficult concepts very well (avg. 5.16).
	• GEMS instructors are excited to do hands-on activities with participants (avg. 5.42) and enjoy hands-on activities as much or more than participants (avg. 4.98). Participants like to learn from instructors because the instructors are just as interested and excited as the students (avg. 5.27).

GEMS successfully implements STEM enrichment experiences that are hands-on, inquiry-based educational modules that enhance in-school learning.	• GEMS engages participants in hands-on lab activities more than "once per day" as compared to schools which engage participants in hands-on lab activities "once every two weeks".
	• GEMS engages participants in the following activities "4-5 times per week": observe teachers performing an experiment and take notes; go through the procedure of a pre-determined experiment or activity and then use a workbook to answer questions; and conduct an experiment from a set of instructions while being allowed to themselves create a hypothesis and independently draw conclusions. Participants report that they experience the same activities "once every two weeks" in their schools:
GEMS increases participant knowledge in targeted STEM areas and laboratory skills.	• GEMS increases participant laboratory and STEM research skills (avg. 4.93 on a 6 point scale, difference of 0.39).
	• GEMS increases participant abilities in the following skills: working with equipment in a science or engineering lab (difference of 0.32); laboratory techniques that are used in scientific or engineering experiments (difference of 0.70); and STEM research skills that include creating testable hypotheses (difference of 0.50), explaining experimental results (difference of 0.36), communicating science/engineering concepts (difference of 0.37), and finding STEM research information using library resources (difference of 0.39).
	• GEMS increases participants' confidence in their abilities to perform critical STEM research activities (post-program avg. 5.01, difference of 0.30).
	• GEMS increases participant confidence in the following areas: ability to effectively use a laboratory (difference of 0.36); ability to perform lab techniques (difference of 0.30); and STEM research skills that include creating useful hypotheses (difference of 0.22), interpreting experimental results (difference of 0.29), communicating science/engineering concepts (difference of 0.34), drawing conclusions from experimental results (difference of 0.25), and finding STEM research information using a library (difference of 0.37).
GEMS provides STEM outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM.	• The 2012 GEMS program provided outreach to a diverse population. 25% of participants were from racial/ethnic groups that have been historically underrepresented and underserved in STEM. 11% of participants qualify for free or reduced lunch - another population that is underrepresented and underserved in STEM.
	• 54% of 2012 GEMS participants were male and 46% were female. The plurality of participants identified as Caucasian (42%). Other racial and ethnic groups represented included: Asian (19%), Black or African American (17%), Hispanic or Latino (7%), and Native American (1%).
	• The majority of 2012 GEMS participants reported that they attend public school (71%), private school (12%), or a public magnet school (11%). While most participants attend school in a suburban setting (61%), others attend school in urban (20%) or rural communities (18%).

GEMS encourages participants to pursue secondary and post-secondary education in STEM.	• GEMS increases participant intent to pursue STEM education in high school, college, and extracurricularly (post-program avg. 5.00 on a 6-point scale, difference of 0.16).
	• GEMS increases participant intent to: participate in a STEM summer program (difference of 0.28), go to college to study STEM (difference of 0.26), do an apprenticeship or internship in STEM (difference of 0.26), choose a career in a STEM field (difference of 0.20), participate in a science fair or competition (difference of 0.15), take more high school classes in STEM (difference of 0.11), and take advanced high school classes in computers (difference of 0.11) or other STEM fields (difference of 0.10).
GEMS educates participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories.	• The average GEMS participant learns about 3.79 STEM careers and 2.61 careers with the Army laboratories during the GEMS program.
	• Participants who attend GEMS programs at sites hosted at Army laboratories report more frequent exposure to both STEM careers (onsite avg. 4.09, off-site avg. 3.08) and Army laboratory careers (on-site avg. 3.30, off-site avg. 0.97) than do those who attend GEMS programs hosted off-site from the sponsoring Army laboratory.
GEMS provides information to participants about opportunities for STEM enrichment through advancing levels of GEMS. The program is not as successful in providing information about other AEOP initiatives.	• 79% of 2012 GEMS participants expressed interest in participating in advanced levels of the GEMS program.
	• Most 2012 GEMS participants reported that they never heard of other AEOP programs including: eCYBERMISSION (77% have not heard of program), the Junior Science & Humanities Symposium (JSHS, 80%), the Science & Engineering Apprenticeship Program (SEAP, 61%), College Qualified Leaders (CQL, 73%), the High School and Undergraduate Apprenticeship Programs (HSAP/URAP, 70%), and the Research & Engineering Apprenticeship Program (REAP, 66%).

RECOMMENDATIONS

The evidence collected during assessment informs the following recommendations for future GEMS programs:

- The number of applications for positions in the programs (more than 2,700 applications for approximately 1,600 slots) is indicative of considerable unmet need. In light of the evidence of program success collected in this assessment, it is recommended that the Army expand the program – engaging more host laboratories and creating more participant slots.

- The 2012 GEMS assessment captured participant perceptions of increased knowledge in STEM areas. If feasible, it would be meaningful to develop a measurement of participant knowledge for incorporation into future evaluation efforts – through content-based pre-program and post-program assessment, through a rubric to be applied to participant performance by instructors/near-peer mentors and other program personnel or assets.

- The 2012 GEMS assessment captured participant perceptions of instructor engagement. Future evaluation efforts should include direct survey/interview/focus groups of instructors and/or near-peer mentors.

- While 25% of the 2012 GEMS participants self-identified with groups historically underserved and underrepresented in STEM, demographics varied by site. It is recommended that program administers incorporate strategies to recruit participants from these target populations in future marketing efforts. Best-practices in outreach to underserved groups should be shared among site coordinators.

- Data indicates that 2012 participants who attended GEMS programs at sites hosted at Army laboratories had more frequent exposure to both STEM careers (onsite avg. 4.09, off-site avg. 3.08) and Army laboratory careers (on-site avg. 3.30, off-site avg. 0.97) than did those who attended GEMS programs hosted off-site from the sponsoring Army laboratory. Efforts should be made to provide equitable exposure to STEM careers and Army laboratory careers to all GEMS participants. Army career professionals could take part in the GEMS curriculum as guest speakers with short presentations followed by questions from the GEMS participants.

- 79% of 2012 GEMS participants expressed interest in participating in advanced levels of the GEMS program. In order to continue the pipeline of support to participants with interest in STEM and pending available funding, advanced levels of GEMS should be established at all sites. SEAP and CQL also provide an opportunity for GEMS participants to continue their work in STEM at the Army laboratories but the number of available positions in these programs is small relative to the number of GEMS participants. In 2012 there were 796 applicants for 154 SEAP positions and 373 applicants for 274 CQL positions. Efforts should be made to expand the opportunity for GEMS participants to continue their STEM work with Army laboratories throughout their education.

- Most of the 2012 GEMS participants reported that they had never heard of the other AEOP elements. It is recommended that each site formally integrate instruction about these opportunities into their curriculum. Ideally, every GEMS participant should leave the program knowing what their next step is with the AEOP. Middle school-level participants should be encouraged to participate in eCYBERMISSION and high school-level participants should be encouraged to participate in JSHS and the AEOP internship programs (SEAP, HSAP, REAP, CQL, and URAP).

Table 2. 2012 GEMS Fast Facts	
AEOP Element	Gains in the Education of Mathematics & Science (GEMS)
Participant Group	Students in grades 5-12 from the areas surrounding participating Army laboratories
Number of Participants	1,722 (including 1,614 participants, 63 near-peer mentors, and 45 teachers)
Total Cost*	$778,000
Average Cost Per Participant	$452

** The total cost includes an AEOP investment of $645,000 and $133,000 in laboratory supplemental funds.*

APPENDIX B:
HIGH SCHOOL APPRENTICESHIP PROGRAM (HSAP) /
UNDERGRADUATE RESEARCH APPRENTICESHIP PROGRAM (URAP)
FY12 EVALUATION

EXECUTIVE SUMMARY

The High School Apprenticeship Program (HSAP) and the Undergraduate Research Apprenticeship Program (URAP), managed together by the Army Research Office (ARO), are Army Educational Outreach Programs (AEOPs) that place talented high school and undergraduates students in research apprenticeships with Army-funded laboratories at colleges and universities throughout the nation. Each HSAP/URAP apprentice works under the direct supervision of a scientist or engineer on a hands-on research project. Through the HSAP/URAP summer experience, apprentices are exposed to the real world of research, they gain valuable mentorship and they learn about education and career opportunities in STEM.

In 2012, HSAP/URAP provided outreach to 97 participants at 53 Army-funded university laboratories. 290 applications were received from students interested in the program.

The 2012 HSAP/URAP program was assessed with a participant questionnaire. Twenty-three of the 97 HSAP/URAP apprentices completed the questionnaire, constituting a total response rate of 23.7%. Although the assessment response rate is not optimal, generalizing the findings from these data to the HSAP/URAP program as a whole is possible with an appropriate amount of caution. The results represent a useful, albeit moderate, amount of insight into the 2012 HSAP/URAP program.

The assessment of 2012 HSAP/URAP indicates achievement of most objectives. In particular, the data indicates that:

Table 1. 2012 HSAP/URAP Outcomes

HSAP/URAP provides hands-on research experiences to high school and undergraduate participants.	• Participants engaged in scientific reasoning activities and in laboratory research activities more than "*once every two weeks*." Participants reported using proper safety procedures (avg. 5.57 on a 6 point scale), cleaning and caring for lab equipment (avg. 5.30), and using advanced science or engineering equipment (avg. 5.26) "multiple times per week" or more.
	• HSAP participants engaged in critical research activities during HSAP (avg. 4.62) much more frequently than in their high school classes (avg. 3.29, difference of 1.34).
	• Participants were exposed to critical university research experiences including advanced scientific projects (avg. 5.30) and scientific research that will have a real-world impact (avg. 5.26).
The assessment was inconclusive in determining if HSAP/URAP is successful at educating participants about the Army's interest and investment in science.	• The majority of HSAP/URAP participants have never heard about other AEOP programs. Only one participant previously took part in an AEOP – the Science & Engineering Apprenticeship Program (SEAP).
	• Participants "*somewhat agreed*" that their mentors taught them about STEM careers sponsored by the Army (avg. 4.30 on a 6 point scale).
	• The assessment did not consider any other indicators of HSAP/URAP's success in educating participants about the Army's interest and investment in science.

