Army Educational Outreach Program

Gains in the Education of Mathematics & Science
FY13 Annual Program Evaluation Report

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Executive Summary

Gains in the Education of Mathematics & Science (GEMS), administered in FY13 by the American Society for Engineering Education (ASEE) on behalf of the Army Educational Outreach Program's (AEOP), is a non-residential summer STEM enrichment program for elementary, middle, and high school students (herein referred to as students). GEMS is hosted by Army laboratories and takes place on site or in close coordination off site with area Army laboratories (herein referred to as GEMS sites). GEMS is driven by the overarching mission: to interest youth in STEM through a hands-on Army laboratory experience that utilizes inquiry-based learning and near-peer mentoring. GEMS is an entry point for a pipeline of AEOP opportunities affiliated with the US Army Research Laboratories. The various GEMS sites are run independently, with ASEE providing support and guidance in program execution to local lab coordinators. Although they operate under a shared mission, GEMS sites are free to include different topics in their curricula that highlight the mission of the laboratory and they may set, in addition to the overall program goals and individual laboratory goals. Instead of having a specific model and curriculum prescribed to GEMS sites, they are able to design curricula (using the hands-on, experiment-based model) and procedures that make sense considering the specialties of their facility and available resources. GEMS programs run from one to four weeks in length with Army scientists and engineers (S&Es), high school and college-level near-peer mentors (NPMs), and/or in-service resource teachers (RTs), facilitating educational activities, exposing students to Army STEM research and careers, and providing adaptive mentorship to students.

In 2013, GEMS provided outreach to 2,038 students at 13 different sites, representing a 26% increase in enrollment from 1,614 student participants in 2012. Consistent with historical data, many of the GEMS sites received applications from more qualified students than they could serve.

This report documents the evaluation of the FY13 GEMS program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for GEMS included pre- and post-GEMS questionnaires for students and on-site focus groups with students and mentors at four sites.

Table 1. 2013 GEMS Fast Facts	
Major Participant Group	Elementary, middle, and high school students
Participating Students	2,038
Participating K-12 Teachers	45
Represented K-12 Schools	628 (28 Title-I schools)
Participating Army Agencies	13
Participating Army S&Es	Not available
Total Cost	$730,070
Participant Stipends	$618,875
Cost Per Participant	$358

Summary of Findings

The FY13 evaluation of GEMS collected data about participants, their perceptions of program processes, resources, and activities, and indicators of achievement related to AEOP's and GEMS objectives and intended outcomes. A summary of findings is provided in Table 2.

Table 2. 2013 GEMS Evaluation Findings	
Participant Profiles	
GEMS student participation in evaluation yields high level of confidence in the findings.	• The statistical reliability achieved for the pre- and post-GEMS student questionnaires, as well as the pre- to post-GEMS matched cases (all <±2%) allow us to sufficiently generalize findings of the evaluation sample to the population. Three case studies for which pre- to post-GEMs statistical analyses were conducted further illustrate the potential effects of the simplest unit of a single GEMS program. Cases included beginner/I, intermediate/II, and advanced/III levels of GEMS and a range of topics.
	• Additional evaluation data contribute to the overall narrative of GEMS's efforts and impact, and highlight areas for future exploration in programming and evaluation, though findings from these data are not intended to be generalized to all GEMS sites and participants.
GEMS serves students of historically underrepresented and underserved populations.	• GEMS attracted participation from female students—a population that is historically underrepresented in engineering fields; however, student questionnaire respondents included more males (52%) than females (47%).
	• GEMS provided outreach to students from historically underserved minority race/ethnicity and low-income groups. Student questionnaire respondents included minority students identifying as Black or African American (23%), American Indian or Alaskan Native (1%), and Hispanic or Latino (7%). A small proportion (12%) of students reported qualifying for free or reduced lunch.
	• GEMS served students across a range of school contexts. Most student questionnaire respondents attended public schools (79%) and suburban settings (64%).
GEMS engages a diverse group of adult participants as STEM mentors.	• GEMS engaged Army Scientists and Engineers (S&Es, number unknown), college-level near-peer mentors (NPMs, 69), and in-service resource teachers (RTs, 45), who facilitated educational activities, exposed students to Army STEM research and careers, and mentored students.
	• At all GEMS sites visited by evaluators, students had access to mentors belonging to either the same gender (female) and/or the same race and ethnicity group.
Actionable Program Evaluation	
GEMS is strongly marketed to schools and teachers serving historically underserved groups.	• ASEE and GEMS sites employed multi-pronged efforts to market programs to and recruit students from populations of historically underserved students. Efforts included partnerships with minority-serving community organizations (e.g., Boys and Girls Clubs, 100 Black Men) and targeted marketing to on-post schools, rural schools, and schools in districts serving high proportions of low-income students.
	• Students most frequently learned about the local GEMS program from parents and family members (more than 50%) and from teachers and others at school (more than 20%).

GEMS students are motivated by positive past experiences and opportunities provided by GEMS.	• Students were most frequently motivated to participate in GEMS this year because of overall satisfaction with previous GEMS participation. Students also sought opportunities to explore or advance their STEM pathways, such as new or deeper learning about topics, developing STEM skills, engaging in hands-on activities, and clarifying future education or career goals.
GEMS mentors engage students in meaningful STEM learning, through team-based and hands-on activities.	• Mentors used a variety of mentor and/or instructional activities for productively engaging students in STEM learning, including: supporting student experimentation and exploration, facilitating small group and partner work, and using one-on-one teaching and peer-to-peer teaching to ensuring student understanding.
	• Most students (74%-93%) found their GEMS mentors to be excited about STEM, accessible to learners, and having impacted their learning. Students perceived that mentors cared about their learning (93%), were excited to do hands-on activities (87%), and were easy to learn from (81%).
GEMS mentors promote AEOP initiatives and Army STEM careers available at Army research laboratories.	• Most mentor interviewees had no awareness of or past participation in an AEOP initiative beyond GEMS or the AEOP's at the site, such as SEAP and CQL. Subsequently, students reported limited exposure and encouragement to pursue AEOP opportunities other than SEAP and CQL.
	• GEMS programs engaged Army S&Es as leaders of educational activities and as invited career speakers, in an effort to expose students to Army STEM research and careers.
	• Mentors at one site reported that their lessons culminate with information that helps them connect Army/DoD jobs and careers with the activities just completed by students in the GEMS program. These curricular supports were considered particularly useful to the NPMs and RTs at the site who were less familiar with the work conducted by the Army/DoD.
GEMS benefits participants over typical school STEM offerings.	• Mentors perceived that GEMS provides students with opportunities to explore and advance their STEM pathways and provides learning opportunities (e.g., environments, resources, and activities) not available in typical school settings.
	• Mentors perceived that GEMS benefits mentors, by expanding their STEM networks, their teaching and mentoring skills, and their instructional resources. GEMS is highly motivating environment.
	• Mentors suggest expanding GEMS' to address unmet need and to extend its geographic and demographic reach. Mentors also suggested that educators would benefit from outreach.
Outcomes Evaluation	
GEMS students have more frequent opportunities for students to engage in STEM activities than they have in school.	• Most students (75-90%) reported engaging in the various STEM activities multiple times per week during GEMS. Fewer students (26%-45%) reported participating in various activities at the same frequency in school.
	• The in-school vs. in-GEMS difference is statistically significant with a moderately strong to very strong effect across all GEMS program data. The strongest effects are related to students having opportunities to participate in hands-on activities and to decide how to carry out an experiment or activity to answer ones' own question. Strength of effects generally diminish with the advanced GEMS case.
	• Students suggested that hands-on activities during GEMS provided more meaningful learning than could be obtained through lectures and reading typical in school and were more engaging to students.

GEMS students have higher opinion of their STEM knowledge, skills, and abilities after GEMS.	• Greater proportions of students reported seven STEM skills and/or abilities post-GEMS (63%-81%) as compared to pre-GEMS (41%-72%).
	• While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. A strong effect is observed with students pre- to post-GEMS assessments of their knowledge of laboratory techniques. The number of significant differences and the strength of the effects generally diminish with the advanced GEMS case.
GEMS students have higher confidence to use their STEM knowledge, skills, and abilities after GEMS.	• Greater proportions of students reported confidence to use seven STEM skills and/or abilities post-GEMS (64%-76%) as compared to pre-GEMS (52%-67%).
	• While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. The strongest effect, and still considered weak, is observed with students pre- to post-GEMS confidence to communicate science and engineering concepts. The number of significant differences and strength of their effects generally diminish as the level of GEMS increases.
GEMS inspires and sustains students' interest in STEM.	• Greater proportions of students reported positive interest in STEM after GEMS (53%-90%) than reported positive interest after their school STEM experiences (44%-86%).
	• Across all items, the after-school vs. after-GEMS differences in attitudes or interest are statistically significant, but with weak effects. The largest effect was observed for interest level in learning from STEM classes (in school) vs. GEMS. Students participating in the advanced GEMS case exhibit no significant differences.
GEMS inspires and sustains students' intent to engage in future STEM.	• Greater proportions of students reported intent to engage in future STEM activities, education, and careers post-GEMS (58%-80%), as compared to pre-GEMS (55%-78%).
	• Across all items, the pre- to post-GEMS differences in intentions are statistically significant, but with very weak effects. Only students' intentions to work as a STEM intern or apprentice are considered "substantively important." Each case study revealed significant differences in one or more items that may relate to specific features of programming or to other program offerings at the site: STEM summer programs, STEM fair/competition, and STEM apprenticeships.
GEMS students may be unaware of the full portfolio of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• Most students (71%-80%) expressed interest in participating in the pipeline of programs available at the Army laboratories which hosted or sponsored their GEMS program (e.g., GEMS, SEAP, CQL).
	• Fewer students (43%-49%) expressed interest in the competitions (eCYBERMISSION, West Point Bridge Design Contest, and Junior Science & Humanities Symposium), and summer programs (UNITE) that are available outside of Army laboratories. Most student interviewees generally could not name, or recognize when named, AEOP initiatives outside of the Army laboratory GEMS-SEAP-CQL pipeline.
GEMS increases students' awareness of Army STEM jobs.	• Most students (87%) learned about multiple STEM jobs, and on average, students learned about 4 STEM jobs. Army/DoD STEM jobs received less attention that STEM jobs, with students exposed to an average of 3 Army/DoD STEM jobs.

Recommendations

1. The number of applications for GEMS (4231 applications for 2038 positions) is indicative of considerable unmet need and interest. The evaluation provides evidence of program success in support of expansion to accommodate this unmet need and interest. Expanding geographically to more GEMS sites alone may simply generate new or more need in new communities. Expanding the capacity of existing GEMS sites to serve more students would be needed to accommodate existing need in those communities. To expand the capacity of existing GEMS sites, greater investment may be required to expand site administrative staff, physical infrastructure needs, and mentor participation, most specifically Army S&E participation.

2. GEMS and AEOP objectives include expanding participation of historically underrepresented and underserved populations. While ASEE conducts targeted marketing of GEMS to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in reaching and determining GEMS participants. GEMS may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide, including but not limited to targeted marketing to and partnership with low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations. Guidance may also be provided to ensure other "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and GEMS sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site). In-residence programs, travel accommodations (e.g., bus transportation from schools) may be needed to recruit and make participation feasible for underserved populations living at greater distances from the GEMS sites.

3. Mentors play important roles in GEMS. Mentors design and facilitate learning activities, deliver content through instruction, supervise and support collaboration and teamwork, provide one-on-one support to students, chaperone students, advise students on educational and career paths, and generally serve as STEM role models for GEMS students. The FY13 mentor focus groups served as a baseline effort to collect information from this participant group, but a more systemic assessment of mentors is required to evaluate their engagement as STEM-savvy educators in AEOPs. Any future survey of mentors should, at a minimum, gather information about how mentors become aware of GEMS, motivating factors for participation in GEMS, satisfaction with and suggestions for improving GEMS programs, perceived benefits to participants, and mentor activities, including those relating to exposing students to AEOP opportunities and Army STEM careers.

4. As a whole, students began and ended GEMS with high opinions of and confidence in their STEM competencies, and ambitious STEM extracurricular, education, and career aspirations. The evaluation provides evidence of perceived growth in these outcomes across all program data, albeit with weak effects. Site-level data provides clearer evidence of GEMS' variable impact on students STEM confidence and

ambitions: the GEMS-I and II cases showed moderately strong to strong, significant effects across more indicators while the GEMS-III case showed fewer points of growth that were significant or with strong effect. These findings may indeed be specific to those cases; however, they may also provide evidence that beginning GEMS programs (often those targeted to upper elementary and middle school students) improve outcomes whereas advanced levels of GEMS sustain outcomes. Future evaluation should continue to explore cases to uncover differential effects that are masked when data is averaged across all sites, levels, and curricular topics. Where adequately powered, these case studies may also investigate whether differential effects across different demographic populations.

5. Data suggests that GEMS apprentices have more opportunities to do the *hands-on* aspects of STEM activity and fewer opportunities to engage in the *minds-on* aspects. Minds-on aspects of STEM activity have been linked to greater student affective and achievement outcomes than hands-on activities alone.[1] [2] Programs might consider how to expand students' opportunities to engage in challenging minds-on STEM activities such as generating questions, designing experiments, analyzing and interpreting data, and formulating conclusions for their questions during their GEMS programs. For example, one site required that students work in teams to apply their new learning to solving a case. Another AEOP, the UNITE program, had several sites that used weekly challenges or competitions to engage students in student-directed application of learning. Assessment data also suggest that students value opportunities to apply school learning to real world situations and in collaborative settings, as these are less common in typical school settings. Minds-on experiences may also continue to challenge and inspire older GEMS students and returning GEMS alumni who exhibited less change in outcomes related to STEM competencies and ambitions.

6. Mentor and student interviewees across the focus group samples reported limited awareness of and participation in any given AEOP initiative beyond the Army research lab GEMS-SEAP-CQL pipeline. Mentor interviewees reported spending little or no time educating students about AEOP initiatives for which students qualify during daily program activities, aside from distributing AEOP brochures and highlighting the website. Student interviewees generally could not name, or recognize when named, AEOP initiatives except for GEMS, SEAP, and CQL. However, substantial student interest exists in AEOP opportunities when vaguely described. This interest, especially from students of underserved populations, would benefit from more robust attention by program coordinators and mentors during GEMS program activities, especially since the existing GEMS-SEAP-CQL pipeline cannot accommodate the considerable unmet need. Other AEOPs may be able to provide greater geographical and demographic reach where GEMS sites are simply unable. Continued guidance by ASEE is needed to ensure coordinators and mentors alike are knowledgeable of AEOP opportunities at and beyond the Army research labs, and have reasonable plans and strategies for exposing students to these opportunities before, during, and after program activities.

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

[2] Maltese, A.V. & Tai, R. H. (2011) Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education Policy* 98, 877-906

Introduction

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

This report documents the evaluation of one of the AEOP elements, Gains in the Education of Mathematics & Science (GEMS). GEMS is administered by the American Society for Engineering Education (ASEE). The evaluation was performed by Virginia Tech, the lead organization (LO) in the AEOP CA consortium.

AEOP Goals

Goal 1: STEM Literate Citizenry.

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

Goal 2: STEM Savvy Educators.

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

Goal 3: Sustainable Infrastructure.

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

Program Overview

Gains in the Education of Mathematics & Science (GEMS), administered in FY13 by the American Society for Engineering Education (ASEE) on behalf of the Army Educational Outreach Program's (AEOP), is a non-residential summer STEM enrichment program for elementary, middle, and high school students (herein referred to as students). GEMS is hosted by Army laboratories on site or in close coordination off site with the area Army laboratories (herein referred to as GEMS sites). GEMS is driven by the overarching mission: to interest youth in STEM through a hands-on Army laboratory experience that utilizes inquiry based learning and near-peer mentoring. GEMS is an entry point for a pipeline of AEOP opportunities affiliated with the US Army research laboratories. The various GEMS sites are run independently, with ASEE providing support and guidance in program execution to local lab coordinators. Although they operate under a shared mission, GEMS sites are free to include different topics in their curricula that highlight the mission of the laboratory and they may set, in addition to the overall program goals, individual laboratory goals. Instead of having a specific model and curriculum forced on individual sites, they are able to design curricula (using the hands-on, experiment-based model) and procedures that make sense considering the specialties of their facility and available resources. GEMS programs run from one to four weeks in length.

Mentorship varies by GEMS site. Many of the GEMs sites use Army scientists and engineers (Army S&Es) to lead GEMS educational activities. Some sites use near-peer mentors (NPMs), college students seeking majors in STEM and working with Army S&Es, as a key element in their instructional model. NPMs are developing scientists and engineers who translate and communicate complex STEM content and their own STEM experiences to the young GEMS participant. Many sites also leverage the expertise of in-service resource teachers (RTs) who assist Army S&Es in translating complex STEM research and foundational STEM concepts and practices into educational curriculum, coach and/or supervise NPMs. RTs also provide adaptive support to individual student participants to ensure maximal engagement and learning. Herein, Army S&Es, NPMs, and RTs are referred together as GEMS "mentors," except where it is appropriate to differentiate their experiences.