HSAP/URAP fosters mentorship by a university researcher.	• Participants received educational and career guidance from their mentors. Mentors motivated participants to pursue careers in STEM (avg. 5.39 on a 6 point scale) and spoke with them about their future education and career goals (avg. 5.30).
	• Mentors provided participants with professional development. Mentors helped participants clarify their goals (avg. 4.91) and advised participants on the necessary steps to achieve them (avg. 4.91). Mentors taught participants about professional and educational networks (avg. 4.57) and exposed them to professional organizations (avg. 4.09). Participants reported that their mentor will either write or help them obtain letters of reference (avg. 4.91) and that their mentor helped them craft their résumé (avg. 3.96).
	• Mentors helped participants develop scientific research skills and abilities. Mentors encouraged participants to perform a variety of tasks in the lab (avg. 5.30), perform research (avg. 5.30), work more effectively in the lab (avg. 5.13), and to become better writers of scientific research (avg. 5.04). 83% of HSAP/URAP respondents "*somewhat agree*", "*agree*", or "*strongly agree*" that they frequently worked with their mentor in the laboratory.
	• The majority of HSAP/URAP respondents indicated that they would recommend their mentor to other students (avg. 5.35). 92% of respondents "*agree*" or "stro*ngly agree*" that they would like to work with their mentor again.
HSAP/URAP inspires participants to continue pursuit of STEM interests.	• 100% of responding participants intend to pursue a college degree in a STEM field. 96% of these participants intend to pursue an advanced degree in a STEM field with 74% intending to pursue a doctoral degree in STEM. 100% of URAP participants were enrolled as STEM majors at the time of the program.
	• Participants are very confident that they will achieve their educational goals. Participants are most confident that they will attend a college to pursue their degree of choice (avg. 5.83 on a 6 point scale) and that they will overcome any obstacles between themselves and their desired degree (avg. 5.48).
	• Participants are highly certain that they will apply for (avg. 5.65), get jobs (avg. 5.57), and build careers (avg. 5.61) around STEM. Participants expressed low levels of certainty that they will pursue STEM jobs with the Army (avg. 3.04) or build STEM careers with the Army (avg. 2.87).
	• HSAP/URAP participants gained confidence in the following foundational laboratory research and scientific literacy skills because if their experience in the HSAP/URAP program: contributing within a research team (avg. 5.48 on a 6 point scale), effectively and safely using a laboratory (avg. 5.39), performing equipment calibrations/techniques (avg. 5.22), formulating hypotheses (avg. 5.17), data analysis (avg. 5.17), accounting for limitations and assumptions (avg. 5.04), and completing academic literature reviews (avg. 5.04).
	• If given the opportunity, 96% of participants would participate in HSAP/URAP again. Participants value the hands-on research, mentorship, skill development, and resume-building experience that take place in HSAP/URAP.
	• 100% of respondents were satisfied with the HSAP/URAP research project/ final presentation. Participants value the development of communication skills, being exposed to new topics of research, and being motivated by peers and mentors.

WHAT PARTICIPANTS ARE SAYING

- *[HSAP/URAP] provided me a unique opportunity to work directly with a professor in my field of interest. During the program I gained insight and experience in the engineering research field, and was able to get a better sense of my education and career goals.*

- *I learned enough to submit a competitive research proposal that received funding. I will be working for at least one year with my current advisor, and will submit a paper summarizing the work I began under URAP.*

- *During this summer's program not only did I gain critical knowledge in my field but I also was mentored in such a way that encouraged me to want to pursue more than just want I had my goals set on.*

- *I was very satisfied with the program overall. I think the most valuable part of the experience was having the opportunity to analyze and solve problems myself with relevant tools. An example is an instance where I had to analyze the geometry of a part I was designing with CAD. My research group asked me to find out some information about its geometry, which required me to research and develop my own MATLAB function to do the job. It required a week and a half of me learning new things and trial and error, but after completing this task, I gained a lot of confidence in my abilities as a member of the research team.*

- *[The HSAP/URAP final project] really forced me to critically examine my work and develop my communication skills, mainly through my writing skills. It put a perspective on everything I had achieved this summer as well as allowed me to reflect upon how valuable the experience was as a whole.*

- *My research project was very interesting and exciting, but there were many more road bumps than anticipated. The progress was slower than I would have liked, but we're still making progress. To me, the most valuable part of the URAP experience was being exposed to a new field that generated career interests for me. I am now hoping to pursue studies in MEMS, which was part of my research.*

RECOMMENDATIONS

- The number of applications for positions in the programs (290 applications for 97 funded slots) is indicative of considerable unmet need. In light of the evidence of program success collected in this assessment, it is recommended that the Army expand the initiative – engaging more mentors and creating more participant slots. In particular, it is recommended that more positions be created for high school students with HSAP. In 2012 there were more than twice as many positions with URAP (69) than with HSAP (28).

- Assessment data revealed that HSAP participants engaged in critical research activities during HSAP (avg. 4.62) much more frequently than in their high school classes (avg. 3.29, difference of 1.34). Future evaluation tools should include a similar measure for URAP participants. Does URAP expose undergraduates to scientific experiences that they do not have access to in their regular college environment?

- It is recommended that communications about the HSAP/URAP program (to both mentors and participants) incorporate messaging about the Army's interest and investment in science. Future assessment efforts should include items that measure HSAP/URAP's success at educating participants about this interest in a more comprehensive manner than the 2012 assessment.

- Data indicates that HSAP/URAP participants intend to pursue careers in STEM. While mentors provide participants with information about STEM careers and educational pathways based on participant interest, mentors are less successful in providing information about STEM careers with the Army. It is recommended that a resource on STEM careers with the Army be created (perhaps in conjunction with other AEOP elements that share this challenge) and that it be provided to mentors and participants for use within the HSAP/URAP experience.

- While it was not identified as a specific HSAP/URAP objective at the point of 2012 program implementation, the cross-promotion of other AEOP initiatives has become a recognize priority of all of the AEOP elements. The 2012 HSAP/URAP apprentices were largely unaware of other opportunities available to them in the AEOP. Efforts should be made to significant increase the exposure of both participants and mentors to information about other opportunities in the AEOP portfolio. Specifically, HSAP apprentices should be targeted for participation in the Junior Science & Humanities Symposium (JSHS). This would be an ideal venue for the presentation of research completed through HSAP.

Table 2. 2012 HSAP/URAP Fast Facts	
AEOP Element	High School Apprenticeship Program (HSAP)/ Undergraduate Research Apprenticeship Program (URAP)
Participant Group	High school students and college undergraduates
Number of Participants	97 (28 HSAP, 69 URAP)
Total Cost	$356,302
Cost Per Participant	$3,673

EXECUTIVE SUMMARY

The Junior Science & Humanities Symposium (JSHS), managed by the Academy of Applied Science (AAS), is an Army Educational Outreach Program (AEOP) effort that provides enrichment to high school students throughout the US, Puerto Rico, and DoD Dependent Schools in Europe and the Pacific. In 2012, JSHS engaged 8,400 youth in 47 regional symposia. Participants orally present their original research in an area of science, technology, engineering, and mathematics (STEM) before a panel of expert judges and compete for scholarships and the opportunity to advance to the JSHS National Symposium.

This report documents the evaluation of JSHS at the level of the regional symposia. The two-tiered assessment utilized structured interviews and a follow-up questionnaire to gain information from Regional Directors on the topics of resources, diversity, and value to participants. A second evaluation of JSHS, which focuses on the experience of participants at the National Symposium, is forthcoming.

The findings of the assessment are summarized in Table 1 below.

Table 1. 2012 JSHS Regional Symposia Findings
Resources Supporting JSHS Regional Symposia.
• Critical resources for administration of regional symposia include: funding from AAS (52.6%), support from a university partner (65.8%), and strategic partnerships with non-university organizations (21.1 %).
• Regional events benefit from strategic partnerships with universities, non-profit organizations, and corporations through the receipt of administrative support, enrichment activities, financial support, and volunteers. Strategic partnerships have been negotiated through collaborative outreach initiatives, grassroots efforts, and existing professional networks.
• Regional Directors are interested in forming new strategic partnerships with universities (100%), non-profits (72%), and corporate organizations (67%).
Diversity at JSHS Regional Symposia.
• Only 45.0% of Regional Directors perceived that they were successfully achieving race/ethnic diversity among participants while fewer perceived that they were successfully achieving geographic diversity (32.5%) and socio-economic status (SES) diversity (22.5%).
• Efforts to facilitate diversity at regional symposia include: engaging teachers, administrators, and schools in diverse areas (67.5%); bringing in alternative programming (25%) included allowing non-competitive visits from schools, allowing library research, hosting 8th grade presenters, and facilitating teacher workshops; and partner with organizations aimed at serving diverse populations (22.5%).
• Barriers to achieving diversity among regional symposia participants include: lack of school/teacher buy-in, travel costs, ineffective marketing, military-recruitment stigma, intimidation by the level of work being presented, limits to extracurricular activities related to standardized testing in public schools, lack of participant access to mentors and research facilities, and absence of school district support of participating teachers.

Value of Regional JSHS to all participants.
• Regional Directors agree (92.5%) that mentorship and/or adult support is critical to the success of JSHS students. Regional Directors help to facilitate mentorship for participants by cultivating relationships with available mentors and/or creating a mentor database; forming strategic partnerships with organizations that provide mentorship; and/or providing participants with electronic access to volunteer graduate students or researchers.
• Mentors and teachers who volunteer with JSHS are generally unrewarded for their efforts. The AAS award was the only tangible reward that distributed to mentors or teachers at half of the regional symposia.
• JSHS Regional Directors believe that all regional participants, whether or not they advance to the national competition, benefit from peer interactions (51.3%), undergo personal growth through the competition experience (48.7%), learn about new career and educational pathways (33.3%), and have their horizons broadened as they are exposed to new ideas and opportunities (28.2%).
• Regional Directors agree that participants gain new scientific knowledge from each other (avg. 5.34 on a 6.0 scale), motivate each other to be better scientists (avg. 5.40), and motivate each other to participate in JSHS in the future (avg. 5.40). Regional directors also agree that face-to-face interactions are critical to fostering peer relationships between JSHS students (avg. 5.43).
• According to the Regional Directors, factors that distinguish regional winners from non-winners include: the quality of the JSHS participant's contribution to their study (33.3%), presentation skills (30.8%), access to supporting resources (25.5%), and scientific acumen (23.1%).
• Participants are motivated to return to JSHS year after year because the competition offers them the opportunity to grow as a researcher (53.8%). After receiving feedback from expert judges they are motivated to return with an improved project the next year.
• Regional Directors (60.6%) believe that the JSHS judging process is the key to encouraging all students equally because a set of well-trained judges provides a mechanism to reward the unique contributions of each student to a research project rather than simply rewarding impressive studies. Specifically, well-trained judges can adeptly find and reward students' innovation, use of all available resources, and creativity within the auspices of their larger study.
• Regional Directors agree that high quality judges are critical to: the success of regional symposia (avg. = 5.77 on a 6.0 scale), delivering a quality learning experience to JSHS participants (avg. = 5.71), and discerning the unique contribution of participants to their research project (avg. = 5.46). Regional Directors believe that judges should be trained prior to delivering their judgments and feedback to student-presenters (avg. = 5.26), judges' feedback provides a valuable learning opportunity for all JSHS participants (avg. = 5.09), and observing students can learn about research by witnessing the student – judge interactions at JSHS (avg. = 4.94).
• Of the 34 Regional Directors, only 20 (58.8%) stated that they currently have a formal process in place to deliver judges' feedback to students. Several other judging-related processes were mentioned by respondents and include: informal meetings with judges (14.7%), only delivering feedback upon students' requests (11.8%), students are only given the written review of their paper (8.8%), students are provided with audience/peer feedback (5.9%), and feedback is only delivered to winning students prior to their trip to the JSHS National Symposium (5.9%).

RECOMMENDATIONS

The assessment data indicates that strategic partnerships are critical to the success of regional symposia. While Regional Directors make efforts to facilitate diversity at symposia, they face considerable barriers. Regional Directors perceive that participants, whether or not they advance to the national competition, benefit from peer interactions and the judging process that takes place at the regional event. The evidence collected during assessment informs the following recommendations for future development of regional symposia:

- Regional Directors indicated the importance of strategic relationships with universities, non-profits, and corporations to providing funding, enrichment activities, administrative support, and volunteers (staff,

judges, and mentors) for regional symposia. It is recommended that the Regional Directors be provided with support to assist them in identifying, negotiating, and facilitating these relationships. Regional Directors may benefit from sharing best practices around this topic – perhaps in an ongoing online platform or JSHS Regional Directors Conference (which could be virtual). The administering organization, AAS, might produce a standardized "partnerships kit" that includes FAQ sheets on the purpose, impact, and history of JSHS as well as templates for use by the Regional Directors in reaching out to potential partners and acknowledging the contributions of current partners. It is recommended that AAS collect a list of all partnering organizations and consider publicizing this list through the JSHS website and or a press release. Ideally the publicity will provide partners with acknowledgement and attract new partners to regional events. AAS might also consider developing a partnership with a national organization, such as a large corporation, non-profit, or professional organization, that may help support multiple regionals throughout the country as part of their own outreach mission.

- It is a challenge for Regional Directors to facilitate racial/ethnic, socio-economic status (SES), and geographic diversity among their participant population. As with the above recommendation, Regional Directors may benefit from sharing best practices around this topic - specifically sharing strategies for engaging new teacher/administrators/schools from diverse areas, adding non-competition based enrichment activities to the JSHS event, and forming partnerships with minority serving organizations. AAS can provide leadership by supplying Regional Directors with diversity goals and information about why diversity is valued by the AEOP and JSHS efforts. It is recommended that regional marketing of JSHS include images and storied of participants from diverse populations.

- Access to mentorship is perceived as critical to the success of JSHS students. It is recommended that best practices in establishing mentorship networks be shared among Regional Directors. Access to mentorship can be a limiting factor to participants from diverse populations. Here the issues of diversity and access to mentorship become intertwined. It may beneficial for regions to approach new groups of teachers/administrators/schools from diverse areas with a set of volunteer mentors that has already been established and is invested in the project of providing a new STEM opportunity to the targeted population. By approaching the new population of potential participants with resources in hand, it may prove much easier to obtain teacher/administrator/school buy-in.

- The success of regional JSHS symposia very much relies on the participation of teachers, mentors, judges and other volunteers. While the teacher award is a notable start, it is recommended that a system be developed to provide acknowledgement of other adults who give their time to the project. Once idea would be for each Regional Director to nominate an outstanding mentor (or community partner) from their region to compete for the prize of being invited to attend National JSHS.

- Regional Directors point to the value of the judging process in the overall student experience at regional JSHS symposia. It is recommended that Regional Directors be empowered to share their best practices in judging. Efforts should be made to ensure that all participants have the opportunity to receive feedback from the judges. This, in itself, is a form of mentorship. Regional Directors should also be encouraged to fully train judges so that they are prepared to fairly access research presented by a diverse group of participants with varying access to resources.

The engagement of Regional Directors is fundamental to the success of JSHS. It is recommended that the AEOP invest in supporting the development and continued buy-in of this valued group. Their inspiration and passion for JSHS and the student participants is what drives Regional Directors to continue to improve and grow their regional events despite the challenges of securing resources (funding, volunteers, etc.). The majority of JSHS participation occurs at the regional level. While the participants who advance to the national competition receive considerable attention, it is important to recognize that JSHS' greatest reach is at the regional level. We must continue to ask: What happens to the regional participants who don't advance to nationals? How does the JSHS experience support and encourage their pursuit of education and careers in

STEM? How is the message of the AEOP integrated at the regional level? What can we do to the regional symposia that will engage even more students and provide them with a quality STEM experience?

Table 2. 2012 JSHS Fast Facts	
AEOP Element	Junior Science & Humanities Symposium (JSHS)
Participant Group	High school students from the US, Puerto Rico, and DoD Dependent Schools in Europe and the Pacific.
Number of Participants	8,448 (8,400 students served and 48 teacher awards)
Total Cost	$1,949,258
Total Scholarships	$408,000
Average Cost Per Participant	$231

EXECUTIVE SUMMARY

The Junior Science & Humanities Symposium (JSHS), managed by the Academy of Applied Science (AAS), is an Army Educational Outreach Program (AEOP) effort that provides enrichment to high school students throughout the US, Puerto Rico, and DoD Dependent Schools in Europe and the Pacific. In 2012, JSHS engaged 8,400 youth in 47 regional symposia. Participants orally present their original research in an area of science, technology, engineering, and mathematics (STEM) before a panel of expert judges and compete for scholarships and the opportunity to advance to the JSHS National Symposium.

This report documents the evaluation of JSHS at the level of the National Symposium. The assessment utilized post-program questionnaire to capture a profile of participants, indicators of program success, and participant satisfaction. A second evaluation of 2012 JSHS, focusing on Regional Directors and the impact of the regional symposia, was also performed. For a comprehensive understanding of the program, the assessments should be reviewed together.

The assessment outcomes are summarized in Table 1 below.

Table 1. 2012 National JSHS Outcomes

Participant Profile	
National JSHS is successful in providing outreach to an even distribution of males and females. It does not provide outreach to a representative population from groups historically underserved and underrepresented in STEM.	• 90 of 240 participants (38%) in National JSHS completed the assessment. The pool included a representative group of oral research presenters, research poster presenters, and student delegates.
	• Slightly more females than males completed the questionnaire and 92% of respondents identified with the race/ethnicity categories of Caucasian (59%) or Asian (33%). Only 1% of respondents identified as Black/African American. No respondents identified as Hispanic/Latino or Native American.
	• Respondents were typically in the latter-years of their high school education, with 79% being between the ages of 16 and 18 years old at the time of the competition.
National JSHS provides outreach to the Nation's future STEM workforce.	• 100% of the respondents reported that they intended to pursue a college degree. 89% plan to pursue a degree in a STEM field. 67% of respondents plan to pursue a doctoral degree in a STEM field.
	• 92% of respondents indicated their intent to pursue a career in a STEM field. Medicine/Health (36%), Life Science (19%), and Engineering (16%) were chosen more frequently than any of the other fields.

Indicators of Program Achievement	
National JSHS is successful at fostering development in critical skills for STEM research among participants.	• Participants experienced significant personal gain as a result of undergoing the oral research presentation and judging process. They became better speakers (avg. 4.89 on a 6 point scale) and writers (avg. 4.17), improved their research (avg. 4.67), and gained confidence (avg. 5.03).
	• Participants who presented research posters did not report the same level of growth as those who gave oral research presentations. They did, however, indicate that the poster process helped improve their presentation skills (avg. 4.18) and confidence (avg. 4.12).
	• Participants in both the oral research presentation and research poster competitions valued judges' feedback and desired more constructive feedback from the judges for application in their future research. Respondents believe that written feedback, comment sheets, more judges for each project, and more time for the judges to speak with the students would improve the judging process.
National JSHS expands the horizons of research-oriented students by exposing them to opportunities in the academic, industrial, and governmental communities.	• The comprehensive experience of National JSHS broadened participant horizons in STEM. Respondents were presented with new information/knowledge in STEM (avg. 4.74-5.41 on a 6 point scale) and were motivated to achieve more in STEM (avg. 4.38-4.91). The event increased participant interest in STEM (4.31-4.78) and challenged their previous thinking/assumptions in STEM (avg. 4.03-4.57). The guest speakers and oral research presentations had the most impact on broadening participant horizons in STEM while the poster presentations had the least influence.
	• Respondents agreed that the guest speakers at National JSHS inspired them to pursue a STEM pathway (avg. 4.32) and taught them the value of pursuing DoD or government service (avg. 4.16). They agreed that the DoD and Federal Laboratory Showcase informed them about educational opportunities offered by the DoD (avg. 4.84), expanded their career horizons (avg. 4.56), and challenged their assumptions about the work done by the DoD and federal government (avg. 4.55). Respondents agreed that showcase motivated them to explore DoD and government careers (avg. 4.01).
Participants value and are motivated by interactions with like-minded peers at National JSHS.	• Respondents find their peer interactions at National JSHS highly valuable. They agreed that their peers motivated them to continue STEM research (avg. 4.71 on a 6 point scale), that their peers at JSHS were easier to relate to than those at school (avg. 4.83), and that their peers helped them become a better scientist (avg. 4.62). Participants indicated most often that they made new friends (avg. 5.39), were inspired by their peers (avg. 5.20), and felt a sense of camaraderie with their peers (avg. 5.01). Respondents agreed less frequently that they will maintain contact with their peers (avg. 4.49) and that they exchanged ideas with their peers at the event (avg. 4.55).
	• There is a notable gap between respondents' perceptions of the value of peer interactions at the National event as compared to the value of peer interactions at regional symposia. Respondents most frequently agreed that their peers at regional symposia inspired them (avg. 4.34) and that they made new friends (avg. 4.22). Participants agreed least frequently that they exchanged research ideas with their regional JSHS peers (avg. 3.82) and that exchanging ideas with their peers at regional symposia motivated them to continue STEM research (avg. 4.03).