All GEMS programs are designed to meet the following objectives:

1. To nurture interest and excitement in STEM for elementary, middle, and high school participants;
2. To nurture interest and excitement in STEM for mentor and teacher participants;
3. To implement STEM enrichment experiences that is hands-on, inquiry-based, educational modules that enhance in-school learning;
4. To increase participant knowledge in targeted STEM areas and laboratory skills;
5. To outreach participants inclusive of youth from groups historically underrepresented and underserved in STEM;
6. To encourage participants to pursue secondary and post-secondary education in STEM;
7. To educate participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories; and
8. To provide information to participants about opportunities for STEM enrichment through advancing levels of GEMS as well as other AEOP initiatives.

GEMS were completed at 13 Army research laboratories, universities, or high schools in 8 states, summarized in Table 3.

Table 3. 2013 GEMS Sites

Laboratory	Command*	Location
USAMRMC Fort Detrick - Hood College	USAMRMC	Frederick, MD
US Army Medical Research Institute of Chemical Defense (USAMRICD)	USAMRMC	Aberdeen, MD
US Army Research Institute for Surgical Research (USAISR)	USAMRMC	San Antonio, TX
US Army Research Institute for Environmental Medicine (USARIEM)	USAMRMC	Natick, MA
US Army Aeromedical Research Laboratory (USAARL)	USAMRMC	Fort Rucker, AL
US Armed Forces Medical Examiner System (AFMES)	USAMRMC	Dover AFB, DE
Walter Reed Army Institute of Research (WRAIR)	USAMRMC	Silver Spring, MD
Walter Reed Army Institute of Research - Wheaton High School	USAMRMC	Silver Spring, MD
US Army Research Laboratory- Aberdeen Proving Ground (ARL-APG)	RDECOM	Aberdeen, MD
US Army Research Laboratory- Adelphi (ARL-A)	RDECOM	Adelphi, MD
US Army Research Laboratory- White Sands Missile Range (ARL-WSMR)	RDECOM	White Sands, NM
Engineer Research & Development Center- Construction Engineering Research Laboratory (ERDC-CERL)	USACE	Champaign, IL
Engineer Research & Development Center - Vicksburg, MS (ERDC-MS)	USACE	Vicksburg, MS

Commands: "MRMC" is the Medical Research and Materiel Command, "RDECOM" is the Research Development and Engineering Command, and "USACE" is the US Army Corps of Engineers.

In 2013, GEMS provided outreach to 2,038 students at 13 different sites, representing a 26% increase in enrollment from 1,614 student participants in 2012. Consistent with historical data, many of the GEMS sites received applications from more qualified students than they could serve. A total of 4,231 GEMS application were submitted centrally through the online AEOP application tool. Some additional paper applications may have been submitted directly to the program sites. Table 4 provides the application (App) and participation (Part) data by GEMS site for 2011-2013.

Table 4. 2011-2013[3] GEMS Participation by Command

Command	Lab	2011			2012			2013		
		# App	# Part	Rate	# App	# Part	Rate	# App	# Part	Rate
CID	USACIL			%			%	0	0	0%
MRMC	USAARL		51	%		85	%	148	121	82%
	ARL-CSID			%			%	0	0	0%
	USAFMES			%			%	149	92	62%
	USACEHR			%			%	0	0	0%
	USAMRICD		75	%		44	%	0	151[4]	%
	AMRIID		606	%		404	%	1008	364	36%
	USARIEM		83	%		118	%	230	195	85%
	USAISR			%		73	%	95	68	75%
	WRAIR		400	%		475	%	1002	468[5]	%
RDECOM	ECBC			%			%	0	0	0%
	NVESD			%			%	0	0	0%
	AMRDEC			%			%	275	132	48%
	ARL-APG			%			%	888	359	40%
	ARL-A			%			%	172	95	55%
	NSRDEC			%			%	0	0	0%
	ARL-WSMR			%			%	111	38	34%
ASACE	ERCD-CERL			%			%	39	28	72%
	ERCD-MS			%			%	114	78	68%
	ERDC-TEC			%			%	0	0	0%
Lab N/A				%			%	0	0	0%
Total			**1,215**	%	**2,700[6]**	**1,614[7]**	%	**4,231**	**2,038**	**48%**

[3] Complete data 2011 and 2012 are unavailable at the time of this report. This data collection effort is underway, directed by Army Cooperative Agreement Managers. These data will be included in an amended report that is submitted to the Army, when they become available.

[4] Conflicting data regarding participation at this GEMS site

[5] A total of 515 students participated in WRAIR's GEMS programs; 47 participated voluntarily as non-stipend participants.

[6] From FY12 GEMS Evaluation Report

[7] From FY12 GEMS Evaluation Report

The total cost of the 2013 GEMS program was $730,070. The average cost per student was $358. Aligned with the rates of similar AEOP initiatives, GEMS provides participants with an average stipend of $100 per week. Table 5 summarizes these and other 2013 GEMS program costs.

Table 5. 2013 GEMS Program Costs	
2013 GEMS – Cost Per Participant	
Total Participants	2,038
Total Cost	$730,070
Cost Per Participant	$358
2013 GEMS - Cost Breakdown Per Participant	
Administrative Cost to ASEE	$111,195
Participant Stipends	$618,875
Cost Per Participant	$358

Evidence-Based Program Change

ASEE's efforts primarily focused on tasks associated with transitioning the GEMS program administration from George Washington University to ASEE, including:

1. Collaborating with GEMS site coordinators to support program promotion, applicant selection, applicant security/access approval, payment of stipends, and administration of evaluation assessments;
2. Print and electronic marketing to elementary, middle, and high schools in areas surrounding participating Army laboratories; and
3. Promotion of GEMS program to ASEE's K-12 distribution list and social media outlets (e.g., Facebook, Twitter, e-GFI newsletters and blogs).

The 2013 evaluation assessed recommendations of the 2012 evaluation and included other changes that were made to assessments AEOP-wide, including:

1. Focus groups conducted with students and mentors at 3 GEMS sites;
2. Enhanced Actionable Program Evaluation, including participants (students' and mentors') perceptions of:
    - Marketing and recruitment to the GEMS program;
    - Motivation to participate in GEMS;
    - Satisfaction with GEMS activities;
    - Benefits of GEMS; and
    - Suggestions for improvement to GEMS.
3. Baseline data collection from mentors on current activities, challenges, and additional support needed related to
    - Educating participants about AEOP opportunities; and
    - Educating participantsabout AEOP opportunities STEM jobs and careers, and specifically those within the Army or DoD sectors.

FY13 Evaluation At-A-Glance

Virginia Tech, in collaboration with ASEE, conducted a comprehensive evaluation study of the GEMS program. The GEMS logic model below presents a summary of the expected outputs and outcomes for the GEMS program in relation to the AEOP and GEMS-specific priorities. This logic model provided guidance for the overall GEMS evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • ASEE providing oversight of site programming • Operations conducted by 13 sites consisting of Army labs, universities, and high schools • 2075 Students participating in GEMS programs • Army S&Es, Near Peers, and Resource Teachers participating in GEMS as mentors • Stipends for students to support meals and travel • Centralized branding and comprehensive marketing • Centralized evaluation	• Students engage in hands-on and experiment-based STEM programs • Army S&Es, Near Peers, and Resource Teachers facilitate hands-on learning experiences for students	• Number and diversity of student participants engaged in GEMS • Number and diversity of Army S&Es serving as mentors in GEMS • Number and diversity of , Near Peers serving as mentors in GEMS • Number and diversity of Resource Teacher serving as mentors in GEMS • Number and Title 1 status of schools served through participant engagement • Students, mentors, site coordinators, and ASEE contributing to evaluation	• Increased participant STEM competencies (confidence, knowledge, skills, and/or abilities to do STEM) • Increased interest in future STEM engagement • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in STEM research and careers • Increased participant awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve GEMS programs	• Increased student participation in other AEOP opportunities and Army/DoD-sponsored scholarship/ fellowship programs • Increased student pursuit of STEM coursework in secondary and post-secondary schooling • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of GEMS

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

Key Evaluation Questions

- What aspects of GEMS programs motivate participation?
- What aspects of GEMS program structure and processes are working well?
- What aspects of GEMS programs could be improved?
- Did participation in GEMS programs:
  - Increase students' STEM competencies?
  - Increase students' interest in future STEM engagement?
  - Increase students' awareness of and interest in other AEOP opportunities?
  - Increase students' awareness of and interest in Army/DoD STEM careers?

The assessment strategy for GEMS included pre- and post-GEMS student questionnaires, onsite focus groups with student and mentor participants at three sites, and reported efforts collected by ASEE from three GEMS sites, which were provided to Virginia Tech. Tables 6-8 outline the information collected in student and mentor assessments.

Table 6. 2013 Student Assessments

Category	Description
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
Satisfaction & Suggestions	Awareness of GEMS, motivating factors for participation, satisfaction with and suggestions for improving GEMS programs
AEOP Goal 1- Indicators of Program Achievement	**STEM Competencies:** Students' engagement in STEM activities (in GEMS vs. in school), STEM skills, abilities, and confidence (pre- vs. post-GEMS)
	Attitudes toward STEM: Students' attitudes toward STEM learning (in GEMS vs. in school)
	Future STEM Engagement: Students' intent to pursue STEM activities, education, and careers (pre- vs. post-GEMS)
	Army STEM: AEOP Opportunities – Students' past participation, exposure to, and interest in participating in other AEOP programs
	Army STEM: Army/DoD STEM Careers – Students' exposure to and interest in STEM and Army/DoD STEM jobs
AEOP Goal 2 Program Efforts	**Mentor Capacity:** Perceptions of GEMS mentors

Table 7. 2013 Mentor Focus Groups

Category	Description
Profile	Occupation, past participation
Satisfaction & Suggestions	Awareness of GEMS, motivating factors for participation, satisfaction with and suggestions for improving GEMS programs, benefits to participants
AEOP Goal 1 & 2 Program Efforts	**AEOP Opportunities:** Efforts to expose students to AEOP opportunities
	Army/DoD STEM Careers: Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Day-to-day mentor activities

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data is summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and footnotes providing results from tests for significance.[8] Questionnaires and respective data summaries are provided in Appendix B (pre-program) and Appendix C (post-program). Pre- to post-GEMS comparisons of matched cases, including three site-level matched-bases analyses, are provided in Appendix D. Focus group protocols are provided in Appendices E (students) and F (mentors). Major trends in data and analyses are reported herein.

[8] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

Study Sample

The pre- and post-GEMS questionnaires were provided to the 2013 GEMS host sites in either paper-and-pencil or electronic format using the Qualtrics® survey system hosted by Virginia Tech. Students from all GEMS sites responded to questionnaires. Table 8 provides an analysis of students' participation in pre- and post-GEMS questionnaires, the response rate, and the statistical reliability achieved with each sample, as given by the margin of error at the 95% confidence level. The statistical reliability achieved for pre-, post-, and pre- to post-GEMS matched pairs samples (all <±2%) suggest adequate representativeness of the population, allowing us to generalize findings of evaluation sample to the total population of GEMS participants.

Because GEMS is a complex intervention that varies by site, by level—GEMS I (Beginner), II (Intermediate), and III (Advanced)—and by curricular topic, evaluators selected three cases for additional statistical analyses to illustrate the potential effects of the simplest "unit" of a single GEMS program. Each case represents a single GEMS site, level, and curriculum topic. The three cases were selected such that: 1) the three cases represent different GEMS levels and curricular topics; 2) each case studies a GEMS curriculum that was implemented at least three times as the site; 3) each case is adequately powered (greater than 33 participants); and assessment participation yielded a margin of error less than 5%.

Table 8. 2013 GEMS Student Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[9]
Students – Pre-GEMS[10]	1,437	2,038	71%	±1.4%
Students – Post-GEMS	1,501	2,038	74%	±1.3%
Students – Pre- to Post-GEMS Matched Pairs	1,126	2,038	55%	±2.0%
GEMS I: Physical Science and Forensics at USAARL	65	71	92%	±3.6%
GEMS II: Biomedical at WRAIR	100	117	85%	±3.7%
GEMS III: Robotics at Hood College	41	44	94%	±4.0%

The evaluation included focus groups with students and mentors at three sites in the Eastern U.S. Mentor focus groups included 17 mentors (8 females, 9 males). Mentor focus groups included Army S&Es (4), NPMs (8), and RTs (5). Student focus groups included 44 students (21 females, 23 males). Student focus groups included students ranging from grades 5 to 12 and participating in Beginner, Intermediate, and Advanced GEMS levels. Two sites were at Army research labs in the National Capitol Region. One site was a university site. Evaluators also visited a fourth site—at a local high school—but were unable to conduct focus groups during that visit. Focus groups were not intended to yield generalizable findings;

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

[10] Using unverified 2,236 population, Pre-GEMS: 64% response, ±1.5% MoE; Post-GEMS: 67% response, ±1.5% MoE; Match Pairs: 50% response, ±2.1% MoE

rather they were intended to provide additional evidence of, explanation for, or illustrations of student questionnaire data.

Three additional sites provided information to ASEE regarding specific efforts and activities to address GEMS program objectives. Site and NPM program data and findings were provided to VT and used in illustrations herein. Independent studies of the near-peer mentoring program were conducted by investigators at Walter Reid Army Institute of Research and US Army Centers for Environmental Health Research. Information about NPM training and findings related to NPM mentor capacity are summarized herein with permission of the authors. [11][12]All information reported herein about GEMS activities, participants' perceptions of activities, and participant outcomes add to the overall narrative of GEMS's efforts and impact, and highlight areas for future exploration in programming and evaluation.

[11] Tenenbaum, L., Anderson, M., Jett, M, and Yourick, D. (2014) An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus. *Innovations in Higher Education* (DOI) 10.1007/s10755-014-9286-3)

[12]Anderson, M. & Yourick, D. (in review) Undergraduates in a U.S. Army internship acquire mentoring and instructional skills with pre-college students in the STEM disciplines.

Respondent Profiles

Student demographics. Demographic information collected from GEMS respondents in the post-GEMS questionnaire is summarized in Table 9.

Table 9. 2012 and 2013 GEMS Apprentice Questionnaire Respondent Demographics				
Demographic Category	**2012**		**2013**	
Gender				
Female	586/1282	46%	691/1477	47%
Male	687	54%	765	52%
Choose not to report	9	<1%	21	1%
Race/Ethnicity				
American Indian or Alaskan Native	12/1266	<1%	16/1472	1%
Asian or Other Pacific Islander[13]	**239**	**19%**	**222**	**15%***
Black or African American	**219**	**17%**	**339**	**23%***
Hispanic or Latino	92	7%	97	7%
White or Caucasian	537	42%	637	43%
Other	86	7%	86	6%
Choose not to report	81	6%	75	5%
Socioeconomic Indicators (most frequent responses given)				
Public School Type	**914/1282**	**71%**	**1162/1476**	**79%***
Suburban School Setting	**750/1237**	**61%**	**921/1424**	**65%***
Do Not Qualify for Free or Reduced Lunch	793/1280	62%	922/1470	63%
Grade Level and Age				
Elementary school (grades 4-5)			72/1314	5%
Middle school (grades 6-8)			583	44%
High school (grades 9-12)			659	51%
Average Age	17 years		13.4 years	

*Note: Other Race/Ethnicity includes multiracial (77), Middle Eastern (6), and Caribbean (3). * = significant at $p < 0.05$.*

More males (52%) than females (47%) completed the questionnaire. More students identified with race/ethnicity category of White43%) than any other single race/ethnic category, though there is representation of American Indians or Alaskan Natives (1%), Black or African (23%), and Hispanic or Latino (7%) populations. Respondents most frequently reported that they do not qualify for free or reduced lunch (63%); qualifying for free or reduced lunch is a common indicator of low income status. Most respondents attend public schools (79%) in suburban settings (65%). The average age of students was 13.4 years old, and most students (96%) have greater than one year of school left.

One objective of GEMS (and all AEOPs) is to increase the percentage of students from underrepresented and underserved segments of our population, such as women, African Americans, and Hispanics, in pursuing science and engineering

[13] The 2012 demographic category consisted of Asian-Pacific American, whereas the 2013 demographic category consisted of both Asian and Other Pacific Islander. These data categories will be parsed out into separate 'Asian' and 'Native Hawaiian and Other Pacific Islander' categories in 2014 evaluations to reflect OSTP demographic categories and the Army's definition of underserved populations.

education and careers through participation in Army-sponsored education programs. A comparison of 2012 and 2013 data suggest that limited progress was made toward expanding the participation of underserved and underrepresented populations through 2013 GEMS programming; success was most notably in the inclusion of Black or African American students. There was no statistically significant expansion in the participation of female students or students from other racial or ethnic minority or low-income groups. Future evaluation and annual program reporting may provide a clearer picture of GEMS's success in this area.

In summary, 2013 evaluation data reveal that GEMS succeeded in providing outreach to students from historically underrepresented and underserved populations, however, it had limited success in expanding the participation of those groups from 2012 to 2013. In 2013 GEMS engaged female students (47%), a population that is historically underrepresented in certain STEM fields. GEMS had some success in providing outreach to students from historically underserved minority race/ethnicity groups (30%) and low-income groups (12%), as determined by free or reduced lunch status. However, GEMS expanded participation of Black or African American students from 2012 to 2013 <5%, though small the difference is statistically significant. Expanding participation of other underserved groups remains an area for growth for GEMS.