National JSHS participants receive a high level of support and motivation from their research mentors.	• 43% of respondents indicated that they actively searched for and found their research mentor. Another 21% indicated that their teacher served as their research mentor.
	• Respondents perceived a uniformly high level of support from their mentors. Respondents agreed most often that their mentor helped motivate them (avg. 5.12 on a 6 point scale), that they learned more from their mentor than they did from their high-school experiences (avg. 5.10), and that their mentor was critical to their success at JSHS (avg. 4.75).
	• Respondents indicated that their mentor provided them with tangible support in the form of access to equipment or letters of reference, non-tangible support in the form of guidance, inspiration, and motivation, and valuable knowledge and clarification with scientific reasoning.
Symposium Satisfaction	
Participants express a high level of satisfaction with National JSHS.	• Participants expressed high levels of satisfaction with the major components of the National JSHS event (averages were between 4.22 and 5.23 on a 6 point scale). The ceremonies (avg. 5.23), invited speakers (avg. 5.03), and oral research presentations (avg. 5.02) were held in especially high regard.
	• Respondents expressed the lowest levels of satisfaction with the National Monuments Twilight Tour (avg. 4.22), the DoD and Federal Laboratory Showcase (avg. 4.57), and the research poster presentations (avg. 4.59). Participants liked the concept of these elements of National JSHS but they wanted more from them – specifically more advanced knowledge and more time to engage.

WHAT PARTICIPANTS ARE SAYING

- *The most inspirational part of JSHS was hearing the student speakers and other poster presenters, as it reaffirms the ability of this nation to produce many talented young minds leading us into the future. Having the chance to share research with peers in an open and accepting environment is always an invaluable experience.*

- *I really enjoyed listening to the guest speakers talk about how they made it to where they are now, how they have reached their success, it showed me that if you just work hard at something and continue to try new things, you can really get somewhere.*

- *The activity of most value to me was the STEM booths [DoD and Federal Laboratory Showcase] representing aspects and research from the various branches of military. There, I had the opportunity to collaborate with professional researchers about my work and gain knowledge of potential internship opportunities available to me.*

- *Listening to other students present their work was inspirational. It opened my eyes to what I myself can accomplish right now if I work for it. I don't have to wait until I am an adult or graduate from college to do high level research.*

- *The most inspirational/motivational activity at National JSHS would have to be the key note speakers. It was through their presentations and their personal stories that we were able to witness living proof that we honestly can make a difference by embracing our interests and becoming dedication to our field.*

- *The session with that showcased the sort of research the military is doing was the most inspirational because a lot of them showed real-world applications of research.*

- *I found meeting the other delegates most motivational because we all talked about our work and our futures.*

- *The closing ceremony was definitely the most inspirational because it instilled a feeling of promise in me after its completion, with various speakers emphasizing the importance of pursuing research in the future.*

RECOMMENDATIONS

The evidence collected during assessment informs the following recommendations for future development of National JSHS:

- The demographic information provided by respondents to the assessment indicates that members of groups that have been historically underserved and underrepresented in STEM – Black/African American, Hispanic/Latino, and Native American populations – are virtually absent from the pool of JSHS participants that advances to National JSHS. While a common response to this fact is often that the competition process is objective and that we simply do not have participants from underserved populations presenting the best research, we must look beyond this perspective.

  What can JSHS administrators do to increase participation of marginalized populations at the National level? It is recommended that administrators address this challenge with multiple approaches. First, efforts should be made to facilitate participation in JSHS from diverse populations at the level of regional symposia. Demographic information should be collected on the participant pool at this level. If regional symposia do not already engage populations that have been historically underserved and underrepresented in STEM, then changes should be made to do so. Previous assessments have indicated that access to mentorship and laboratory resources are critical to a participants' success in JSHS. How can JSHS better facilitate participant-mentor relationships so that a potential participant without access to resources has a similar opportunity to succeed as a participant who has access? By addressing this question, JSHS can truly provide outreach to new populations.

  Another approach to the challenge of engaging more participants from groups historically underserved and underrepresented in STEM at the National level of JSHS involves looking at the judging process at the regional symposia. Participants in National JSHS are selected through the judging process that occurs at regional symposia. It is possible that larger percentages of participants from underserved groups do participate at regionals but that they are not selected to advance to Nationals. If this is the case, we must ask why? Ideally the demographic representation at National JSHS should parallel the demographic representation at regional symposia. It is possible that the judging process combines with issues with mentorship and resources to be prohibitive to certain populations (moving beyond racial and ethnic categories to include additional factors such as socio-economic status, geographical location, etc.) How does the judging process compare projects from participants with extensive access to laboratory resources and mentorship to the projects from participants without or with less access? How do judges navigate inequities in resources to identify the best projects?

  A third approach to addressing the lack of representation of participants from minority groups in STEM at National JSHS is to ask if JSHS provides an environment in which members from such groups feel included. Are there judges and guest speakers from the targeted minority groups to role model the possibility of success in STEM for these participants? Is the climate supportive and nurturing for all participants – including those who do not advance to the National competition? It is recommended that future assessment efforts ask participants why they chose to take part in JSHS. It could be meaningful

to interview JSHS-participating teachers from schools that serve minority populations in STEM and students from this population to learn their thoughts on how we can engage more participants from diverse backgrounds.

- Based on comments made by participants at National JSHS, the Virginia Tech evaluation team observed that participants at National JSHS seem to be finalists in other high-level research competitions. To begin to explore this phenomenon, the list of 2012 National JSHS participants was compared to the list of Intel Science Talent Search 2013 Semifinalists. Of the 300 students identified by Intel in 2013, seventeen participated in the 2012 National JSHS. It is recommended that future assessments of National JSHS capture information on the other STEM competitions that participants take part in.

- Assessment indicates that 100% of National JSHS participants plan to go to college, 67% plan to pursue a doctoral degree in STEM, and 92% intend to pursue a career in STEM. JSHS is successful at serving the future STEM workforce. It is recommended that efforts be made to publicize this result – specifically sharing profiles of winners. This is a true example of the success of the AEOP.

- Assessment with regards to perceptions of personal growth and broadening horizons yielded data that indicated that National JSHS participants get greater value out of the oral research presentations than they do the research poster competition. Many factors may contribute to these perceptions – including the perception that the poster event is a second-tier of the National JSHS competition. It is recommended that administrators explore ways in which the research poster competition may be improved so that participants experience increased growth and motivation to pursue STEM through the experience.

- Participants value the interactions that they have with their peers at National JSHS. It could be meaningful to further develop these interactions with the introduction of a team project to the National event. The ability to work on teams is critical for STEM professionals. Can JSHS participants who each have exemplary knowledge of a different STEM field come together to develop unique solutions to a select problem while at JSHS? The addition of such an event to JSHS may introduce new pathways for participants of varying roles (oral research presenters, research poster presenters, student delegates) to come together and produce something new at Nationals. Such an event could separate JSHS from other high-level STEM competitions.

- The assessment indicates that mentorship is highly valued by National JSHS participants. It is recommended that efforts be made at the level of regional symposia to develop mentorship networks. It may be meaningful to build resources and an acknowledgement system specifically for JSHS mentors.

- According to assessment data, participants at National JSHS want more constructive feedback from judges as they consider this feedback important to their future research. It is recommended that JSHS administrators consider adding a written feedback component, perhaps in response to the written reports that are reviewed prior to the oral presentations, to the judging process. It may be meaningful to provide student presenters with additional opportunities to engage with judges. This could be accomplished by providing a set time period where judges are available to meet one-on-one with presenters.

- Participants valued the DoD and Federal Laboratory Showcase, a new event for National JSHS. The showcase broadened the horizons of participants by providing them with information about careers and educational opportunities. It is recommended that this event become a regular part of the National JSHS program.

Table 2. 2012 JSHS Fast Facts	
AEOP Element	Junior Science & Humanities Symposium (JSHS)
Participant Group	High school students from the US, Puerto Rico, and DoD Dependent Schools in Europe and the Pacific.
Number of Participants	8,448 (8,400 students served and 48 teacher awards)
Total Cost	$1,949,258
Total Scholarships	$408,000
Average Cost Per Participant	$231

EXECUTIVE SUMMARY

The Research Engineering & Apprenticeship Program (REAP), managed by the Academy of Applied Science (AAS), is an Army Educational Outreach Program (AEOP) that places high school students in summer research apprenticeships at colleges and universities throughout the nation. Each REAP apprentice works under the direct supervision of a scientist or engineer on a hands-on research project. Through the five to eight week REAP experience, apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM.

In 2012, REAP provided outreach to 131 participants at 52 hosting university laboratories. More than 1,500 applications were received from students interested in REAP.

The 2012 REAP program was assessed with a participant questionnaire and a mentor questionnaire and rubric. Twenty-nine of 131 REAP apprentices completed a participant questionnaire, constituting a total response rate of 22.1%. Twenty-four mentor questionnaire and rubric forms were completed by 17 mentors (some mentors host multiple apprentices). The data set includes nine matched pairs of student and mentor assessment forms. Although the assessment response rate is not optimal, generalizing the findings from these data to the REAP program as a whole is possible with an appropriate amount of caution. The results represent a useful, albeit moderate, amount of insight into the 2012 REAP program

The assessment of 2012 REAP indicates achievement of most objectives. In particular, the data indicates that:

Table 1. 2012 REAP Outcomes

REAP motivates participants towards a career in STEM.	• 100% of participants intend to pursue a bachelor's degree or higher and 79% plan to pursue their degree in a STEM field. 71% intend to complete an advanced degree in a STEM field.
	• Participants express high levels of confidence that they will attend college to pursue their desired degree (avg. 5.71 on a 6 point scale) and that they will finish their desired degree (avg. 5.43).
	• Participants intend to pursue STEM careers (avg. 5.29) but they are uncertain if they will pursue STEM careers with the Army or DoD (avg. 2.86).
	• Participants perceive their mentors as motivating them to pursue a STEM career (avg. 5.29). While participants agree that their mentors educated them about STEM careers based on their interests (avg. 4.71), they agree less that their mentors taught them about STEM careers with the Army (avg. 3.43).
	• Mentors perceive that they came to know about participants' career and educational goals (avg. 4.92). Mentors agree that they attempted to educate participants on STEM career pathways (avg. 4.79) but agreed less that they provided participants with information on STEM careers with the Army (avg. 2.77)
	• Mentors agree that participants expressed a lot of interest in pursuing a STEM careers (avg. 5.25) and that participants have the motivation necessary to be successful in STEM careers (avg. 5.79).

REAP expands participants' background and understanding of STEM research.	• 93% of participants "*agree*" or "*strongly agree*" that they learned a lot about performing STEM research from their mentor and 100% of participants "*agree*" or "*strongly agree*" that they would like to work with their REAP mentor again.
	• Participants reported that their mentors encouraged them to perform lab tasks (avg. 5.14 on a 6 point scale); taught them to work effectively in a laboratory (avg. 5.07); helped them formulate their educational goals (avg. 5.00); helped them become a better writer or scientific research (avg. 4.86); and frequently worked with them in the laboratory (avg. 4.79).
	• REAP increased participant confidence in the following skills and abilities associated with scientific research: safe and effective use of a laboratory (avg. 5.21), contributing to a research team (avg. 5.21), data analysis (avg. 5.07), the formulation and testing of hypotheses (avg. 4.86), accounting for limitations and assumptions when formulating conclusions (avg. 4.79), completing academic literature reviews (avg. 4.79), and the performance of equipment calibrations and complex lab techniques (avg. 4.57).
	• Mentors believe that participants are competent in the following areas: scientific reasoning (avg. 4.79 on a 6 point scale), information literacy (avg. 5.23), quantitative literacy (avg. 4.78), laboratory skills (avg. 4.79), data collection techniques (avg. 4.91), and teamwork/collaboration (avg. 5.24).
REAP engages participants in the philosophy and objectives of scientific research.	• Mentors reported that participants organized and handled data, observed an experiment, and analyzed experimental data more than four or five times per week. Participants used advanced laboratory equipment, designed their own experiments, and created their own hypotheses and conclusions at least two or three times per week.
	• Participants reported that they engaged in team research, engaged in academic research activities, synthesized academic information, and critically evaluated academic information more than once per week during REAP. Participants reported that they defined research questions and used ethics in their own work at least two to three times per month.
	• Participants reported that they engaged in hands-on research activities at least two to three times per month during REAP. Data indicates that while some REAP apprentices frequently engage in complex activities, others do so very infrequently.
REAP exposes participants to science experiences not readily available in high school.	• Participants reported that they engaged in scientific reasoning and hands-on research activities more frequently in REAP than in their high school classes. Participants reported that they used advanced science or engineering equipment and worked as a team on research projects more than "once per week" during REAP but reported doing so less than "2 or 3 times per month" during high school.

REAP introduces participants to the real world of research in STEM.	• Participants and mentors agreed that participants were exposed to advanced scientific projects led by a university scientist (participant avg. 5.33 on a 6 point scale, mentor avg. 5.78) and that participants were exposed to scientific research that will have a real-world impact (participant avg.5.56, mentor avg. 5.67).
REAP partners participants with faculty mentors to support current and future professional growth and development.	• Participants would recommend their mentors (avg. 5.56 on a 6 point scale) and mentors would recommend their participants (avg. 5.78) for participation in future internships. Both participants (avg. 4.67) and mentors (avg. 5.00) are interested in participating in other AEOP programs or taking REAP apprentices in the future.
	• Participants agreed most often that their mentor helped them clarify pathways to achieve academic goals (avg. 5.11), gave them advice about necessary steps to achieve their goals (avg. 4.89), and taught them about professional and educational networks that will help them in the future (avg. 4.89).
	• Mentors agreed most often that they will write letters of reference for participants (avg. 5.78) and that they gave their participants advice about steps for achieving their professional goals (avg. 5.00).

RECOMMENDATIONS

The evidence collected during the 2012 assessment informs the following recommendations for future REAP programs:

- The number of applications for positions in the programs (more than 1,500 applications for 112 funded slots) is indicative of considerable unmet need. In light of the evidence of program success collected in this assessment, it is recommended that the Army expand the initiative – engaging more mentors and creating more participant slots.

- The geographic mapping of 2012 REAP apprenticeships indicate that opportunities to participate in REAP are concentrated in certain areas instead of being available throughout the nation. Of the fourteen mentors who participated in the assessment, nine have had previous experience as REAP members – one has hosted 50 apprentices over the last 30 years. It is recommended that the process of selecting mentors and participants be reviewed to maximize both access for participants and mentor quality.

- Data indicates that REAP participants intend to pursue careers in STEM. While mentors provide participants with information about STEM careers and educational pathways based on participant interest, mentors are less successful in providing information about STEM careers with the Army. It is recommended that a resource on STEM careers with the Army be created (perhaps in conjunction with other AEOP elements that share this challenge) and that it be provided to mentors and participants for use within the REAP experience.

- While it was not identified as a specific REAP objective at the point of 2012 program implementation, cross-promotion of other AEOP initiatives has become a recognized priority for all of the AEOP elements. The 2012 REAP apprentices were largely unaware of other opportunities available to them in the AEOP. Efforts should be made to significant increase the exposure of both participants and mentors to information about other opportunities in the AEOP portfolio. Specifically, REAP apprentices

should be targeted for participation in the Junior Science & Humanities Symposium (JSHS). This would be an ideal venue for the presentation of research completed through REAP.

- Considering the specific AEOP objective of expanding STEM outreach to representatives of groups that are historically underserved and underrepresented in STEM, it is recommended that REAP return to its original intent of providing research experiences to members of these target populations. This change is in the process of being implemented for the 2013 program. Additionally, the REAP administrator is collaborating with the administrator of UNITE, an AEOP pre-engineering summer program for members of historically underserved and underrepresented groups, to develop a pipeline for participants between the programs. Several alumni from the 2012 UNITE program will serve as 2013 REAP apprentices.

Table 2. 2012 REAP Fast Facts	
AEOP Element	Research & Engineering Apprentice Program
Participant Group	High school students
Number of Participants	131 (112 funded slots)*
Total Cost	$420,540 (FY12 investment of $347,000)
Average Cost Per Participant	$3,210

** Universities that host REAP students are provided with $1,300. Often this funding goes to support the mentor. In some cases this funding is reallocated to afford an additional REAP apprenticeship. In 2012, 19 additional apprenticeships were supported through this process*

EXECUTIVE SUMMARY

The Science & Engineering Apprentice Program (SEAP), managed in FY12 by George Washington University (GWU) and in FY13 by the American Society for Engineering Education (ASEE), is an Army Educational Outreach Program (AEOP) that places high school students in summer apprenticeships at Army research facilities. Each SEAP apprentice works under the direct supervision of a scientist or engineer on a hands-on research project. Through the eight week SEAP experience, apprentices are exposed to the real world of research, they gain valuable mentorship, and they learn about education and career opportunities in STEM. SEAP participants learn how their research can benefit the Army as well as the civilian community.

In 2012, SEAP provided outreach to 154 participants at 12 laboratory sites. 796 students submitted applications to the program.

The 2012 SEAP program was assessed with a participant questionnaire and a mentor questionnaire and rubric. Although the questionnaires were distributed to all participating laboratories, completed forms were received from only half of the sites. Fifty-one (33%) SEAP apprentices completed a participant questionnaire. Forty-two (27%) mentor questionnaire and rubric forms were completed by 34 mentors (some mentors host multiple apprentices). The data set includes 23 matched pairs of student and mentor assessment forms. Seventy of 154 participants in the 2012 SEAP program are represented in the data set, constituting a total response rate of 45.5%. While the assessment response rate is not optimal, it is sufficient to generalize the findings from the data to the SEAP program as a whole. However, only half of the SEAP sites and less than half of SEAP apprentices are represented in the evaluation making it necessary to use an appropriate amount of caution when interpreting specific results that may be idiosyncratic to one site and not another.

The assessment of 2012 SEAP indicates achievement of most objectives. In particular, the data indicates that:

Table 1. SEAP 2012 Outcomes

SEAP nurtures interest and excitement in STEM for high school participants.	• Participants reported high levels of interest and positive attitudes toward STEM (scale avg. 5.12 on a 6 point scale). Participants enjoyed hands-on activities at SEAP (avg. 5.59) and want to study more STEM after participating in SEAP (avg. 5.37).
	• Participants reported that they received STEM educational and career guidance from their mentors (scale avg. 4.98). Participants felt that their mentors encouraged them to perform a variety of tasks in the laboratory (avg. 5.35), worked with them in the laboratory (avg. 4.80), and helped them become better writers of scientific research (avg. 4.98).

SEAP provides STEM outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM.	• Over 10% of 2012 responding SEAP participants were from groups historically underrepresented and underserved in STEM (7% Black/African American, 3% Hispanic/Latino). 77% of participants attended public schools, 10% attended private schools, and 14% were home schooled. 35% of participants attended rural or urban schools. None of the SEAP participants reported that they qualified for free or reduced lunch.
	• Of the SEAP mentors that participated in the assessment, there were significantly more males (62%) than females (38%). 12% of responding mentors were from groups historically underrepresented and underrepresented and underserved in STEM (9% Black or African American and 3% Native American).
SEAP increases participant knowledge in targeted STEM areas and develops participant research and laboratory skills as evidenced by mentor evaluation and the completion of a presentation of research (poster, paper, oral presentation, etc.).	• Participants engaged in scientific reasoning activities more than 2-3 times per month (avg. 3.64 on a 6 point scale) and engaged in hands-on research activities more than once per week (avg. 4.17). Participants engaged in the same activities less often during their regular school experiences (scientific reasoning activities avg. 2.99, hands-on reasoning activities avg. 3.22).
	• Participants reported very high levels of confidence in their STEM research skills and abilities (avg. 5.10).
	• On four rubrics with skills ratings from 1 to 6, SEAP mentors rated participant STEM research skills very highly (avg. 4.58 to 4.83). On six rubrics, mentors gave participant final research projects very high marks for quality (avg. 4.74 to 5.19).
SEAP encourages participants to pursue post-secondary education in STEM.	• 92% of participants intend to pursue a bachelor's degree. 88% of intend to pursue a bachelor's degree, or beyond, within a STEM field and 54% intend to pursue a doctoral degree within a STEM field.
	• Participants are very confident that they will achieve their educational goals: attend college to pursue their desired degree (avg. 5.71 on a 6 point scale), finish their desired degree (avg. 5.43 on a 6 point scale), and get good grades in class (avg. 5.36).
SEAP educates participants about careers in STEM fields with a particular focus on STEM careers in DoD laboratories.	• Participants reported that they learned about new STEM careers (avg. 4.76 on a 6 point scale) and new DoD STEM careers (avg. 4.68) during SEAP.
	• Participants reported some interest in the STEM careers (avg. 3.90) and DoD STEM careers (avg. 4.02) that they learned about during SEAP. Mentors reported that participants were interested in pursuing STEM careers (avg. 4.59) and had some interest in DoD STEM careers (avg. 3.85).
	• 79% of participants reported being most interested in applied research fields (chemistry, engineering, technology, medical, etc.). Others were interested in academic research (12%) or service careers (9%).
	• 76% of mentors agreed that they educated participants about a variety of STEM careers and 80% agreed that they educated their participants specifically about DoD STEM careers. 70% of mentors agreed that they provided information to participants about civilian research programs within the DoD.