Mentor demographics. Demographic information was not collected from mentors in evaluation assessments. However, at each of the four sites visited by evaluators, students appeared to have access to mentors (inclusive of Army S&Es, NPMs, and/or RTs) belonging to the same gender (female) or the same race or ethnicity group who could serve as a role model. This finding is corroborated elsewhere.[14]

[14] Anderson, M. & Yourick, D. (in preparation) Undergraduates in a U.S. Army internship acquire mentoring and instructional skills with pre-college students in the STEM disciplines.

Actionable Program Evaluation

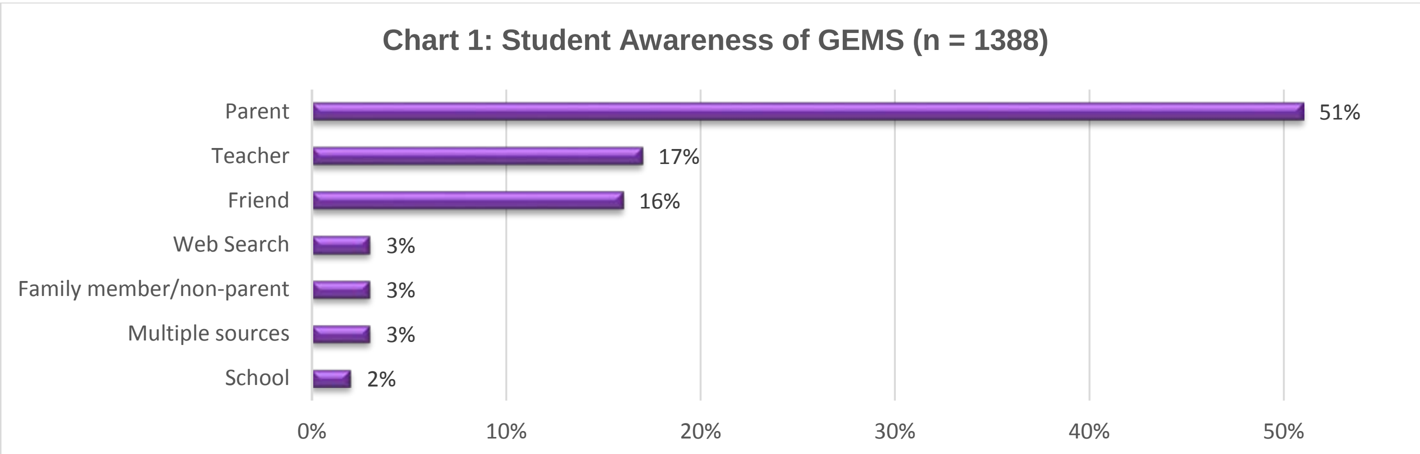
Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. This section highlights information outlined in the Satisfaction & Suggestions sections of Tables 6-8 as well as the AEOP Goal 1 & 2 Program Efforts section of Tables 7 and 8.

A focus of the Actionable Program Evaluation are efforts toward the long-term goal of GEMS and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. GEMS sites reach out to students of traditionally underserved populations. Thus, it is important to consider how GEMS is marketed and ultimately recruits student participants, the factors that motivate students to participate in GEMS, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. In the sections that follow, we report perceptions of student, mentors, and site program coordinators (from their program reports), in an effort to both understand current efforts and recommend evidence-based improvements toward expanding and supporting the participation of students from underserved groups in achieving outcomes related to AEOP and program objectives.

Marketing and Recruiting Underserved Populations

The GEMS manager, ASEE, reported conducting targeted marketing in communities and organizations serving high populations of minority and low-income students, including Prince George's County, MD and in Washington, DC through email blasts to public school administrators and teachers, Boys and Girls Clubs, and other community groups. Specific illustrations of site efforts to market and recruit talented students from historically underserved or underrepresented populations in STEM include partnerships with minority-serving community organizations (e.g., WRAIR's local partnership with 100 Black Men) and targeted marketing to on-post schools, rural schools, and schools in districts serving high proportions of low-income students. Additional site-level marketing and recruitment efforts included email and print advertising to past GEMS participants and their parents, to surrounding public school districts and private schools, to teachers attending Army lab-sponsored events and workshops, and to other groups such as Boy Scouts, Girl Scouts, Dover Air Force Base Youth center, churches, and libraries. Lab coordinators also advertised programs by word of mouth. It is not clear the extent to which these additional site-level marketing efforts targeted underserved or underrepresented populations; however, one site accepts no less than 50% female participants to ensure representation of females in its programs.

Student questionnaires asked students how they learned about GEMS, in order to understand how GEMS sites ultimately attract students. Chart 1 summarizes students' responses having frequencies greater than 2%. Students most frequently learned about the local GEMS program from a parent or other family member (more than 50%) and from teachers or others at school (about 20%). Additionally 1% or less of students reported learning of GEMS through each of newspaper or other print flyers, other programs, acquaintances or colleagues of parents, science conventions, previous participation, or invitations to participate. The findings from how students learn about GEMS suggest that GEMS generally finds students (through parents, teachers, friends, etc.), rather than students finding GEMS.



Mentor interviewees most frequently reported learning of GEMS through others who have current or past connections to GEMS. For example, they learned about GEMS from colleagues or other peers who have participated in GEMS in the past, or who currently work with the GEMS program or site. At one site, NPMs were recruited from a distant university that has strong ties to the GEMS site coordinator. While the RTs we interviewed received advertisements of GEMS through their school, they suggested that many teachers in their schools and districts knew of GEMS through word of mouth.

Motivating Factors for Participation

Student questionnaires as well as student and mentor focus groups included questions to explore participants' motivations to participate in GEMS. Questionnaire data (inclusive of only the three cases described previously) are summarized in Appendices B and C, with narrow themes and illustrative comments, while broad themes are described here. Mentor focus group responses are summarized below.

Motivating factors for students. In questionnaires and focus groups, students most frequently reported being motivated to participate in GEMS this year because of their overall satisfaction with previous GEMS participation: GEMS was fun, interesting, and enriching. In addition, students sought opportunities to explore or advance STEM pathways: to learn about new topics or to dig deeper into topics explored previously, to develop or practice specific STEM skills, to engage in hands-on experiments and activities that were not possible in their typical school setting, and to clarify future education or career goals.

Motivating factors for mentors. Most GEMS mentor interviewees were influenced to participate through their personal and professional connections to GEMS. In addition, more than half of mentor interviewees reported that their own positive experiences as a GEMS mentor in the past were the primary reason for returning this year. Some mentors sought experience teaching STEM and making contacts in the STEM teaching community. One mentor was continuing an education research project from the previous year. Mentors also desired to contribute in meaningful ways to the STEM learning experiences of student participants.

Mentor Capacity

The nature and quality of mentoring provided is a critical factor for maximizing students' engagement during STEM activities and for inspiring or sustaining their interest in future STEM. Understanding how mentors are ultimately prepared for their GEMS duties, and the perceived needs of mentors, is important for ensuring quality mentorship. Understanding mentor activities from the perspectives of both mentors and students can further inform programmatic improvements related to mentor capacity.

GEMS sites provided information regarding mentor training and preparation broadly. NPM studies provide additional information about NPM-specific training.[15] [16] During focus groups, mentor interviewees were asked to describe the mentoring they provided to students on an average day. Student assessments elicited students' perceptions of mentor engagement (7 questionnaire items). The student assessments included items pertaining to the nature and frequency of students' opportunities to engage in STEM activities (5 questionnaire items) and the role of hands-on activities in their STEM learning (1 focus group item). While these items relate to mentor activities, they also pertain to students' engagement in STEM practices and development of STEM competencies; as such they are reported in the Outcomes Evaluation.

Mentor training and preparation. Sites reported a range of training available to mentors. For example, one site offered a day of training for resource teachers (RTs) serving as GEMS mentors. The training included a tour of the facility and briefings on mission and operations. At another site, secondary education college students serving as a near-peer mentor (NPM) shared teaching skills with Army S&Es and assisted them in preparing educational activities.

NPMs as a group received unique professional development opportunities to prepare them as mentors of GEMS students and as aspiring STEM researchers. While NPM training varied by site, most NPMs participated in Wiki-based online or on-site training through their specific GEMS site in spring 2013, followed by onsite training before the launch of GEMS programs in the summer. The length of training varies by site, but two to four weeks is typical. NPM preparation included laboratory safety courses, pedagogical training, laboratory training, and development of lessons that translated their laboratory experiences into a teaching experience. NPMs were mentored by an Army S&E who supervised their STEM research in the lab setting, much like the undergraduate research model. NPMs were also mentored by a licensed STEM teacher, who provided supervision and support as they translated their research into grade-level appropriate lessons for GEMS students, much like the typical pre-service student teaching models.

[15] Anderson, M. & Yourick, D. (in review) Undergraduates in a U.S. Army internship acquire mentoring and instructional skills with pre-college students in the STEM disciplines.
[16] Tenenbaum, L., Anderson, M., Jett, M, and Yourick, D. (2014) An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus. *Innovations in Higher Education* (DOI) 10.1007/s10755-014-9286-3)

Mentor activities. Mentor interviewees used a variety of mentoring and/or instructional activities for productively engaging students in STEM learning, including:

- encouraging and supporting students' exploration and experimentation;
- providing small group and one-on-one teaching (includes posing and answering questions);
- facilitating small group or partner work;
- encouraging peer-to-peer instruction and explaining;
- assessing and ensuring conceptual understanding;
- facilitating hands-on and other project-based learning;
- connecting GEMS concepts and skills to school learning; and
- connecting GEMS concepts and skills to Army STEM research and careers.

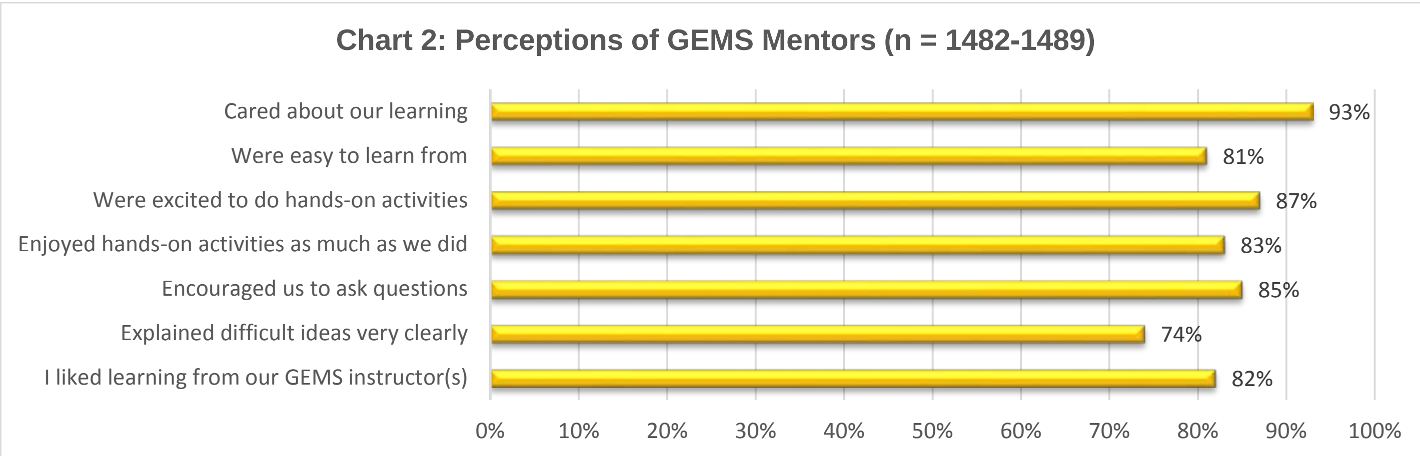
RTs also described that their day to day mentoring which included mentoring not only students, but Army S&Es and NPMs. RTs described helping Army S&Es use age-level appropriate descriptions. RTs described mentoring NPMs in their teaching and use of specific strategies to support student learning. These reports are consistent with the role described for RTs in the NPM studies [17][18] to include supervision, assistance, feedback, and support of NPMs.

Engaging students in hands-on or experiential STEM learning. GEMS sites and mentors had different ways of engaging students in hands-on or experiential STEM learning. Examples provided here illustrate the range of curricula and activities available to GEMS students. One site used commercially available kits (e.g., Bio-Rad Genes in a Bottle and STEM Electrophoresis of Food Dye kits and Material World Module Nanotechnology, Smart Sensors and Dye-Sensitized Solar Cells kits) to engage students in STEM explorations. The site supplemented the kit-based program with related Army research demonstrations, such as fuel cell application, tri-axial earthquake and shock simulator, and geology sensing. At another site, Army S&E mentors gave presentations including STEM facts, videos, games, and activities to introduce experiments to students. Throughout the experiments, the mentors encouraged students to discuss their ideas and guided students' conversations about the experiments. At yet another site students learned foundational information about crime documents, blood typing and splatter analyses, hair and fiber analyses, DNA and fingerprinting, shoe prints and impressions, fingerprinting, and flame testing through interactive labs. In the culminating activity students were assigned to small groups, who worked together to apply their new learning to solve a case. Students then presented their cases, investigation processes, and findings to the rest of the class.

Students' perceptions of mentors. The post-GEMS questionnaire elicited students' perceptions of their GEMS mentors. Items included perceptions of mentor qualities such as caring about student learning, excitement about hands-on learning, teaching and mentoring skills, and students' learning from their mentors. Students responded on a 6-point scale from 1 = "Strongly Disagree" to 6 = "Strongly Agree." A total of 1489 GEMs students responded to some or all of these items, many of whom were taught by NPMs. Chart 2 summarizes the proportions of students who selected "agree" or "strongly agree"

[17] Tenenbaum, L., Anderson, M., Jett, M, and Yourick, D. (2014) An innovative near-peer mentoring model for undergraduate and secondary students: STEM focus. *Innovations in Higher Education* (DOI) 10.1007/s10755-014-9286-3)
[18] Anderson, M. & Yourick, D. (in review) Undergraduates in a U.S. Army internship acquire mentoring and instructional skills with pre-college students in the STEM disciplines.

for each item. The full set of items and data are available in Appendix C. Students clearly found their GEMS mentors to be excited, accessible, and impactful as most students generally agreed (greater than 70%) with all items.



Army STEM

AEOP opportunities. Most of the 2012 GEMS participants reported that they had never heard of the other AEOP elements. In FY13 ASEE provided guidance that GEMS sites should distribute AEOP brochures and promotional materials (such as Rite in Rain notebooks and lab coats with the AEOP-logo) and discuss other AEOP opportunities with students and parents. At the site level, coordinators report different mechanisms for generating awareness of AEOPs. One site used emails, posters, and brochures to notify parents of past and present GEMS participants, past and present GEMS mentors, and other target student and mentor audiences of GEMS and other AEOP programs. Another site provided parents with promotional materials and website information during the closing ceremonies, and answered inquiries about other AEOPs before, during, and after the program. At yet another site, participants received a copy of the AEOP brochure and had opportunities to interact with current SEAP and CQL participants, which may have yielded discussion of those particular AEOPs.

Focus groups with mentors assessed whether they were knowledgeable of AEOP initiatives and the extent to which they educated their students about future AEOP opportunities. Most mentor interviewees had little awareness of or past participation in an AEOP initiative beyond those offered at the GEMS site. Army S&Es mentors were often repeat GEMS mentors, and a few had also mentored SEAP apprentices at the GEMS site. NPMs were often past GEMS students and/or SEAP apprentices. However, no more than a single mentor at each site had participated (as either a mentor or as a student participant) in other AEOPs, such as eCYBERMISSION, Junior Solar Sprint, and Junior Science & Humanities Symposium. Mentor interviewees reported little awareness of AEOPs outside of the GEMS-SEAP-CQL pipeline at the Army lab. While most mentors reported distributing the AEOP brochure and/or a lab-specific GEMS flyer to students, few reported discussing AEOP initiatives for which students qualify during daily program activities. Two mentors report that former

GEMS students often contact them for such information after the program ends and when students are looking toward the next summers' activities.

Focus groups with students assessed whether they were knowledgeable of AEOP initiatives and had participated in any AEOPs in the past. Of 18 students to whom the question "Who has participated in other AEOP programs?" was asked, nearly a third were past GEMS participants. When asked whether they were familiar with other AEOPs, nearly the same proportion was familiar with SEAP and CQL. However, no more than one student reported awareness of any of these AEOPS: eCYBERMISSION, West Point Bridge Design Contest, and Junior Science & Humanities Symposium.

Army/DoD STEM careers. GEMS sites engage students in Army STEM interests in two primary ways. First, Army S&Es lead GEMS educational activities. Second, Army S&Es speak about career opportunities at the lab. In both cases, Army S&Es may speak about or demonstrate their research or provide tours of their laboratories to students to either support an educational activity or to provide context for discussing career opportunities. Just a few examples that were provided by one site included the following:

- DoD scientist and safety expert discussed Army parachutes, their past design, their recent re-design, and how the parachute's design characteristics impact Solder safety and performance. Students were encouraged to incorporate Army parachute design characteristics into the design of their chute used during the egg drop experiment.
- Two DoD psychologists designed and led for students an activity about the psychology of the brain and how unreliable memory can be. They also discussed the roles of DoD research psychologists and the many areas in which psychology professionals may work.
- DoD engineers gave to students a tour of USAARL's Injury Biomechanics Branch, specializing in spine and traumatic brain injury research. The students were shown demonstrations of the vertical drop tower and horizontal sled, which are pieces of equipment used to access the protection afforded by helmets. The engineers explained the science and engineering of testing helmets.
- A member of the U.S. Army Combat Readiness/Safety Center demonstrated unmanned aerial vehicles (UAVs) and their uses for military and civilian environments/operations.

Another site described that their GEMS program included daily invited speakers. For example, Mondays featured Death Investigators, Tuesdays featured DNA personnel, Wednesdays featured Autopsy Technicians, and Thursdays featured the deputy Medical Examiners. The closing ceremonies on Fridays featured the Armed Forces Medical Examiner (The Director) and his deputy as the VIP speakers. In addition, mentors at one site reported that their lessons culminate with information that helps them connect Army/DoD jobs and careers with the activities just completed by students in the GEMS program. These curricular supports were considered particularly useful to the NPMs and local teachers at the site who are less familiar with the work conducted by the Army/DoD.

Mentor interviewees echoed the important role that "invited" Army S&E speakers play in generating students' awareness of Army STEM careers. At one site local teachers serving as GEMS mentors also reported how Army S&E speakers increased teachers' awareness of Army STEM, which had implications on their classroom teaching back at school. These teachers described educating their school students about the research that is conducted at the GEMS sites, in an effort to connect concepts and skills learned in school to the real-world applications of them. They also described engaging Army S&Es in school visits for career day events and even leading educational activities. One teacher reported having a student alumnus who had received a SMART scholarship, come back to talk about his experiences at an Army lab.

Perceptions of GEMS

Assessments elicited student and mentor perceptions of GEMS, including perceived value of GEMS, perceived influence of GEMS on students' STEM pathways and careers and NPM capacities, and overall satisfaction with program activities.

Value of GEMS. Mentors were asked in focus groups what they perceive as the value of the GEMS program. Mentors' comments primarily center on value to students, but also suggest benefit to mentors and to the community.

First, mentors most frequently described the ways in which GEMS allows students to explore and advance their STEM pathways. Mentors reported that GEMS:

- prepares students for next steps in their education;
- creates a network to support STEM interest and experiences; and
- exposes students to new topics, college majors, and career options.

Second, mentors perceived that GEMS provides learning experiences and resources that are not otherwise available to students. Mentors—who include local teachers—described unique learning environments, activities, and resources available to GEMS students, which are perceived as atypical of regular school classrooms. They also described the ways in which the learning processes go beyond typical school learning processes. In GEMS, students:

- understand the value of collaboration and teamwork in learning;
- apply school knowledge to solve real world problems;
- learn valuable laboratory skills and contribute to Army research through hands-on activities; and
- receive unique mentorship opportunities from near-peers mentors and Army S&Es.

Third, mentors described the GEMS' value in terms of their own benefit. Mentors reported that during GEMS they:

- develop or expand their network of STEM teachers, professionals (Army S&Es), and organizations;
- develop or expand their teaching and mentoring skills;
- acquire new knowledge and resources that can be applied in their own classroom teaching;
- become better team members themselves through team-teaching models;
- work in a highly motivating, resource-rich alternative to typical classroom teaching; and
- build their résumé.

Influence on students' STEM pathways and careers. As reported previously, student questionnaires revealed that students were motivated to participate in GEMS because of the potential to explore and advance STEM pathways. Students were also asked in focus groups how GEMS prepared them for work in STEM fields. Students' responses frequently pertained to the notion that GEMS broadened their horizons in STEM research—by providing opportunities to learn about and use laboratory equipment and procedures, by providing opportunities to learn and/or apply scientific principles and practices in real-world research contexts, exposing them to different research fields, and by providing them a sense of what it is like to work in research laboratories on a daily basis. Several students again favorably described the depth, breadth, and modes of learning in GEMs as compared learning in school.

Reflections of Near Peers Mentors' capacities. The NPM study[19] included open-response pre- and post-NPM program questionnaires focused on determining NPM's expectations of their experience (pre-program) and their development resulting from their experience (post-program). According to study authors, NPMs' responses demonstrated growth in the following areas related to mentor capacity:

- awareness of mentoring as a necessary part of learning;
- willingness to serve as mentors and STEM literacy advocates;
- instructional skills, including flexibility, time management, patience, and communication with diverse learners;
- attention to and learning from the learning styles, needs, outlooks, and capabilities of learners; and
- awareness and interest in teaching as a profession.

Overall satisfaction*.* Students and mentors were asked items to gauge their overall satisfaction. In focus groups students were asked what they would share with a friend who is considering participating in GEMS. In the post-GEMS questionnaire students were asked if they would participate in the GEMS program again if given the chance. To gauge mentor satisfaction, mentors were asked "If you had one minute to talk to an Army decision maker about GEMS, what would you say?" Responses from these items are summarized below.

More than half of students wanted their friends to know how much they enjoyed and/or benefited from their GEMS experience: students found GEMS challenging and hard work, yet fun and full of potential for new learning and friendships. One quarter of student interviewees wanted friends to know about hands-on experiments and another quarter wanted friends to know about opportunities to learn about jobs and careers in a professional laboratory setting. A number of students credited mentors with being interactive, engaging, supportive, and respectful of all learners. Several students noted that their friends should how important it was to pay attention, stay focused, and/or ask questions during GEMS.

Of the 229 respondents whose responses we analyzed (from the three case studies), 213 said they would participate again if given the chance. Their reasons most frequently centered on learning: what they learned, how much they learned, or how they learned it. Students appreciated the hands-on experiments and activities, and their role in learning, including opportunities to learn laboratory skills and techniques. Students also reported that GEMS helps students to explore, clarify, and advance STEM educational and career options. Most students expressed general satisfaction with their GEMS program experience: it was fun, enjoyable, interesting, and inspiring. A few students liked the idea of "getting paid" to learn, suggesting some students misunderstand the purpose of the stipend (to offset costs to attend). Others find the learning environment—one where everyone wants to learn—exciting and motivating. Of those claiming that they would

[19]Anderson, M. & Yourick, D. (in review) Undergraduates in a U.S. Army internship acquire mentoring and instructional skills with pre-college students in the STEM disciplines.

not or are unsure if they would participate again, the reasons include that they are not particularly interested in STEM or the specific subject offered by the program, or in other program logistics (e.g., long commute, short sessions).

Mentors reiterated sentiments expressed previously about the value of GEMS. GEMS benefits students, teachers, Army S&Es and Army laboratories. GEMS helps students explore, clarify, and advance their STEM pathways. GEMS provides learning opportunities not available in typical classroom settings. Mentors also would share their recommendations for improving GEMS's impact, including that GEMS should:

- expand the program's geographic reach, including transportation options from distant schools or districts;
- expand the program's capacity to address unmet need (too many students for too few spots);
- expand outreach to inner-city schools and recruit more diverse populations;
- provide outreach to educators, who have much to gain from GEMS;
- offer more math modules; and
- increase advertising of GEMS and other AEOPS to the public.

Outcomes Evaluation

The evaluation of GEMS included measurement of several outcomes relating to AEOP and program objectives aligned with AEOP Goal 1: STEM Literate Citizenry. Toward AEOP Goal 1, the evaluation measured students' pre- and post-GEMS perceptions of STEM competencies, attitudes toward STEM, interest in future STEM engagement, and awareness and interest in educational and career opportunities in Army STEM.

STEM Competencies

STEM competencies are necessary for a STEM-literate citizenry. STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important for those engaging in STEM enterprises, but also all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of GEMS measured students self-reported engagement in authentic STEM activities (in GEMS vs. in School), STEM knowledge, skills, and abilities (pre- to post-GEMS), and confidence in STEM skills and abilities (pre- to post-GEMS). These measures align with the following GEMS Objectives:

- Objective 3: To implement STEM enrichment experiences that are hands-on, inquiry-based, educational modules that enhance in-school learning; and
- Objective 4: To increase participant knowledge in targeted STEM areas and laboratory skills.

Engagement in STEM activities. Five items measured participants' engagement in STEM activities in school (in pre-GEMS questionnaire) and in GEMS (in post-GEMS questionnaire.) The items address the nature and frequency of students' engagement, including participation in hands-on and minds-on STEM activities, and engagement in both teacher-directed (or GEMS mentor-directed) and student-directed STEM activities. Students responded on a 6-point scale of 1 = "Never," 2 = "Once per month," 3 = "Once per week," 4 = "2-3 times per week," 5 = Every day," and 6 = "Multiple times per day." Charts 3 and 4 on the next page summarize pre- and post-GEMS responses to these items.

Charts 3 and 4 reveal that GEMS provides more frequent opportunities for students to engage in STEM activities than they have in school. Most students (75-90%) reported engaging in the various STEM activities multiple times per week during GEMS. A small proportion (< 10%) of students claimed to never engage in such behaviors. On average, students report daily opportunities to participate in hands-on activities in GEMS. Students most frequently report that those activities involve using a set of instructions and questions that are given to them and observing demonstrations conducted by GEMS instructors. However, greater than 70% of GEMS students reported having multiple opportunities per week to engage in more student-centered and minds-on activities, such as creating questions and drawing conclusions and deciding how to carry out experiments or activities to answer their own question. Fewer students (26%-45%) reported participating in these activities with the same frequency in school. The most notable difference is that only one quarter (26%) of students reported two or more opportunities per week to decide how to carry out experiments or activities to answer their own questions in school; however, 74% reported two or more opportunities per week in GEMS.

Chart 3: Engagement in authentic STEM activities in School (n = 1240-1258)

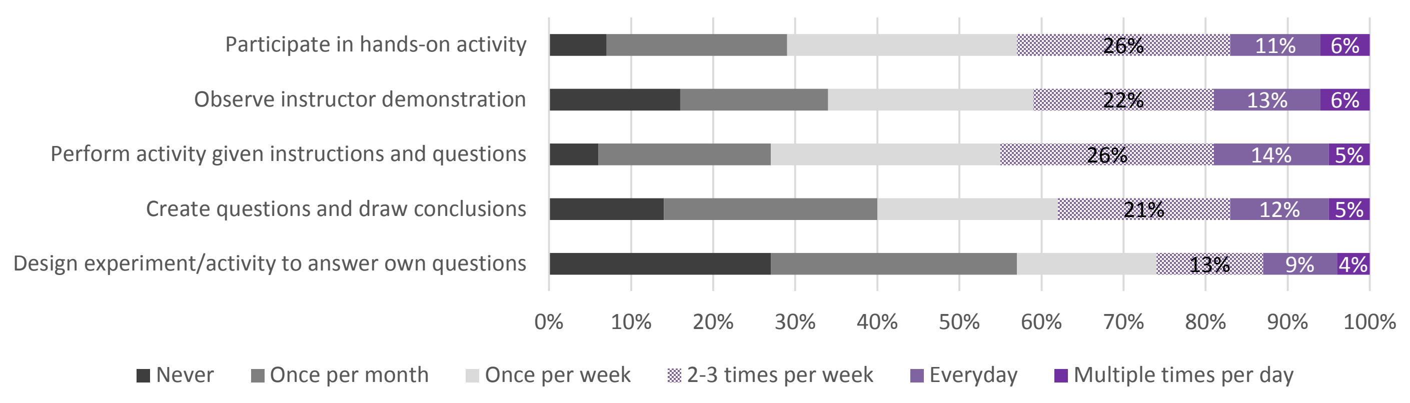


Chart 4: Engagement in authentic STEM activities in GEMS (n = 1481-1495)

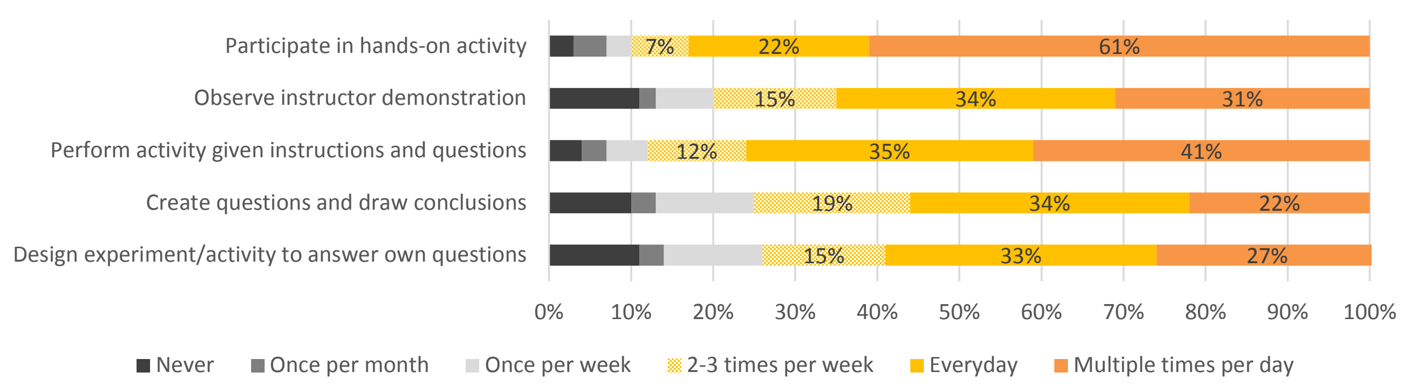


Table 10 (next page) reveals that the differences between the frequency with which students report engaging in STEM activities in school and in GEMS are significant. The in-school vs. in-GEMS difference is statistically significant with a moderately strong to very strong effect across all GEMS program data. The largest differences and strongest effects are found in the items that involve participating in hands-on activities (first and third item), and opportunities to decide how to carry out the experiment or activity to answer ones' own question (fifth item). This is not surprising given the myriad of contextual factors that limit or altogether prevent teachers' use of hands-on activities in the classroom, especially the more student-directed activities.

An examination of these same items across the three cases (see Appendix D) reveals significant differences with strong effects for the GEMS-I (Physical Science and Forensics)[20] and GEMS- II (Biomedical)[21] cases. The GEMS-III case had significant differences but with weaker effects (ranging from weak to strong) than seen with the other cases.[22] The especially weak effects observed with GEMS-III students' reports of items, such as observing teacher demonstrations and drawing conclusion given instructions, could also suggest that as students advance in GEMS level they are more likely to encounter those more teacher-directed STEM activities in school. Indeed, lecture demonstrations, highly structured inquiry activities, and verification-style labs are commonplace instruction in high school science classrooms nationwide.[23]

Table 10. Engagement in authentic STEM activities, matched pairs in school vs. in GEMS

Item	In School Avg. (SD)	In GEMS Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
How often do you usually get to participate in "hands-on" activities [during your STEM classes / at GEMS]?	3.30 (1.27)	5.26 (1.24)	1121	**1.970***	40.30	.000	1.204
Your [teacher / GEMS instructors] **demonstrate the experiment or activity – you get to observe it while taking notes.**	3.14 (1.44)	4.51 (1.60)	1108	**1.370***	24.33	.000	.731
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	3.35 (1.27)	4.97 (1.25)	1103	**1.620***	32.35	.000	.974
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	3.06 (1.41)	4.30 (1.54)	1115	**1.240***	22.16	.000	.664
You get to decide how to do an experiment or activity to answer a hypothesis. Your [teacher / GEMS instructors] **offer assistance but you try to perform the experiment or activity yourself.**	2.55 (1.42)	4.37 (1.59)	1115	**1.820***	32.08	.000	.961

Students were asked in focus groups "How have the hands-on aspects of this program helped you learn STEM?" For many students, the hands-on experiences provided for more meaningful learning than could be obtained elsewhere. For example, students reported learning more from hands-on activities than from the kinds of activities encountered at school—lectures and reading. Students reported a sense of accomplishment from learning *from* experiments rather than

[20] Range is *d* = .839 (strong effect) for teacher/ instructor demonstration to *d* = 1.426 (very strong effect) for design experiment/activity to answer own questions.

[21] Range is *d* = .796 (approaching strong effect) for teacher/instructor demonstration to *d* = 1.476 (very strong effect) for participating in hands-on activities.

[22] Range is *d* = .316 (weak effect) for teacher/instructor demonstration to *d* = .819 (strong effect) for participating in hands-on activities.

[23] Hudson, S.B., McMahon, K.C., & Overstreet, C.M. (2002). The 2000 national survey of science and mathematics education: Compendium of tables. Chapel Hill, NC: Horizon Research.

learning *about* experiments. Students also reported that hands-on experiences were more engaging for them as learners—while hands-on activities required students' full attention; they simply made learning more fun.

STEM knowledge, skills, and abilities. Seven items measured students' self-assessed STEM knowledge, skills, and abilities (pre- to post-GEMS). The items included a range of competencies that included hands on STEM activity (i.e., using equipment and laboratory techniques), minds on STEM activity (i.e., creating testable questions and drawing conclusions), and obtaining and communicating STEM knowledge and findings (i.e., explaining concepts and experimental findings, finding research information). Students responded on a 6-point scale of 1 = "Nothing like me," to 6 = "Exactly like me." Charts 5 and 6 summarize pre- and post-GEMS responses to these items.