SEAP acquaints participants with the activities of DoD laboratories in a way that encourages a positive image and supportive attitude towards our defense community.	• Participants reported positive opinions of the DoD and impact that DoD research has on society (avg. 5.18 to 5.50 on a 6 point scale).
	• Mentors reported that participants have a positive attitude toward the DoD and the STEM careers that it offers (avg.4.44).
SEAP has limited success in providing information to participants about opportunities for STEM enrichment through the Junior Science & Humanities Symposium (JSHS), College Qualified Leaders (CQL), and other AEOP opportunities.	• With the exception of GEMS, apprentices did not participate in AEOP programs prior to their involvement with SEAP. 98% of apprentices have not heard about Junior Solar Sprint (JSS), 86% have not heard about eCYBERMISSION, and 74% have not heard about the Gains in the Education of Mathematics & Science (GEMS)-Near Peer program. 60% of 2012 SEAP participants have heard of GEMS and 35% are alumni of the GEMS program.
	• With the exception of CQL, SEAP apprentices have not heard about the AEOP programs that they will be eligible to participate in during the coming years. 90% have not heard of JSHS, 80% have not heard of the High School Apprenticeship Program/ Undergraduate Research Apprenticeship Program (HSAP/URAP), and 76% have not heard of the Research & Engineering Apprenticeship Program (REAP). 60% of SEAP participants have heard about the CQL program and 45% of apprentices would like to take part in it.
	• SEAP mentors are uninformed about many AEOP programs – specifically those that take place outside of the Army laboratories. While 78% of mentors knew about the CQL program, only 34% knew about JSHS. Only 35% of mentors agreed that they provided information to participants about one or more AEOP program.

2012 SEAP participants and mentors expressed a high level of satisfaction with the program. 89% of participants and 90% of mentors indicated that they would participate in SEAP again, if provided the opportunity.

WHAT PARTICIPANTS ARE SAYING

- *I had a good overall experience with the SEAP research I did this summer. One of the best parts was working with other interns and mentors and learning information related to other projects as well. I enjoyed working in a professional environment and working with equipment I am normally not exposed to.*

- *The most valuable part of the experience is being able to work with a scientist closely in a lab environment. It helped expose me to where I see myself in the future.*

- *Overall, I am satisfied with my SEAP research project and final presentation. I feel that I've worked hard and learned a lot, which having an enjoyable experience with a great mentor and great coworkers. The most valuable part was learning about the patience and persistence it often takes to do research and all the work it takes to write a thorough lab research paper.*

- *I was exceedingly satisfied as it was one of the highest level projects I had ever worked on. Furthermore, it was a fun atmosphere, and made me look forward to working on ARL every day.*

- *SEAP was a very enjoyable, educational experience. I learned a lot about different experimental techniques, and how to work in a lab environment. The final presentation helped me to learn to present my work to a large audience. The most valuable part of the experience was being able to conduct and present my own research.*

- *My project provided great insight into the daily life of a scientist. The fact that research is trial and error, new ideas, and continually modifying designs. It was invaluable knowledge.*

- *[my apprentice] is a very intelligent individual that was enjoyable and frustrating to work with. Working with him was enjoyable because of his intense curiosity, inquisitiveness, and outgoing personality. At times, however, progress was constrained due to issues of overconfidence, assumptions, and assertiveness. Over the course of the summer, it became clear that [my apprentice] has not frequently been in a situation of being inexperienced and often wrong in his understandings. However, given enough time and discussion, his progress learning was continuous and progress was significantly useful.*

- [*my apprentice] showed great ability to learn and conduct research. He grew a lot over this summer and will make an excellent summer student next year and even better student after entering college.*

RECOMMENDATIONS

The evidence collected during 2012's assessment informs the following recommendations for future SEAP programs:

- The number of applications for positions in the programs (795 applications for 154 funded slots) is indicative of considerable unmet need. In light of the evidence of program success collected in this assessment, it is recommended that the Army expand the initiative – engaging more mentors and creating more participant slots. 35% of the 2012 SEAP participants indicated that they were alumni of the GEMS program. Efforts should be made to enable GEMS alumni who are qualified and interested in SEAP the opportunity to participate in the program. (Note. At some sites where GEMS programs exist through the high school level, GEMS participants will skip SEAP and move directly to CQL when they enter college.)

- The 2012 SEAP program objectives included providing STEM outreach to participants inclusive of youth from groups historically underrepresented and underserved in STEM. There was considerable discussion of this objective during the RFP process to solicit the FY13 administering organization (ASEE). It is recommended that the objective be reviewed by Army administrators to ensure alignment with the Army's vision for the SEAP program. If the objective is to remain, it recommended that strategies to recruit more participants from populations historically underrepresented and underserved in STEM be incorporated in future marketing efforts. Best-practices in outreach to underserved groups should be shared among site coordinators.

- SEAP educates participants about careers in STEM fields with a particular focus on STEM careers in Army and DoD laboratories. It is recommended that a resource on STEM careers with the Army and DoD laboratories be created (perhaps in conjunction with other AEOP elements that share this challenge) and that it be provided to mentors and participants for use within the SEAP experience.

- Few SEAP participants have heard of AEOP opportunities beyond the GEMS and CQL programs – which often take place in the same location as SEAP. Ideally, every SEAP participant should leave the program knowing what their next step is with the AEOP. Participants should be encouraged to submit the research they accomplished in SEAP to the Junior Science & Humanities Symposium high school research competition. Considering that 45% of SEAP participants are interested in taking part in CQL, efforts should be made to ensure that the program maintains enough positions to meet the need of SEAP alumni. The pipeline between GEMS, SEAP, and CQL is a localized best practice in STEM outreach (see the 2011 AEOP Summative Evaluation Report).

Table 2. 2012 SEAP Fast Facts	
AEOP Element	Science & Engineering Apprentice Program (SEAP)
Participant Group	High school students
Number of Participants	154
Total Cost	$468,000*
Average Cost Per Participant	$3,309

** The 2012 SEAP program cost includes $118,000 in administrative costs to the AEOP and $350,000 in stipend costs to participating laboratories.*

EXECUTIVE SUMMARY

The STEM Teacher Program Initiative (STPI), managed by the University of New Hampshire, is an Army Educational Outreach Program (AEOP) effort that supports and empowers educators with Army research and technology resources. STPI provides science, technology, engineering, and mathematics (STEM) content, professional development, and experiential learning environments for K-12 teachers. In partnership with Harford Community College (HCC) and the Army Research Laboratory at Aberdeen Proving Ground (ARI-APG), STPI organized the first STEM Teachers Academy (STA) in the summer of 2012. The STA provided 52 teachers - representing 31 schools, all STEM disciplines, and grade levels ranging from elementary through high school – with a one-week professional development experience focused on environmental literacy. During this week, participants received instruction from ARL scientists and engineers along with faculty from HCC. STA participants are expected to complete several program requirements and maintain electronic communication with administering personnel for a year following the initial experience.

The 2012 STA was assessed with a participant questionnaire at the culmination of the one-week professional development experience. Additional waves of assessment will occur at six and nine months post-event. The initial assessment of the 2012 STA indicates achievement of most objectives. In particular, data indicates:

Table 1. 2012 STPI Outcomes

STA content, activities, and presentations will be adapted to lesson plans and teaching in participant classrooms.	• Participants intend to develop lesson plans and teachings around energy literacy (87%), environmental literacy (88%), and other STA content (82%).
STA encouraged participants to seek out collaborations with other teachers and STEM professionals.	• Participants agree that STA encouraged them to seek out collaborative opportunities with other teachers (avg. 5.03 on a 6.0 scale) and STEM professionals (avg. 5.09).
	• Participants agree that they will need to collaborate with teachers across subject and grade levels to bring environmental and energy literacy to their schools.
STA provided participants with the content and confidence to develop professional development activities for their schools.	• Participants agree that STA content could be used to inform important professional development activities (avg. 4.47 on a 6.0 scale).
	• Participants are confident that they can develop (avg. 4.43) and lead (avg. 4.40) professional development activities at their schools.
STA participants intend to use STA content to lead energy and environmental literacy initiatives within their schools.	• Participants will use STA content to motivate students to participate in energy and environmental literacy activities (avg. 5.0 on a 6.0 scale) and will improve the environmental sustainability of their schools (avg. 4.97).
	• Participants intend to lead energy and environmental literacy efforts at their schools (avg. 4.72) and intend to analyze sustainability efforts at their schools (avg. 4.56).

STA increased the energy and environmental literacy of participants.	• Participants agree that STA increased their knowledge of energy science (avg. 5.58 on a 6.0 scale), electricity (avg. 5.29), alternative energy (avg. 5.48) and environmental impact (avg. 5.23).
	• Participants agree that STA increased their confidence with energy science (avg. 5.32) and environmental literacy (avg. 5.23).
STA had limited success in increasing the visibility of AEOPs to participants.	• STA participants are most familiar with the Gains in the Education of Mathematics & Science (GEMS, 84%), Science & Engineering Apprenticeship Program (SEAP, 70%), eCYBERMISSION (68%), and the Research & Engineering Apprenticeship Program (REAP, 63%).
	• STA participants are least familiar with the Junior Science and Humanities Symposium (JSHS, 57%), Junior Solar Sprint (43%), and College Qualified Leaders (CQL, 41%) initiatives.

WHAT PARTICIPANTS ARE SAYING

"I thought the program was very well put together and well thought out. There was a very diverse group of experts that taught us the complexities of energy, from the science behind how it's captured and stored, to the science behind how and why it's used… All avenues of energy literacy were explored and presented in a way that we could make sense with."