Charts 5 and 6 suggest that students have higher opinions of their STEM knowledge, skills, and abilities after GEMS. The proportions of students claiming the statement is "true of me" or "very true of me" increased across all seven skills and/or abilities, with the largest increase was observed for knowledge of laboratory techniques (+31%) and the smallest for drawing conclusions from results (+8%).

Chart 5: STEM Knowledge, Skills, and Abilities, pre-GEMS (n = 1252-1263)

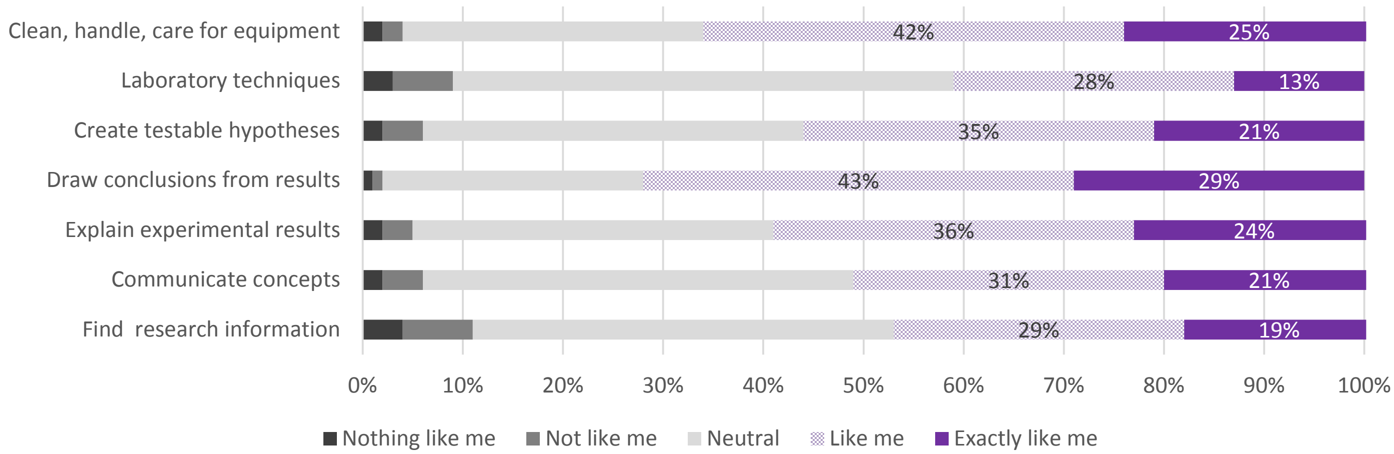


Chart 6: STEM Knowledge, Skills, and Abilities, post-GEMS (n = 1489-1496)

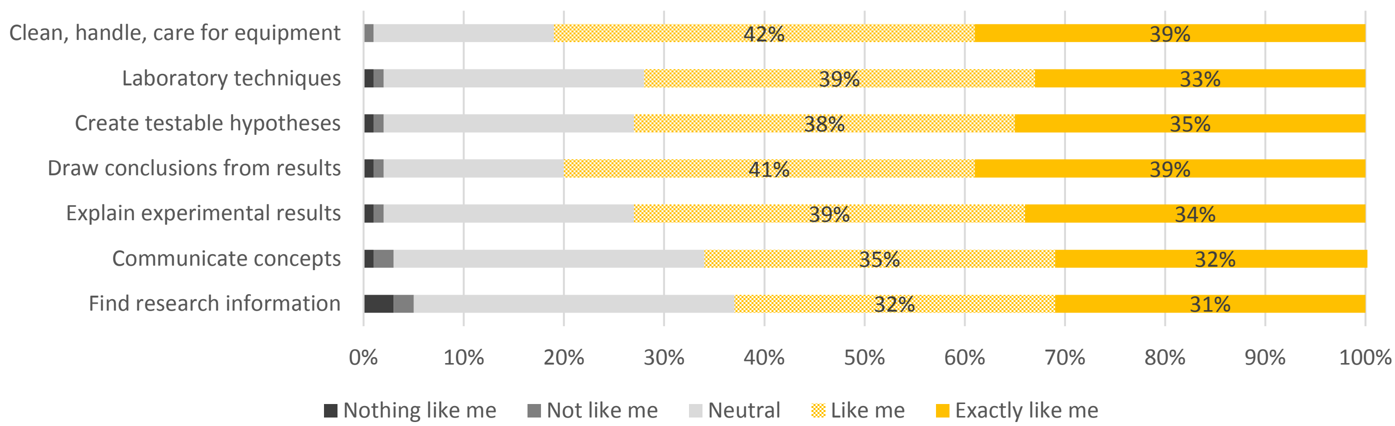


Table 11 summarizes the pre- to post-GEMS comparison of students' self-assessed STEM knowledge, skills, and abilities for the program-wide matched pairs. These data more clearly reveal that students think fairly highly of their STEM knowledge, skills, and abilities before and after participating in the GEMS program, with average responses in the range of "somewhat like me" to "like me" range for both administrations. While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. However, a strong effect is observed with students pre- to post-GEMS assessments of their knowledge of laboratory techniques.

Examining these same items across the three cases revealed significant differences with effects ranging from weak to strong for the GEMS-I (Physical Science and Forensics)[24] and GEMS- II (Biomedical)[25] cases. Knowledge of laboratory techniques again showed the strongest effect for both cases. The GEMS-III case[26] revealed only two significant differences, and both having only weak effects: creating testable hypotheses and knowing how and where to find STEM research information. These data may again suggest that as students progress through GEMS levels, students likely encounter more opportunities in school or elsewhere to develop their STEM knowledge, skills, and abilities, and/or the GEMS experience is no longer substantially different from those opportunities to challenge students' notions of these activities.

Table 11. STEM Knowledge, Skills, and Abilities, matched pairs pre- to post-GEMS

Item	Pre-GEMS Avg. (SD)	Post-GEMS Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I know how to clean, handle, and care for equipment in a science or engineering lab	4.75 (1.04)	5.17 (0.87)	1133	**.410***	14.80	.000	.440
I know laboratory techniques that are used in scientific or engineering experiments	4.10 (1.23)	4.94 (1.00)	1130	**.850***	25.98	.000	.773
I know how to create a testable hypotheses using science or engineering principles	4.49 (1.19)	4.96 (1.05)	1125	**.460***	14.10	.000	.420
I know how to explain experimental results	4.61 (1.13)	4.99 (0.97)	1124	**.380***	13.06	.000	.389
I am good at communicating science or engineering concepts to others	4.44 (1.17)	4.85 (1.07)	1125	**.410***	13.39	.000	.399
I can draw conclusions from the results of an experiment	4.88 (0.99)	5.12 (0.92)	1127	**.240***	8.58	.000	.255
I know how and where to find STEM research information using library resources	4.25 (1.29)	4.68 (1.24)	1125	**.430***	12.82	.000	.382

[24] Range is *d* = .418 (weak effect) for finding STEM research information to *d* = 1.002 (strong effect) for knowledge of laboratory techniques.
[25] Range is *d* = .368 for drawing conclusions (weak effect) to *d* = 1.085 (strong effect) for knowledge of laboratory techniques.
[26] Range is *d* = .424 (weak effect) for creating testable hypotheses to *d* = .448 (weak effect) for finding STEM research information.

STEM confidence. Seven items measured students' confidence in their use of STEM knowledge, skills, and abilities from pre- to post-GEMS. The items elicited students confidence to apply a range of competencies that included hands on STEM activity (i.e., using a laboratory and techniques), minds-on STEM activity (i.e., creating useful hypotheses, interpreting experimental results, drawing conclusions), and obtaining and communicating STEM knowledge and findings (i.e., explaining concepts, finding research information). Students responded on a 6-point scale of 1 = "Nothing like me," to 6 = "Exactly like me." Charts 7 and 8 summarize pre- and post-GEMS responses to these items.

Chart 7: STEM Confidence, pre-GEMS (n = 1244-1255)

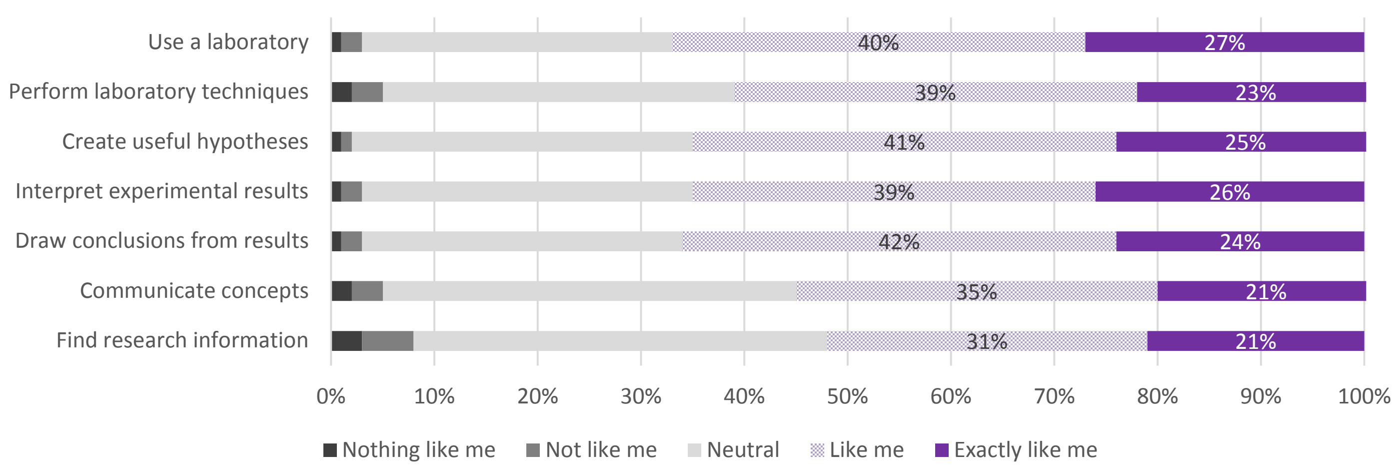
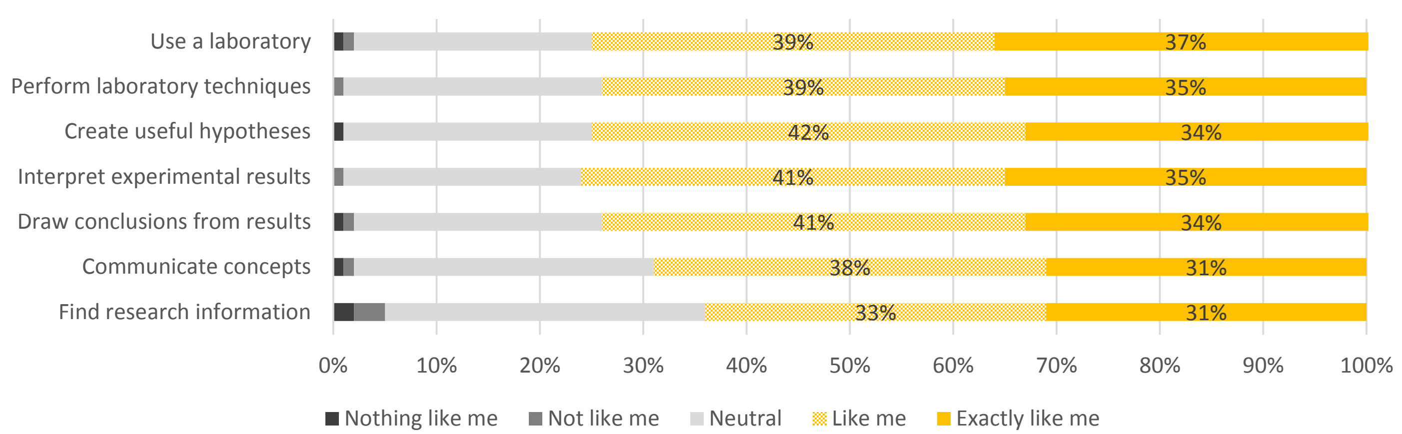


Chart 8: STEM Confidence, post-GEMS (n = 1485-1492)



Charts 7 and 8 suggest that students have higher confidence to use their STEM knowledge, skills, and abilities after GEMS. The proportions of students claiming the statement is "true of me" or "very true of me" increased across all seven skills and/or abilities (9-13%), with the largest increases observed for communicating science and engineering concepts (+13%), performing a range of laboratory techniques (+12%), and finding research information (+12%).

Table 12 summarizes the pre- to post-GEMS comparison of students' confidence to use STEM knowledge, skills, and abilities for the program-wide matched pairs. These data more clearly reveal that students have high levels of confidence both before and after participating in the GEMS program, with average responses approaching "like me" range for all items even before students have participated in GEMS. While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. Indeed, the average post-GEMS response approaches and/or barely exceeds the "like me" rating. The strongest effect, yet still considered weak, is observed with students pre- to post-GEMS confidence to communicate science and engineering concepts.

Table 12. STEM Confidence, matched pairs pre- to post-GEMS

Item	In School Avg. (SD)	In GEMS Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I am confident that I can effectively use a science or engineering laboratory	4.75 (1.08)	5.07 (0.92)	1123	**.320***	11.90	.000	.355
I am confident that I can perform a variety of laboratory techniques during an experiment	4.65 (1.12)	5.03 (0.93)	1119	**.380***	13.06	.000	.390
I am confident in my ability to create useful hypotheses	4.78 (1.01)	5.02 (0.92)	1113	**.240***	8.59	.000	.257
I am confident in my ability to interpret the results of an experiment	4.76 (1.03)	5.05 (0.92)	1115	**.280***	10.40	.000	.311
I am confident that I can communicate science or engineering concepts to other people	4.51 (1.14)	4.91 (1.00)	1115	**.400***	13.61	.000	.408
In am confident in the conclusions that I draw from the results of an experiment	4.74 (1.04)	5.01 (0.93)	1118	**.270***	9.72	.000	.292
I am confident that I can find STEM research information using library resources	4.40 (1.28)	4.75 (1.18)	1109	**.350***	10.36	.000	.311

Across the three cases, we found significant differences across all items and generally weak to moderately strong effects for the GEMS-I (Physical Science and Forensics)[27] and moderately strong effects for GEMS- II (Biomedical)[28] cases. For GEMS-I creating useful hypotheses showed the strongest effect. For GEMS-II communicating science or engineering

[27] Range is *d* = .405 (weak effect) for drawing conclusions from results to *d* = .515 (moderately strong effect) for creating useful hypotheses.
[28] Range is *d* = .500 for creating useful hypotheses (moderately strong effect) to *d* = .721 (moderately strong effect) for communicating science and engineering concepts.

concepts showed the strongest effect. The GEMS-III case[29] revealed four significant differences, and all having weak effects: interpreting results (p = .04, d = .329, drawing conclusions (p = .03, d = .351), communicating concepts (p = .02, d = .385), and finding research information (p = .01, d = .445).

Limited growth in students' STEM confidence is reasonable considering the short duration of GEMS programming and students' already high levels of confidence upon entry to the program. From our onsite observations and from focus group interactions with students and mentors, evaluators suspect that AEOPs sufficiently challenge most students' notions of STEM through a more authentic context of a "professional" lab as opposed to a school lab, and students may actually become less confident in their knowledge, skills, and abilities, though arguably more competent, through their participation in AEOPs. Recognizing the limitations of one's knowledge, skills, and abilities is a necessary part of learning, and may be reflected in students' post-GEMS confidence levels.

In summary, GEMS provides more frequent opportunities for students to engage in these STEM activities than they have in school and after participating in GEMS, students have significantly higher opinion of their knowledge, skills, and abilities and significantly higher confidence to apply their knowledge, skills, and abilities. The strength of GEMS' effect on student engagement, opinion of knowledge, skills, and abilities, and on confidence appears to diminish in the more advanced GEMS level. A greater number of case studies are necessary to further explore the finding.