"I was impressed with the ways the DOD at APG has developed the use of fuel cells for use in the field. Many of these will make it into the civilian market and change the ways we power our technologies."

"The speakers provided excellent information and resources. It was educational to see applications of research. The field trips provided excellent reinforcement of the basic research."

"I would love to invite a few of the presenters to my classroom as a guest speaker to give the students an opportunity to meet and talk with a practicing scientist. That would mean more to them then hearing it from their teacher, while knowledgeable, not quite in the thick of things."

"I will be bringing my class on a tour of green building technologies with one of our presenters from the STA. I plan to keep in touch with the four other members of my lesson plan group in order to share teaching methods and ideas."

"I got to appreciate what the Tech Ed teacher in my school does and her desire to know the science applications behind her topics. We started and will continue to talk about ways to cross reference each other's material to allow students to understand that we do not teach separate subjects, but they all intersect somewhere. This holistic approach should increase student achievement across subject areas."

"At [my school] we are working to become towards green school certification as part of our School Improvement Plan. We would like to present some of the lessons we have created to our faculty in an attempt to spark their interests and get feedback on how the lessons could be adapted to their content areas."

RECOMMENDATIONS

The first STA was successful in providing STEM content, exposure to Army STEM experts, opportunities for collaboration among participants, and material for participants to use in STEM professional development

activities at their schools. The evidence collected during assessment informs the following recommendations for future STA programs:

- While the STEM content of STA is important, participants are focused on how they will be able to translate the material to their classrooms and schools. It is recommended that STA be structured so that participants leave the program with hands-on activities and lessons that can be directly applied in their classrooms. This should include supporting resources such as ideas for local field trips and a list of potential guest speakers.

- As teachers, STA participants are aware of the teaching methods utilized in the presentation of content and are critical of a strict lecture format. It is recommended that STA administrators work with the STEM expert presenters to help them model best-practices in pedagogy. Through this practice, participants will receive professional development in STEM content and teaching methods.

- STA participants value the opportunity to collaborate with their peers in developing lessons based on program content. This is also one of the program objectives. It is recommended that the program be structured to provide adequate time for and support of this practice.

- STA participants questioned the 2012 program structure that separated the group into two tracks and resulted in limiting participants' ability to take part on area STEM field trips. It is recommended that the program structure be reviewed to ensure that it is effective and provides equivalent opportunities to all participants.

- In the effort to achieve the objective of increasing the visibility of AEOP opportunities, it is recommended that information about AEOP initiatives be purposefully programmed into the STA curriculum. Location pending, it may be possible for STA participants to visit a GEMS program and/or tour the Army Labs in which Science & Engineering Apprenticeship Program (SEAP) and College Qualified Leaders (CQL) students have their internships. STA administrators should provide participants with Junior Solar Sprint (JSS) and eCYBERMISSION curriculum resources which provide a direct link between the AEOP and the classroom.

Table 2. 2012 STPI Fast Facts	
AEOP Element	STEM Teacher Program Initiative (STPI)
2012 Initiatives	STEM Teachers Academy (STA)
Participant Group	Teachers (grades 4-12), from Maryland's Harford and Cecil Counties
Number of Participants	52
Total Cost	$78,772
Average Cost Per Participant	$1,515

APPENDIX H:
UNITE
FY12 EVALUATION

EXECUTIVE SUMMARY

UNITE, managed by the Technology Student Association (TSA), is an Army Educational Outreach Program (AEOP) pre-collegiate initiative for high school students from groups historically underrepresented and underserved in science, technology, engineering, and mathematics (STEM). UNITE encourages and helps prepare high school students to pursue a college education and career in engineering. In a four to six-week summer program, hosted at sites throughout the country, UNITE provides academic and social support to participants so that they have the ability and confidence to become successful engineers.

In FY12, TSA facilitated a competitive RFP process to identify UNITE host sites – something that had not been done for many years. Sixty proposals were submitted in response to the UNITE host site RFP and nine were competitively selected to receive funding. The host sites received applications from twice as many qualified students as they had positions for the 2012 UNITE program. 420 students applied and 193 enrolled. All participants were members of groups that are historically underserved and underrepresented in STEM.

The 2012 UNITE program was assessed with pre-program and post-program questionnaires. Data was combined from matched questionnaires to measure participants' perceptions of their change and growth through UNITE. The assessment of the 2012 UNITE indicates achievement of most objectives. In particular, data indicates:

Table 1. 2012 UNITE Outcomes	
UNITE effectively shows participants the real-world applications of math and science.	• 78% of participants agree that they learned ways that science and math can be applied to solve real world problems.
	• 83% of participants agree that they learned many different ways that science and math are applied in different careers.
	• 79% of participants agree that they learned about new jobs that frequently apply science and math.
	• 75% of participants agree that they learned about different pathways toward a career or job that uses math and science applications.
UNITE raises participant confidence in the ability to participate in engineering activities.	• UNITE participants demonstrate confidence in their ability to participate in engineering activities before they start the program (overall average confidence rating of 4.64 on a 6.0 scale).
	• UNITE participants experience an increase in confidence in their own engineering skills and abilities through the program (overall average confidence rating of 4.76 on a 6.0 scale).
	• UNITE has the most significant impact on growth in participant's confidence with regards to their ability to apply engineering principles to solve real world problems and their skill at identifying, formulating, and solving engineering problems.

UNITE inspires participants to consider engineering majors in college by providing participants with an understanding of what it means to work as an engineer, illustrating pathways to engineering, and establishing support systems.	• UNITE participants experienced an increase in agreement with measures of the extent to which they knew about pathways to becoming an engineer, the extent to which they identify as an engineer, and the support that they received to pursue engineering same measures (increase of 0.36, final overall average agreement rating of 4.43 on a 6.0 scale).
	• UNITE participants gained knowledge about the high school course work required to pursue engineering studies at the collegiate level (0.38 difference), and gained a better understanding about different types of engineering majors (0.50 difference).
	• UNITE increased participants' support networks. After UNITE, participants indicated that they had a better support network to become an engineer from UNITE staff members (1.10 difference), from current engineering majors (0.71 difference), and those working in the field (0.31 difference).
UNITE works to remove social barriers and negative attitudes about engineering. While students experience an increase in motivation they also experience an increase in disengagement.	• UNITE participants start the program with positive attitudes about engineering and the academic precursors needed to pursue a degree in the field (overall average motivation rating of 4.24 on a 6.0 scale, overall average perceived importance of knowledge and skills rating 5.05, and overall disengagement rating of 1.86).
	• UNITE participants start and end the program with similar strong perceptions of the importance of knowledge and skills to engineering (0.03 difference).
	• UNITE participants report an increase in their level of disengagement at the culmination of the program (0.29 difference). The most significant increases in disengagement are indicated with participants' increase in agreement that they often turn in math, science, and engineering assignments late (0.38 difference) and their increase in agreement that they are often late to math, science, or engineering classes (0.30 difference).
UNITE promotes collaboration and problem-solving in a team environment.	• Almost all participants indicated that they regularly engaged in the collaboration and teamwork behaviors during UNITE. Participants indicated that they most frequently participated in active listening (avg. 4.15 on a scale where "two to three times per week" is coded as 3, "four to five times per week is coded as 4, and "multiple times per day" is coded as 5), used the ideas of teammates in problem-solving (avg. 3.94), and shared answers (avg. 3.88) or ideas (avg. 3.81) with team members.
UNITE works to increase the number of STEM graduates to fill the projected shortfall of scientists and engineers in national and Department of Defense (DoD) careers.	• UNITE participants intend to pursue a Bachelor's level of education or higher (93.3%) and a majority of them intend to pursue advanced degrees (Master's or Doctoral at 77.1%).
	• A majority of participants intend to pursue a STEM-related college degree (56.5%).
	• UNITE participants express a high level of confidence that they will achieve their educational goals.
UNITE exposes participants to STEM careers in the Army and DoD.	• On average, participants indicated that they learned about four or more STEM careers in the Army and DoD during UNITE.

WHAT ARE PARTICIPANTS SAYING

What was the most interesting STEM topic you learned about in UNITE?

- *The most interesting science/engineering topic i learned in the Unite program was how to build robotic arms. All of the topics I participated in were interesting because the UNITE program was very fun! I would be happy to come back.*

- *Biomedical/Mechanical engineering was my favorite topic during UNITE. I enjoyed learning about how math and science can be turned into devices to help the human body. I am pretty positive I want to pursue a career in this field.*

- *When we saw engineers at work (ex. Beach field trip) and the results of their work (Brickell field trip). I also liked how we were able to hear about the college experience of engineers in the E for Engineering Career Fair.*

- *The most interesting science/engineering topic I learned about in UNITE was about metallurgical engineering and their role in other engineering disciplines as providing the materials necessary for engineers to do their job.*

- *The most interesting science/engineering topic that I learned about was the engineering involved in preparing NASA rovers to explore Mars.*

- *The most interesting STEM topic I've learned about has to be Military Ethical hacking; I wanted to actually learn more about it.*

- *The most interesting topic we discussed has to be building a robotic arm. Also I enjoyed being able to visit University of Alabama, and Auburn University to take a look at their engineering programs. We also made earthquake tower, water jet cars, and sumo-bots in teams of four.*

- *The topic that was interested to me the most in engineering was going to Huntsville, the engineering classes, going on Maxwell Air Force Base, and the forensic science building tour, and learning how to solve a case.*

- *The most interesting topic that I learned about in Unite was biomedical engineering. In a course called "Engineering the Human Body", I learned how complex the solutions to different human body problems are and how biomedicines are able to solve these problems.*

RECOMMENDATIONS

The evidence collected during assessment informs the following recommendations for future UNITE programs:

- Data indicates that participants start the UNITE program with confidence in their ability to participate in engineering activities and motivation to pursue engineering. While a slight increase in confidence in both areas is indicated by the 2012 data, it is recommended that efforts be made to deepen the program's impact on participants.

- It is recommended that host sites consider the data on disengagement captured in this assessment during program implementation. What do the host-site administrators perceive to be the cause of increased disengagement? How can this be addressed?

- According to assessment data participants indicate that they learned about numerous careers and gained a support network through UNITE. If resources allow, it is recommended that efforts be made to formalize a mentor relationship for each student – perhaps a mentor in their engineering career field of choice. This

effort could help address the issue of providing continued support to participants at the culmination of UNITE.