Interest and Future Engagement in STEM

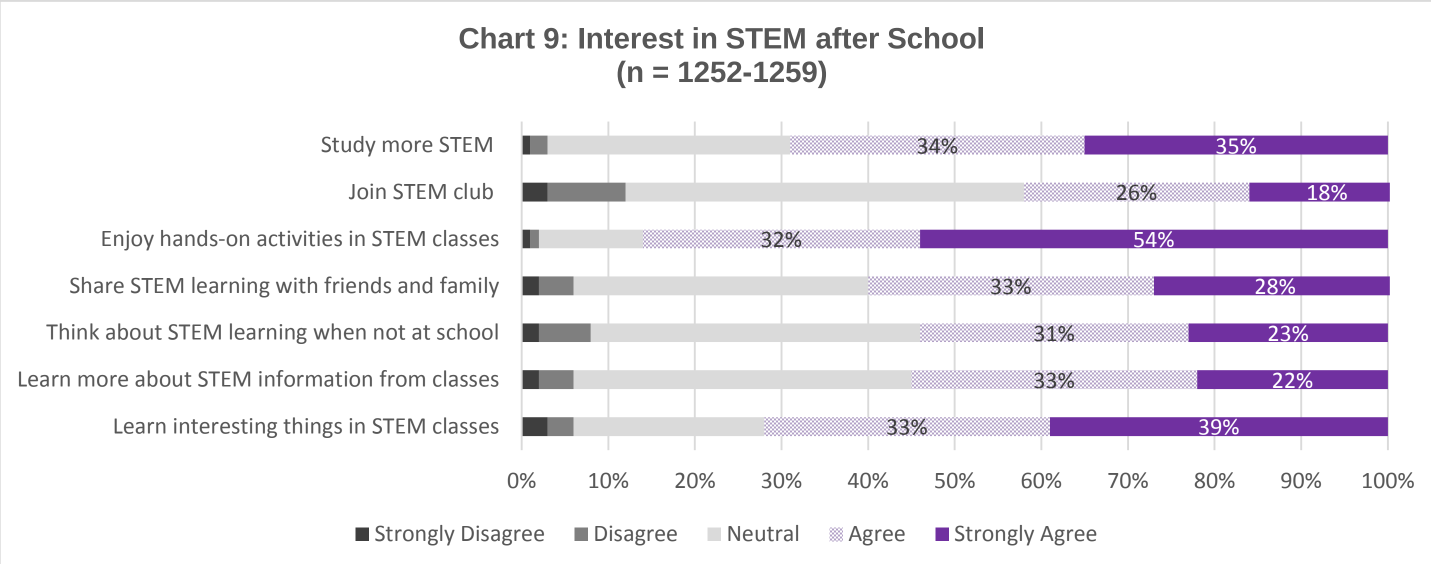
Thirteen items in the pre- and post-GEMS questionnaires measured students' interest and anticipated future engagement in STEM. These items address the following GEMS Objectives:

- Objective 1: To nurture interest and excitement in STEM for middle and high school participants; and
- Objective 6: To encourage participants to pursue secondary and post-secondary education in STEM.

Interest in STEM. Seven items in the pre- and post-GEMS questionnaires measured students' interest in STEM activities after GEMS as compared to after school. For these items students responded on a 6-point scale of 1 = "Strongly Disagree" to 6 = "Strongly Agree." Charts 9 and 10 summarize these data.

Charts 9 and 10 suggest that students have more positive attitudes toward and interest in STEM after GEMS. Across all seven items, the proportions of students who "agree" or "strongly agree" are greater after GEMS as compared to after school STEM experiences. The largest differences in proportions that agree relate to students' interest in joining a STEM club after GEMS as compared to after school, and their interest level in the things they learn in GEMS as compared to school.

[29] Range is d = .424 (weak effect) for creating testable hypotheses to d = .448 (weak effect) for finding STEM research information.



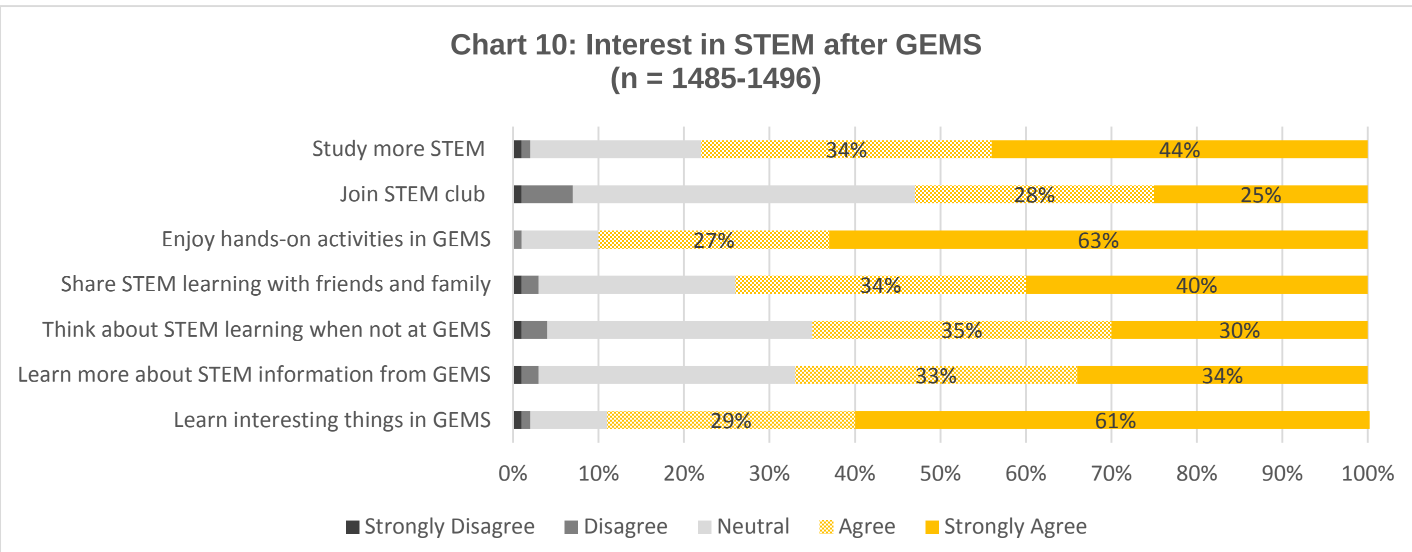


Table 13 (next page) reveals that the differences between the frequency with which students report positive attitudes toward and interest in STEM after school and after GEMS are significant. Across all items, the after school vs. after GEMS differences in attitudes or interest are statistically significant with weak effects. The largest effect, observed for interest level in learning from STEM classes vs. GEMS, approaches moderate strength ($p = .00$, $d = .466$). We again found significant differences across all item for the GEMS-I (Physical Science and Forensics)[30] and GEMS- II (Biomedical)[31] cases. The GEMS-

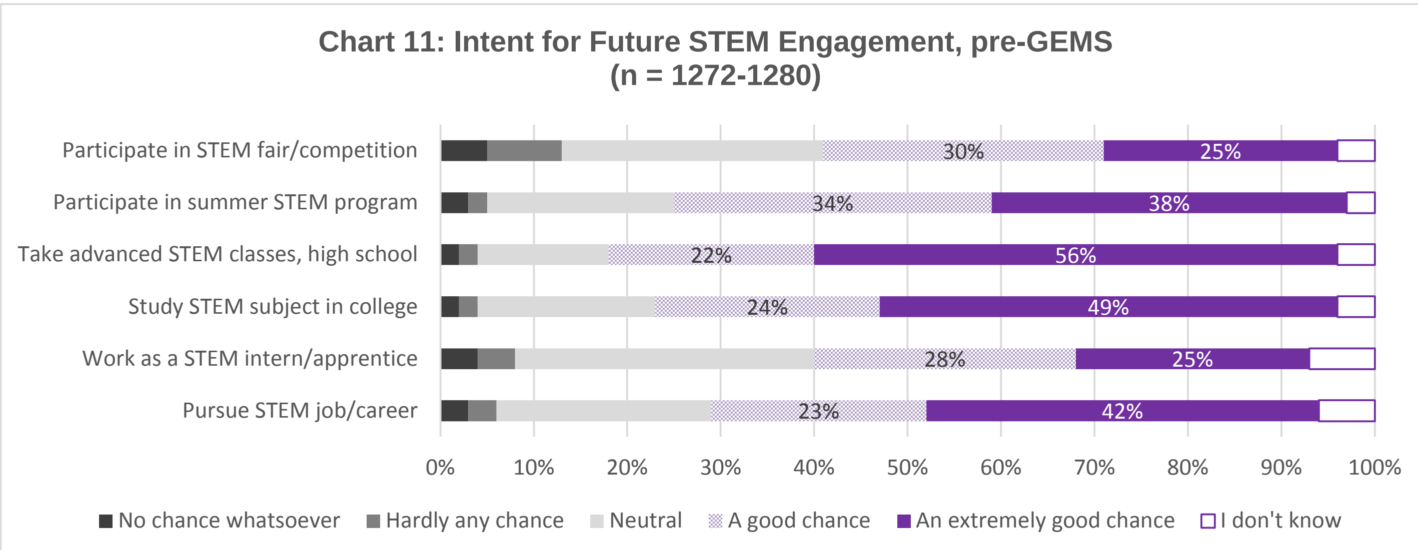
[30] Range is $d = .355$ (weak effect) for learn more about STEM information from class/GEMS to $d = .930$ (strong effect) for thinking about STEM learning outside of class/GEMS.
[31] Range is $d = .332$ (weak effect) for study more STEM to $d = .610$ (moderately strong effect) for learning more about STEM information from class/GEMS, learning interesting things in class/GEMS.

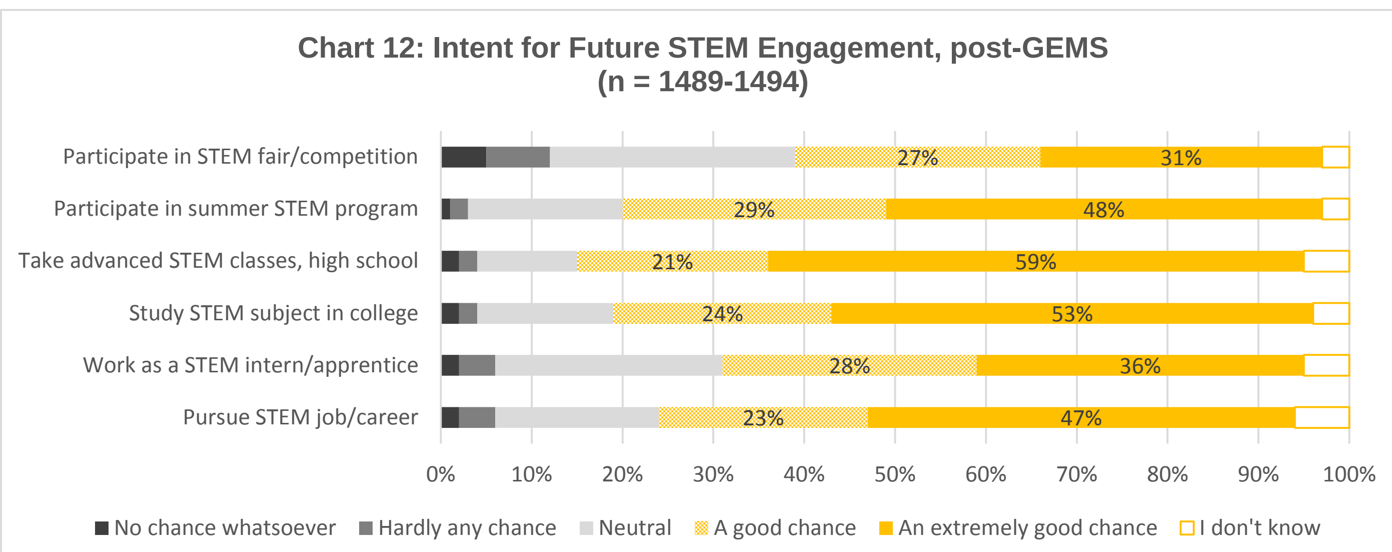
III case revealed no significant differences in students' attitudes toward or interest in STEM after GEMS as compared to after school STEM. In this case, it's worth noting that GEMS-III students' had on average, higher levels of positive attitudes toward or interest in STEM before participating in GEMS than did GEMS-I and GEMS-II students, as reflected by average responses that approach or exceed "agree." In this case, GEMS likely serves to sustain those positive attitudes and interest more so than inspiring new interest. All case data are reported in Appendix D.

Table 13. Interest in STEM, matched pairs after school vs. after GEMS

Item	In School Avg. (SD)	In GEMS Avg. (SD)	n	Mean Diff.	*t*	*p*	*d*
I want to study more Science, Technology, Engineering or Math (STEM) [after my classes / after participating in GEMS]	4.90 (1.07)	5.14 (0.94)	1127	**.250***	8.85	.000	.264
I would like to join a STEM club [outside of school / after participating in GEMS]	4.17 (1.28)	4.58 (1.19)	1118	**.410***	12.95	.000	.387
I enjoy doing the hands-on activities [in my classes / at GEMS]	5.35 (0.90)	5.55 (0.72)	1112	**.200***	7.19	.000	.216
I like to share what I learn [in my STEM classes / in GEMS] **with my friends and family**	4.67 (1.17)	5.06 (1.02)	1115	**.380***	11.77	.000	.352
I think about the things I learn [in my STEM classes / in GEMS] **when I'm not** [at school / in GEMS]	4.49 (1.22)	4.82 (1.08)	1113	**.330***	9.32	.000	.279
After [class / GEMS]**, I want to learn more about the STEM information that I learned about in class**	4.52 (1.16)	4.90 (1.06)	1117	**.380***	11.85	.000	.355
I learn interesting things [in my STEM classes at school / during the STEM activities at GEMS]	4.93 (1.21)	5.51 (0.77)	1116	**.580***	15.58	.000	.466

Future Engagement in STEM. Six items measured students' intent for future STEM engagement before and after GEMS, inclusive of intent to pursue formal STEM education, extracurricular STEM opportunities, and even employment opportunities. Students responded on a 6-point scale of 1 = "No chance whatsoever" to 6 = "An extremely good chance." Students also had the option of answering "I don't know," especially important since many younger GEMS participants may not have well established goals for post-secondary education and career. Charts 11 and 12 summarize these data.





Charts 11 and 12 suggest that student intent to engage in STEM expands after GEMS. Across all seven items, the proportions of students who "agree" or "strongly agree" are greater after GEMS as compared to before GEMS. The largest differences in proportions of students reporting agreement relate to students' intent to work as a STEM intern or apprentice, or to participate in a summer STEM program.

Table 14. Intent for Future STEM Engagement, matched pairs pre- to post- GEMS							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**n**	**Mean Diff.**	***t***	***p***	***d***
Participate in a science fair or science competition	4.36 (1.45)	4.56 (1.45)	1068	**.190***	6.16	.000	.188
Participate in a summer program related to STEM (e.g., club, camp, etc.)	4.93 (1.19)	5.16 (1.07)	1065	**.230***	7.29	.000	.223
Go to college and study a STEM subject	5.08 (1.24)	5.18 (1.16)	1044	**.100***	3.33	.000	.103
Take advanced high school classes in STEM (e.g., AP courses, dual enrollment, etc.)	5.25 (1.17)	5.30 (1.10)	1039	**.060***	2.01	.040	.062
Work as a STEM intern or apprentice	4.45 (1.37)	4.82 (1.26)	1007	**.370***	10.13	.000	.319
Pursue a job or a career in a STEM related field	4.87 (1.36)	5.00 (1.30)	1003	**.130***	3.97	.000	.125

Table 14 reveals that while the differences in students' pre- to post-GEMS intentions are significant, they are generally considered very small or having very weak effect. In fact, only students' intentions to work as a STEM intern or apprentice are considered "substantively important."[32] When we look across the three cases, we find only a few significant differences all of which are weak in strength:

- GEMS-I: Students' intent to work as a STEM intern or apprentice[33]
- GEMS-II: Students' intent to participate in a summer program[34]
- GEMS-II: Students' intent to work as a STEM intern or apprentice[35]
- GEMS-III: Students' intent to participate in a STEM fair/competition[36]

The differences noted may be linked to specific features of programming or to other program offerings at the site. For example, the GEMS-III curriculum was robotics, the focus of many engineering STEM competitions and growing popularity as extracurricular school club. In another example the site for the GEMS-II case, WRAIR, has a comprehensive suite of GEMS programs available to students, and many students may want to participate in GEMS again to explore a topic in greater depth or to explore a wider breadth of topics. In addition, WRAIR also has a strong pipeline of AEOPs including GEMS, GEMS-Near Peer, SEAP, and CQL the latter three are all internship or apprenticeship programs. Again,

[32] U.S. Department of Education, What Work's Clearinghouse Procedures and Standards Handbook, accessed June 30 http://ies.ed.gov/ncee/wwc/pdf/reference_resources/wwc_procedures_v3_0_draft_standards_handbook.pdf
[33] Mean Diff = .590, *p* = .000, *d* = .404
[34] Mean Diff = .510, *p* = .000, *d* = .444
[35] Mean Diff = .380, *p* = .000, *d* = .382
[36] Mean Diff = .330, *p* = .010, *d* = .425

questionnaire and focus group data suggest that many students wish to repeatedly engage in AEOPs at the site as they advance in age or grade level.

In summary, these data suggest that after GEMS, significantly more students have interest in STEM and intent for future STEM engagement though the strengths of GEMS effects on both vary considerably. GEMS' effect on students' STEM interest seems to vary by level, with the effect diminishing as the GEMS level increases. Thus, GEMS-I (which are often focused on upper elementary and middle grades) may serve to cultivate new interests, whereas GEMS-III (which are often focused on high school grades or for GEMS alumni) serves more to sustain existing interest.

Army STEM

The Army's goal of establishing a coherent pipeline of opportunities for engaging and developing STEM talent from kindergarten to college, and then attracting that talent to Army/DoD careers, requires that each program promote its participants' awareness of both AEOP initiatives and Army/DoD STEM careers. Students and mentors who are aware of the portfolio of AEOP programs can serve as stewards of AEOP in their personal and professional relationships, advancing the AEOP's mission of outreach. Mentors who are aware of and knowledgeable about the portfolio of AEOP programs can provide guidance and encouragement to students regarding next steps in their AEOP pathway. Mentors who are knowledgeable about Army/DoD STEM career opportunities can inspire students' interest and appreciation of them and provide guidance about educational pathways to achieve them. Students that have greater awareness of and positive attitudes toward Army/DoD STEM careers are more likely to seek them out in the future.

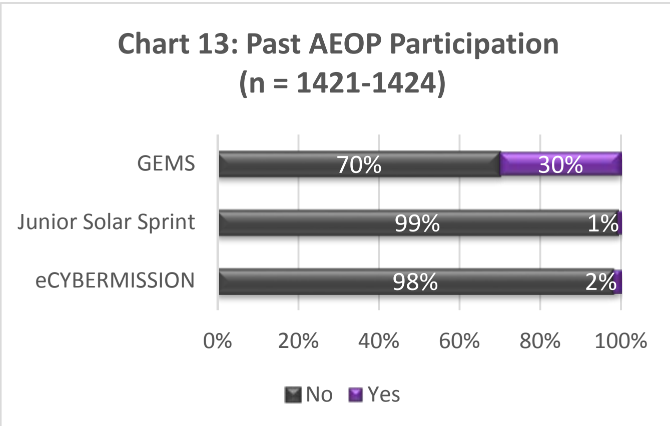
Army Educational Outreach Programs

- Junior Solar Sprint (JSS)
- Gains in Mathematics and Science Education (GEMS)
- West Point Bridge Design Competition (WPBDC)
- eCYBERMISSION (eCM)
- High School Apprenticeship Program (HSAP)
- Research and Engineering Apprenticeship Program (REAP)
- Science and Engineering Apprentices Program (SEAP)
- Undergraduate Research Apprenticeship Program (URAP)
- College Qualified Leaders (CQL)
- Science, Mathematics, & Research for Transformation (SMART) scholarship (Offered by DoD)
- National Defense Science and Engineering Graduate (NDSEG) (Offered by DoD)

The assessments measured students' past participation in and interest in future AEOP opportunities, as well as student awareness of Army/DoD STEM careers. Mentor focus groups included corresponding items to corroborate student findings and are shown here for comparison. These measures correspond to GEMS program objectives:

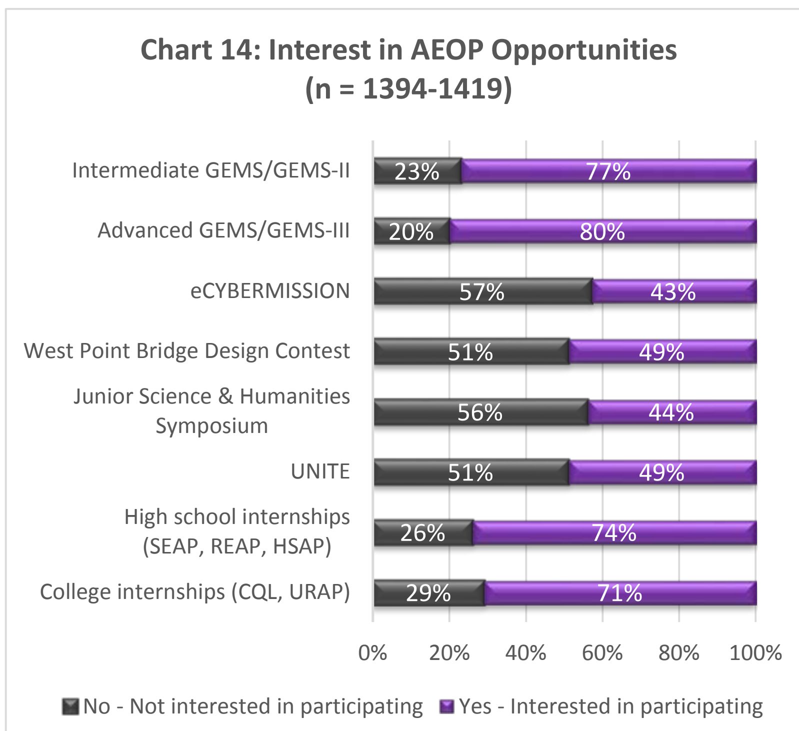
- Objective 7: To educate participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories; and
- Objective 8: To provide information to participants about opportunities for STEM enrichment through advancing levels of GEMS as well as other AEOP initiatives.

AEOP Opportunities. The evaluation measured students' past participation in AEOP programs before GEMS (Chart 13) and interest in future AEOP opportunities after participating in GEMS (Chart 14).



Student questionnaires elicited past participation in other AEOP programs that students may have been exposed to in or outside of school. As shown in Chart 13, 30% of GEMS students reported being GEMS alumni. Students had participated from 2 times (19%) to 6+ times (<1%). A very small number of students had participated in other age or grade-relevant AEOPs, Junior Solar Sprint (<1%) and eCYBERMISSION (<1%). This suggests that GEMS largely serves as an entry point to the AEOP pipeline of programs, and a substantial portion are retained in the pipeline through the repeated participation in GEMS programs alone.

Chart 14 summarizes students' post-GEMS interest in other AEOP opportunities listed. A majority of students (71%-80%) expressed interest in participating in the pipeline of programs available at through the Army laboratories which hosted or sponsored their GEMS program (e.g., Intermediate/GEMS-II, Advanced/GEMS-III, SEAP, CQL). Fewer students (43%-49%) expressed interest in the competitions (eCYBERMISSION, West Point Bridge Design Contest, and Junior Science & Humanities Symposium), and summer program (UNITE) that are available outside of Army laboratories. Since most student interviewees generally could not name, or recognize when named, AEOP initiatives outside of the Army laboratory GEMS-SEAP-CQL pipeline, low interest in the aforementioned competition and summer programs could be due to lack of awareness of them.



Focus groups and past participation rates suggest that students may be largely unaware of other AEOP initiatives that occur outside of the Army laboratory that hosts or sponsors their GEMS program. Focus groups with students and mentors also suggest that students may not be consistently learning about the full array of future AEOP opportunities from their mentors. Yet, substantial student interest exists in AEOP opportunities that would benefit from more robust cross-promotion of AEOP opportunities.

Army/DoD STEM jobs and careers. Two items in the post-GEMS questionnaire measured the extent to which participants perceive they learned about STEM jobs in general, and specifically, STEM jobs within Army/DoD. Chart 15 summarizes students' learning about STEM and Army/DoD STEM jobs during GEMS.

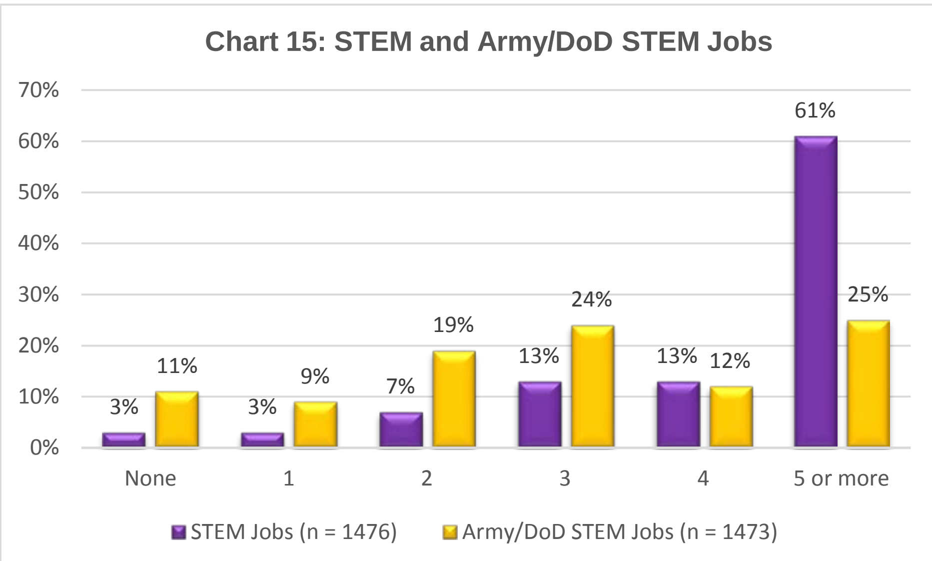
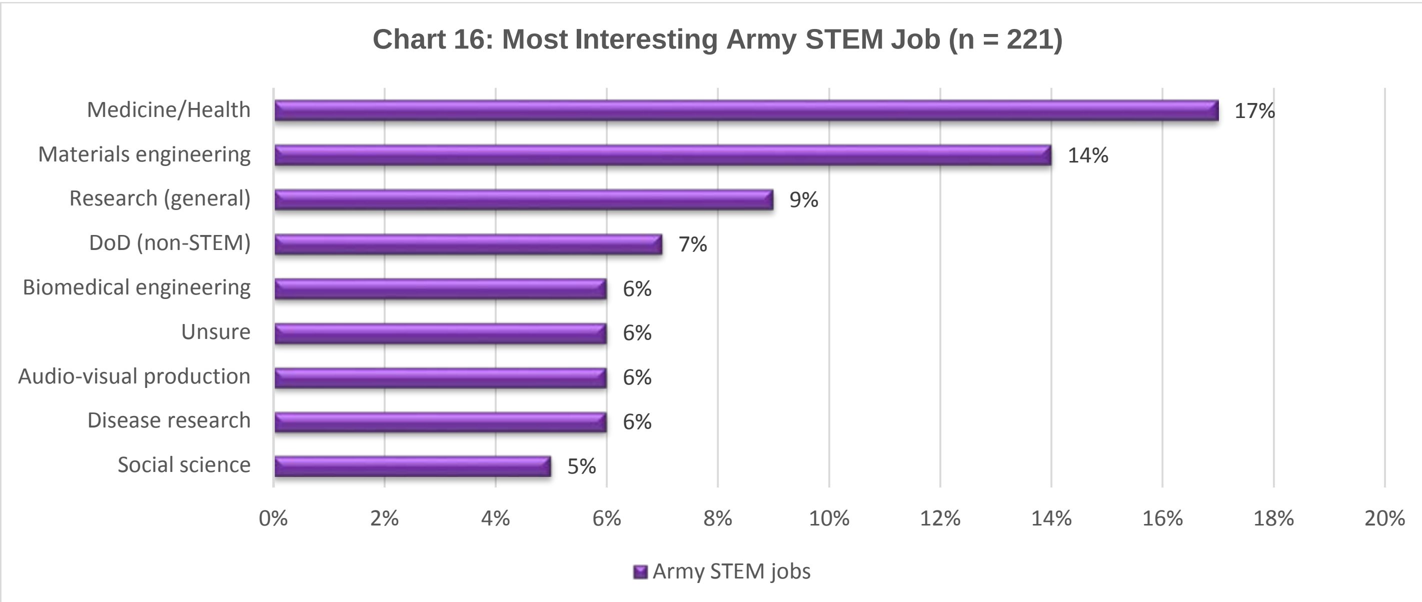
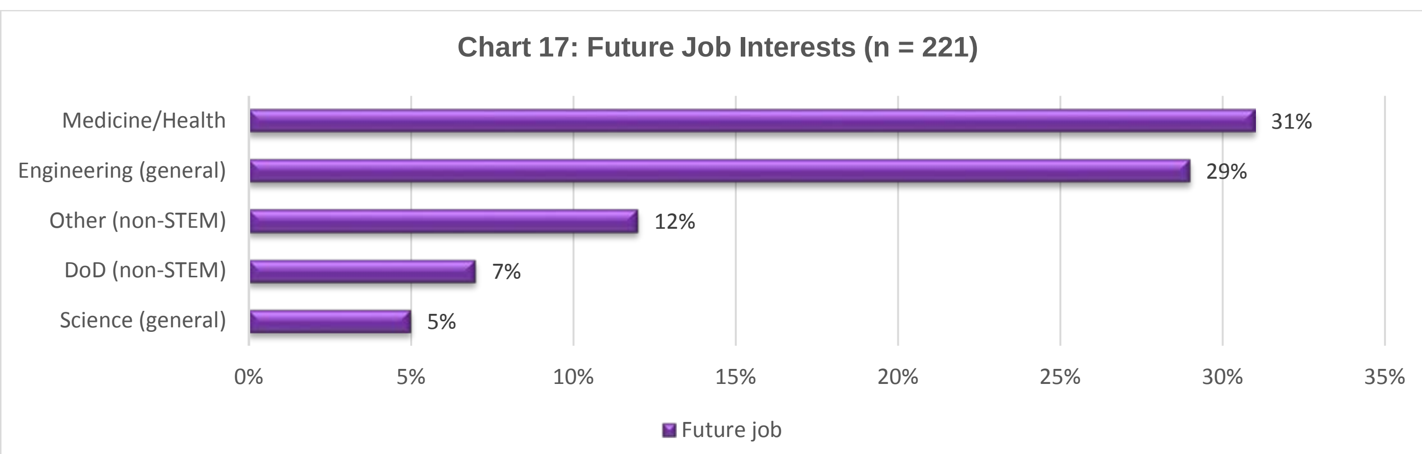


Chart 15 illustrates that most students reported opportunities to learn about STEM jobs during GEMS. Most students (87%) learned about multiple STEM jobs, and on average, students learned about four STEM jobs. Only a small proportion (3%) reported no opportunities to learn about STEM jobs. Army/DoD STEM jobs received less attention than STEM jobs, with students exposed to an average of three Army/DoD STEM jobs. A larger, yet still small, proportion of students (11%) reported no exposure to Army/DoD STEM jobs.

Students were asked an open ended question to elicit which STEM job with the Army they found most interesting and why. Chart 16 summarizes responses that were reported in greater than 5% of the 221 responses from the three cases. Most frequently students mentioned medicine/health-related, materials engineering, and research-related jobs. The top three reasons why case study students found these jobs interesting included that they help people (25%), the job is interesting (22%), and the job invents/improves things (8%). The range of reasons cited in these 221 responses is listed in Appendix C.



Students were also asked an open-ended question about what job they are interested in pursuing. Chart 17 summarizes responses that were reported in greater than 5% of the 228 responses from the three cases. The range of reasons cited in these 228 responses is summarized in Appendix C. The most frequently cited job interests, medicine/health and engineering, are consistent with the GEMS curricular topics of the three cases from which responses were analyzed. Future evaluation will include response choices to allow for summary of the entire data set. Of note, 10% of students reported specific interest in pursuing DOD or government service jobs.



In summary, most students learned about multiple STEM jobs during GEMS (87% learned about 3 or more jobs). While students report that Army STEM jobs get less attention (61% learned about 3 or more jobs), most students (89%) reported learning about at least one Army STEM job. Students' were most frequently interested in pursuing medicine/health-related fields. This is not surprising given that approximately two-thirds of students in this response sample participated in Biomedical (n = 100) and Forensics (n = 64) GEMS curricula, two of the three case studies. However, this also reveals a possible area where GEMS programs can be of particular service to the National STEM goals. Students pursuing undergraduate degrees in STEM fields do so to obtain the necessary foundation of basic science and mathematics required for acceptance into professional degree programs in medicine/health sciences.[37] Recent studies suggest that as many as one third of students leaving undergraduate STEM majors are pre-medical students who have abandoned their pursuit of a medical career (known as the "pre-med phenomenon").[38] STEM programs, such as GEMS, serve a critical need in providing authentic STEM experiences that both inspire and sustain students' interest in STEM and provide them with exciting and obtainable STEM career options to the more highly competitive medicine/health fields.

[37] Georgetown Center on Education and the Workforce (2013), Author STEM http://genprogress.org/voices/2011/10/25/17168/report-more-jobs-this-year-for-recent-graduates/

[38] UCLA's post-Baccalaureate Experiences, Success, and Transition (BEST) project has studied barriers to and facilitators of underrepresented minority students' pathways toward careers in STEM fields since 2004. A number of applicable reports may be found at http://www.heri.ucla.edu/publications-brp.php, including Higher Education Research Institute (2010). *Degrees of success Bachelor's Degree Completion Rages among Initial STEM Majors*.

What Participants are Saying

An overwhelming majority of students and mentors that were surveyed and interviewed spoke highly of their GEMS experiences. Many students and mentors encouraged expansion of GEMS to address perceived unmet local need and suggested more and better marketing for both recruitment (especially of underserved and underrepresented students in urban schools) and greater public awareness of AEOP's role in STEM education. The following quotations provide illustration of overall participant satisfaction:

The hands-on learning is a powerful feature of the GEMS program:

- "It is better than just getting lectures. We get to do it ourselves and get more into it. It is more exciting and it offers a glimpse into the future. At school, there is labs but here they give us a lot of other opportunities that we don't get at school. Dissections, PCR, guest speakers, etc."
- "The opportunities are better, you get to experience more in a limited amount of time. The guest speakers are one example, we also SAW how the science can be applied to their work. In class, we would have just had a PowerPoint but we got the activity here and it is much more fulfilling."
- "I work at Howard University but came to GEMS and got to do PCR. I didn't get that experience at [high] school or at Howard. I get to apply what I do at GEMS and take it to my work at Howard University."
- "Hands on experiences here are invaluable. You will not have another opportunity to do this type of work. I would recommend it highly to my science-interested friends."