- While it was not measured in 2012, participants in the 2013 UNITE program should be exposed to other relevant offerings with the AEOP. A bridge between UNITE and the Research and Engineering Apprentice Program (REAP) is currently under development for implementation in 2013. UNITE participants should also be exposed to opportunities with the Junior Science & Humanities Symposium (JSHS), the West Point Bridge Design Contest, the Science & Engineering Apprenticeship Program (SEAP), and College Qualified Leaders (CQL).

- The significant number of host site applications (60 applications for 9 awards) and number of applications for positions in the programs (420 applications for 193 slots) is indicative of considerable unmet need. In light of the evidence of program success collected in this assessment, it is recommended that the Army expand the program – funding more host sites and more participant slots.

- It is recommended that the program administrator, Technology Student Association, develop an online repository for curriculums and best practices used during UNITE (as an example see the GEMS wiki). Although host sites vary, it could be meaningful in the future to develop a set of shared core curricular concepts. Efforts should also be made to connect host site administrators so that they can share ideas and best practices during the phase of programming planning. While this may not be possible to do in-person due to the expense of travel, it may be valuable to establish an online platform for idea exchange. It is recommended that UNITE capture information from current host site administrators to build the resources of UNITE that will be useful for program replication well in the future.

Table 2. 2012 UNITE Fast Facts	
AEOP Element	UNITE
Participant Group	High school students from groups historically underserved and underrepresented in STEM
Number of Participants	193
Total Cost	$328,401
Cost Per Participant	$1,702

Summative Outcomes FY2012
Highlight Sheet

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.

Virginia Tech is charged with evaluating the AEOP and its constitutive elements. This highlight sheet, prepared by Virginia Tech, is intended to present several key findings of the 2012 evaluative project prior to the release of official assessment reports. Questions should be addressed to Tanner Bateman (tbateman@vt.edu or 540.231.4540).

A list of AEOP acronyms and brief program descriptions is included at the end of this document.

What AEOP participants are saying…

"This GEMS experience was a truly phenomenal experience that helped me decide to pursue a career as, hopefully, an Army research engineer."

~ GEMS Participant, 2012

"Biomedical mechanical engineering was my favorite topic during UNITE. I enjoyed learning about how math and science can be turned into devices to help the human body. I am pretty positive I want to pursue a career in this field."

~ UNITE Participant, 2012

"I am so blessed that I had the chance to participate in JSHS at the Regional and National levels this year. The experience was absolutely life-changing, and has reaffirmed my interest in majoring in a STEM field in college. The friends I have made will definitely be a large part of my life now, as I learn about what kinds of research they are working on and the facilities they have access to. It is incredibly encouraging to see adults today from all parts of the country care to such an amazing extent to better help this generation of students in the pursuit of science. I am so grateful I had this opportunity, and thank you again for all of your hard work in putting this event on each year - it means more to me than I can express in words."

~ JSHS Participant, 2012

"My favorite activity[at the National Judging & Educational Event] was the STEM Tech Expo because it gave me a chance to see all different ways that science is applied to everyday lives of soldiers in our Army, and it also had stations using Biology and Chemistry, my two favorite parts of science."

~eCYBERMISSION Participant, 2012

"The experience was inspiring. I am now confident that I will enjoy and do well in a research field. SEAP revealed what it was like to work in a lab and to be faced with a problem that you must solve: something I don't think I could have learned anywhere else."

~ SEAP Participant, 2012

"[My apprentice] is an exceptional student. He is very intelligent and motivated. Importantly, he is curious and has a true thirst for knowledge. He will be a tremendous asset to the US science and engineering enterprise. I recommend this highly gifted student for academic and research fellowships in the future."

~ REAP Mentor, 2012

AEOP Goals and FY12 Outcomes

GOAL 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.	
Outcomes	
The AEOP provided outreach to approximately 53,408 participants in 2012.	• 52,573 students participated in the 2012 AEOP.
	• 835 teachers and mentors participated in the 2012 AEOP.
	• 17 Army laboratories or installations and 111 American universities or colleges hosted AEOP participants in 2012.
	• The AEOP received applications from many more qualified participants than it could serve in 2012: GEMS received 2,755 applications for 1,614 positions; SEAP received 796 applications for 154 positions; CQL received 373 applications for 274 positions; and REAP received more than 1500 applications for 131 positions.
AEOP participants have education and career aspirations in STEM.	• 99.4% of AEOP high school participants intend to pursue post-secondary education; 74.1% intend to pursue an undergraduate degree in STEM; and 64.3% intend to pursue a graduate degree in STEM.
	• GEMS increases participants intent to go to college to study STEM (9.7% increase) and intent to take a future internship or apprenticeship in STEM (11% increase).
	• 83.3% of HSAP/URAP and REAP participants are certain that they will build a career around their STEM skills.
2,246 AEOP participants were exposed to or participated directly in ongoing DoD research in 2012.	• 525 high school and college students served as apprentices on DoD research projects through SEAP, CQL, and HSAP/URAP.
	• 1614 middle school and high school students as well as 107 near peer mentors and instructors were exposed to DoD research through GEMS.
The AEOP provides participants with frequent exposure to hands-on research activities that they do not have access to in their regular schools.	• GEMS participants report that they get to participate in hands-on research activities more than once per day during the GEMS program as compared to less than once per week during their regular classes at school.
	• HSAP/URAP, REAP, and SEAP participants report that they participate in hands-on research activities multiple times per week during their AEOP apprenticeship as compared to 2-3 times per month in their regular schools.

AEOP mentors are effective in teaching STEM concepts and motivating participants to pursue STEM research and education.	• 81.4% of HSAP/URAP, REAP, and SEAP participants and 68.5% of National JSHS participants credit their mentors for teaching them concepts fundamental to STEM research.
	• 78.1% of National JSHS participants agree that their mentor helped motive them to pursue STEM research.
	• 72.8% of HSAP/URAP, REAP, and SEAP participants agree that their mentor helped them to formulate their educational goals.
The AEOP provides students from underrepresented groups with tools to achieve their educational goals in STEM.	• 193 high school youth from populations that are historically underrepresented and underserved in STEM participated in UNITE, a pre-collegiate engineering summer initiative that took place at nine universities.
	• UNITE participants agree that they learned about new STEM careers (79.3%) and educational pathways to STEM careers (74.9%).
	• UNITE increases participants confidence in their ability to apply engineering principles to solve real world problems (7.1% increase).
AEOP participants are exposed to Army and DoD STEM careers	• 92.2% of UNITE participants reported that they learned about at least one STEM career in the DoD/Army during their summer program. 74.5% of GEMS participants reported the same.
	• 59.3% of HSAP/URAP, REAP, and SEAP participants report that they learned about new STEM careers within the DoD/Army during their apprenticeship.
	• 82.0% of SEAP apprentices would feel very comfortable taking a civilian job with the DoD because the research is valuable to society.

GOAL 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.
Outcomes
• 835 teachers and mentors participated in the 2012 AEOP.
• The AEOP provided online resources to teachers through the eCM and STPI programs.
• JSS was restructured so that it will be an online resource center for teachers and mentors in 2013.
• 52 teachers who participated in the STEM Teachers Academy (a program of STPI) received instruction from Army scientists and engineers.
• The AEOP developed 107 future science educators as near-peer mentors, giving them a firsthand experience implementing inquiry-based teaching methods in the GEMS program

GOAL 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.
Outcomes
• Virginia Tech provided assessment and evaluation for seven of the AEOP elements in 2012 (JSHS, SEAP, GEMS, REAP, UNITE, STPI, and HSAP/URAP). Reports on the individual assessments are forthcoming.
• The 2012 AEOP provided outreach to youth in grades 4-12, college students, and teachers.
• The AEOP developed a logo and branding campaign that will be implemented in a comprehensive marketing strategy in 2013.
• The AEOP leveraged millions of dollars in research funding and in-kind support to build a sustainable program infrastructure and implement STEM education programs for students of all ages. Over $3.7 Million in research funding was contributed by Army labs to support SEAP and CQL interns in 2012.
• The AEOP leveraged existing networks of outreach partners to access over 60,000 science educators/administrators/partners through the National Science Teacher Association (NSTA) and 180,000 STEM-interested middle and high school students through the Technology Student Association (TSA).

AEOP 2012 Participation Numbers

Acronym	AEOP Element	Brief Description	No. of 2012 Participants
AAP	Army Awards Program	Provides awards and judges at local, state, and ISEF science fairs.	**Total Awards = 1,209**
CQL	College Qualified Leaders	Apprentice program for college students at Army and DoD Labs.	*Placement Rate: 73%* Applicants = 373 **Total Participants = 274**
eCM	eCYBERMISSION	Web-based STEM competition for 6-9 grade students.	Students = 15,406 Advisors = 690 **Total Participants = 16,096** Volunteers (Ambassadors, Virtual Judge & CyberGuide)=1,773
GEMS	Gains in the Education of Mathematics & Science	Summer program in Army Labs for middle and high school students.	Student Applicants = 2,755 Student Participants = 1,614 Near Peer Mentors= 63 Teachers = 45 **Total Participants = 1,722**

HSAP/URAP	High School Apprenticeship Program, Undergraduate Research Apprenticeship Program	Apprentice programs for high school and undergraduate students in Army-funded labs at colleges or universities.	*Placement Rate: 33%* Applicants = 290 **Total Participants = 97**
JSHS	Junior Science & Humanities Symposium	Research competition for high school students, 48 regionals.	Students = 8,400 Teacher Awards = 48 **Total Participants = 8,448**
JSS	Junior Solar Sprint	Online resource center for teachers/mentors that supports an online solar car competition for 4-8 grade students.	Transitional year for program. Provided honorariums to support 9 races in the NE.
REAP	Research & Engineering Apprenticeship Program	Apprentice program for high school students at colleges or universities.	*Placement Rate: 9%* Applicants = 1,500+ **Total Participants = 131**
SEAP	Science & Engineering Apprentice Program	Apprentice program for high school students at Army and DoD Labs.	*Placement Rate: 19%* Applicants = 796 **Total Participants = 154**
STPI	STEM Teacher Program Initiatives	STEM professional development initiatives for teachers.	**Total Participants = 52**
UNITE	UNITE	Pre-collegiate, engineering summer program for high school students from groups historically underserved and under-represented in STEM.	*Placement Rate: 46%* Applicants = 420 **Total Participants = 193**
WPBDC	West Point Bridge Design Contest	Online bridge design competition and engineering experience.	**Total Participants = 25,032**
		Total 2012 AEOP Participants	**53,408**