GEMS students think about their futures:

- "We get interested in new STEM subjects and areas of research. I learn new things, I was free to learn about science and the opportunity here is immense."
- "This program has reinforced my love of science. The people and the personnel who are here are awesome, they make things interesting. I do not feel forced to be here so I want to learn what they give me. The NPMs do an excellent job explaining the topics. The people have been awesome."
- "It bridges the gap between what I learn in school and what I will /could learn in the future. It is a great opportunity to expand knowledge and how I think about my future. It gets a much clearer focus on my future."
- "I wanted to be a doctor but being here has opened my eyes about other things that I think I might want to pursue. I am very excited about the neuroscience research I was exposed to here."

GEMS students would participate again if given the chance:

- "I would participate in GEMS again given the chance because I get to learn things I wouldn't learn in school and put what I learned to practical use."
- "Yes because I got to do things like modify DNA that I could never do anywhere else."
- "I learned more in 4 days at GEMS about certain topics than I did in 1 year in my science class at school."
- "This GEMS experience was truly phenomenal experience that helped me decide to pursue a career as, hopefully, an army research engineer."
- "It gave me a unique science experience that would be very hard to replicate. Here, we did the amount of hands-on stuff I'd do in a year in school."
- "I would participate again because I can picture myself getting a job at ARL due to GEMS program."
- "I love the hands on learning experience and working with the mentors. They always are very excited to teach us about their jobs/majors. I will be applying for GEMS advanced next year."

- “This is something that gives young people a chance to get a preview of the different careers in the STEM field. Before I didn't know what I wanted to do for a living, but now since I’m in GEMS, that vision has cleared up.”

GEMS students would recommend the program to friends:

- “It is a great place to find a career if you don’t know what you want to be when you get older.”
- “You learn about different careers but you also have fun while doing science!”
- “I’ve been to some camps that are really boring, you really don’t do anything, you just listen…but you get to do a lot of experiments, see new scientific equipment, and use it [at GEMS].”

GEMS mentors identify the value youth and adults alike:

- “…In a classroom you have 36 kids and there’s not a whole lot of individualized support you can give. But now when you have a group of 6, we can interact with every kid with tremendous depth. It is so difficult to achieve that in a classroom, in terms of getting at what does each and every one of them truly know and how can you help them. Here there is constant feedback.”
- “Personally I find the resources that I’ve developed over the past four or five years, including feedback and whatever I can glean from them (the scientists), even materials (like journals) … Is helpful to me, but also helpful to my students outside of the program, ultimately. Exposing them to new things.”
- “With (the four of) us being in different atmospheres and different job descriptions and levels, we share a lot of what we see in our classroom and in our county which enhances our appreciation for things that we share… So, its’ not only the students and scientists but it’s with us as well – we grow from each other.”
- “The kids see hands-on… come home and say ‘now I can see why I just learned algebra’. It clicks. So it provides an opportunity for all of us to reach a different level that is not accessible in a classroom whether it’s private or public.”
- “In a classroom setting we are so focused on teaching what the subject matter is. Hard to branch out and tie it into the other subjects. Whereas here, we can tie it all in. Kids do see the value. The math, English, even history of what’s going on. Not just the science.”
- “Just being here and seeing that the scientists and engineers are doing these things helps when kids ask ‘when will I ever do this or see this’ and you have this to share with them. Real life example as opposed to saying ‘I don’t know’.”
- “I think it motivates students in STEM fields because it relates science back to real life. In school they just learn facts and they’re not actually able to connect it back to real life… [applying school concepts] that is what GEMS does.”
- “I learn a lot from talking to my fellow teachers about their experiences, the students can benefit similarly and figure out what they want to do [in the future] by interacting with more than one type of person in a major.”
- “[GEMS] makes science cool, schools make it seem boring…but with our different majors we are able to show students that you can find things that you are interested in and there is a scientific application that you can take.”
- “[GEMS] has helped me gain access to the USDA…when I turned in my resume we spoke about my experience with GEMS, my interest in probiotics and how I taught a probiotic lab with the GEMS students…it may lead to a graduate school project.”
- “[GEMS] has added to the repertoire of things that I am more comfortable teaching to kids.”
- “I am learning how things ‘can be’ if you have the resources and kids that want to be there. It is refreshing to see middle school kids who are curious and want to learn.”
- “When upper level students start looking into careers, they do generic activities at school (write a small report about 5 things they may want to do) and this program allows (us) to come in and talk to them about it, because ultimately they pick what they are exposed to.”

Summary of Findings

The FY13 evaluation of GEMS collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 14.

Table 14. 2013 GEMS Evaluation Findings	
Participant Profiles	
GEMS student participation in evaluation yields high level of confidence in the findings.	• The statistical reliability achieved for the pre- and post-GEMS student questionnaires, as well as the pre- to post-GEMS matched cases (all <±2%) allow us to sufficiently generalize findings of the evaluation sample to the population. Three case studies for which pre- to post-GEMs statistical analyses were conducted further illustrate the potential effects of the simplest unit of a single GEMS program. Cases included beginner/I, intermediate/II, and advanced/III levels of GEMS and a range of topics.
	• Additional evaluation data contribute to the overall narrative of GEMS's efforts and impact, and highlight areas for future exploration in programming and evaluation, though findings from these data are not intended to be generalized to all GEMS sites and participants.
GEMS serves students of historically underrepresented and underserved populations.	• GEMS attracted participation from female students—a population that is historically underrepresented in engineering fields; however, student questionnaire respondents included more males (52%) than females (47%).
	• GEMS provided outreach to students from historically underserved minority race/ethnicity and low-income groups. Student questionnaire respondents included minority students identifying as Black or African American (23%), American Indian or Alaskan Native (1%), and Hispanic or Latino (7%). A small proportion (12%) of students reported qualifying for free or reduced lunch.
	• GEMS served students across a range of school contexts. Most student questionnaire respondents attended public schools (79%) and suburban settings (64%).
GEMS engages a diverse group of adult participants as STEM mentors.	• GEMS engaged Army Scientists and Engineers (S&Es, number unknown), college-level near-peer mentors (NPMs, 69), and in-service resource teachers (RTs, 45), who facilitated educational activities, exposed students to Army STEM research and careers, and mentored students.
	• At all GEMS sites visited by evaluators, students had access to mentors belonging to either the same gender (female) and/or the same race and ethnicity group.
Actionable Program Evaluation	
GEMS is strongly marketed to schools and teachers serving historically underserved groups.	• ASEE and GEMS sites employed multi-pronged efforts to market programs to and recruit students from populations of historically underserved students. Efforts included partnerships with minority-serving community organizations (e.g., Boys and Girls Clubs, 100 Black Men) and targeted marketing to on-post schools, rural schools, and schools in districts serving high proportions of low-income students.
	• Students most frequently learned about the local GEMS program from parents and family members (more than 50%) and from teachers and others at school (more than 20%).

GEMS students are motivated by positive past experiences and opportunities provided by GEMS.	• Students were most frequently motivated to participate in GEMS this year because of overall satisfaction with previous GEMS participation. Students also sought opportunities to explore or advance their STEM pathways, such as new or deeper learning about topics, developing STEM skills, engaging in hands-on activities, and clarifying future education or career goals.
GEMS mentors engage students in meaningful STEM learning, through team-based and hands-on activities.	• Mentors used a variety of mentor and/or instructional activities for productively engaging students in STEM learning, including: supporting student experimentation and exploration, facilitating small group and partner work, and using one-on-one teaching and peer-to-peer teaching to ensuring student understanding.
	• Most students (74%-93%) found their GEMS mentors to be excited about STEM, accessible to learners, and having impacted their learning. Students perceived that mentors cared about their learning (93%), were excited to do hands-on activities (87%), and were easy to learn from (81%).
GEMS mentors promote AEOP initiatives and Army STEM careers available at Army research laboratories.	• Most mentor interviewees had no awareness of or past participation in an AEOP initiative beyond GEMS or the AEOP's at the site, such as SEAP and CQL. Subsequently, students reported limited exposure and encouragement to pursue AEOP opportunities other than SEAP and CQL.
	• GEMS programs engaged Army S&Es as leaders of educational activities and as invited career speakers, in an effort to expose students to Army STEM research and careers.
	• Mentors at one site reported that their lessons culminate with information that helps them connect Army/DoD jobs and careers with the activities just completed by students in the GEMS program. These curricular supports were considered particularly useful to the NPMs and RTs at the site who were less familiar with the work conducted by the Army/DoD.
GEMS benefits participants over typical school STEM offerings.	• Mentors perceived that GEMS provides students with opportunities to explore and advance their STEM pathways and provides learning opportunities (e.g., environments, resources, and activities) not available typical school settings.
	• Mentors perceived that GEMS benefits mentors, by expanding their STEM networks, their teaching and mentoring skills, and their instructional resources. GEMS is highly motivating environment.
	• Mentors suggest expanding GEMS' to address unmet need and to extend its geographic and demographic reach. Mentors also suggested that educators would benefit from outreach.
Outcomes Evaluation	
GEMS students have more frequent opportunities for students to engage in STEM activities than they have in school.	• Most students (75-90%) reported engaging in the various STEM activities multiple times per week during GEMS. Fewer students (26%-45%) reported participating in various activities at the same frequency in school.
	• The in school vs. in GEMS difference is statistically significant with a moderately strong to very strong effect across all GEMS program data. The strongest effects are relate to students having opportunities to participate in hands on activities and to decide how to carry out experiment or activity to answer ones' own question. Strength of effects generally diminish with the advanced GEMS case.
	• Students suggested that hands-on activities during GEMS provided more meaningful learning than could be obtained through lectures and reading typical in school and were more engaging to students.

GEMS students have higher opinion of their STEM knowledge, skills, and abilities after GEMS.	• Greater proportions of students reported seven STEM skills and/or abilities post-GEMS (63%-81%) as compared to pre-GEMS (41%-72%).
	• While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. A strong effect is observed with students pre- to post-GEMS assessments of their knowledge of laboratory techniques. The number of significant differences and the strength of the effects generally diminish with the advanced GEMS case.
GEMS students have higher confidence to use their STEM knowledge, skills, and abilities after GEMS.	• Greater proportions of students reported confidence to use seven STEM skills and/or abilities post-GEMS (64%-76%) as compared to pre-GEMS (52%-67%).
	• While the pre- to post-GEMS comparison reveals significant changes in all items, those differences are generally weak in effect. The strongest effect, and still considered weak, is observed with students pre- to post-GEMS confidence to communicate science and engineering concepts. The number of significant differences and strength of their effects generally diminish as the level of GEMS increases.
GEMS inspires and sustains students' interest in STEM.	• Greater proportions of students reported positive interest in STEM after GEMS (53%-90%) than reported positive interest after their school STEM experiences (44%-86%).
	• Across all items, the after school vs. after GEMS differences in attitudes or interest are statistically significant, but with weak effects. The largest effect was observed for interest level in learning from STEM classes (in school) vs. GEMS. Students participating in the advanced GEMS case exhibit no significant differences.
GEMS inspires and sustains students' intent to engage in future STEM.	• Greater proportions of students reported intent to engage in future STEM activities, education, and careers post-GEMS (58%-80%), as compared to pre-GEMS (55%-78%).
	• Across all items, the pre- to post-GEMS differences in intentions are statistically significant, but with very weak effects. Only students' intentions to work as a STEM intern or apprentice are considered "substantively important." Each case study revealed significant differences in one or more items that may relate to specific features of programming or to other program offerings at the site: STEM summer programs, STEM fair/competition, and STEM apprenticeships.
GEMS students may be unaware of the full portfolio of AEOP initiatives, but students show substantial interest in future AEOP opportunities.	• Most students (71%-80%) expressed interest in participating in the pipeline of programs available at the Army laboratories which hosted or sponsored their GEMS program (e.g., GEMS, SEAP, CQL).
	• Fewer students (43%-49%) expressed interest in the competitions (eCYBERMISSION, West Point Bridge Design Contest, and Junior Science & Humanities Symposium), and summer programs (UNITE) that are available outside of Army laboratories. Most student interviewees generally could not name, or recognize when named, AEOP initiatives outside of the Army laboratory GEMS-SEAP-CQL pipeline.
GEMS increases students' awareness of Army STEM jobs.	• Most students (87%) learned about multiple STEM jobs, and on average, students learned about 4 STEM jobs. Army/DoD STEM jobs received less attention that STEM jobs, with students exposed to an average of 3 Army/DoD STEM jobs.

Recommendations

1. The number of applications for GEMS (4,231 applications for 2,038 funded positions) is indicative of considerable unmet need and interest. The evaluation provides evidence of program success in support of expansion to accommodate this unmet need and interest. Expanding geographically to more GEMS sites alone may simply generate new or more need in new communities. Expanding the capacity of existing GEMS sites to serve more students would be needed to accommodate existing need in those communities. To expand the capacity of existing GEMS sites, greater investment may be required to expand site administrative staff, physical infrastructure needs, and mentor participation, most specifically Army S&E participation.

2. GEMS and AEOP objectives include expanding participation of historically underrepresented and underserved populations. While ASEE conducts targeted marketing of GEMS to those populations, assessment data suggests that site-level marketing, recruiting, and selection processes have greater influence in reaching and determining GEMS participants. GEMS may benefit from more Army and ASEE oversight and/or guidance of these site-level processes to maximize the inclusion of underrepresented and underserved students. This guidance may include any number of promising marketing and recruitment practices that should be implemented program-wide, including but not limited to targeted marketing to and partnership with low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations. Guidance may also be provided to ensure other "connected" applicants (e.g., those with family, family friends, or school-based connections to the site) are not disproportionately advantaged over qualified but "un-vetted" candidates who may apply at the AEOP website. The Army, ASEE, and GEMS sites may need to consider practical solutions to the challenge posed by Army facility locations, as proximity alone is likely to advantage some populations more than others (e.g., students with greater proximity, or students with means for longer distance transportation or temporary relocation near the site). In-residence programs, travel accommodations (e.g., bus transportation from schools) may be needed to recruit and make participation feasible for underserved populations living at greater distances from the GEMS sites.

3. Mentors play important roles in GEMS. Mentors design and facilitate learning activities, deliver content through instruction, supervise and support collaboration and teamwork, provide one-on-one support to students, chaperone students, advise students on educational and career paths, and generally serve as STEM role models for GEMS students. The FY13 mentor focus groups served as a baseline effort to collect information from this participant group, but a more systemic assessment of mentors is required to evaluate their engagement as STEM-Savvy Educators in AEOPs. Any future survey of mentors should at a minimum gather information how mentors become aware of GEMS, motivating factors for participation in GEMS, satisfaction with and suggestions for improving GEMS programs, perceived benefits to participants, and mentor activities, including those relating to exposing students to AEOP opportunities and Army STEM careers.

4. As a whole, students began and ended GEMS with high opinions of and confidence in their STEM competencies, and ambitious STEM extracurricular, education, and career aspirations. The evaluation provides evidence of perceived growth in these outcomes across all program data, albeit with weak effects. Site-level data provides clearer evidence of GEMS' variable impact on students STEM confidence and

ambitions: the GEMS-I and II cases showed moderately strong to strong, significant effects across more indicators while the GEMS-III case showed fewer points of growth that were significant or with strong effect. These findings may indeed be specific to those cases; however, they may also provide evidence that beginning GEMS programs (often those targeted to upper elementary and middle school students) improve outcomes whereas advanced levels of GEMS sustain outcomes. Future evaluation should continue to explore cases to uncover differential effects that are masked when data is averaged across all sites, levels, and curricular topics. Where adequately powered, these case studies may also investigate whether differential effects across different demographic populations.

5. Data suggests that GEMS apprentices have more opportunities to do the *hands-on* aspects of STEM activity and fewer opportunities to engage in the *minds-on* aspects. Minds-on aspects of STEM activity have been linked to greater student affective and achievement outcomes than hands-on activities alone.[39] [40] Programs might consider how to expand students' opportunities to engage in challenging minds-on STEM activities such as generating questions, designing experiments, analyzing and interpreting data, and formulating conclusions for their questions during their GEMS programs. For example, one site required that students work in teams to apply their new learning to solving a case. Another AEOP, the UNITE program, had several sites that used weekly challenges or competitions to engage students in student-directed application of learning. Assessment data also suggest that students value opportunities to apply school learning to real world situations and in collaborative settings, as these are less common in typical school settings. Minds-on experiences may also continue to challenge and inspire older GEMS students and returning GEMS alumni who exhibited less change in outcomes related to STEM competencies and ambitions.

6. Mentor and student interviewees across the focus group samples reported limited awareness of and participation in any given AEOP initiative beyond the Army research lab GEMS-SEAP-CQL pipeline. Mentor interviewees reported spending little or no time educating students about AEOP initiatives for which students qualify during daily program activities, aside from distributing AEOP brochures and highlighting the website. Student interviewees generally could not name, or recognize when named, AEOP initiatives except for GEMS, SEAP, and CQL. However, substantial student interest exists in AEOP opportunities when vaguely described. This interest, especially from students of underserved populations, would benefit from more robust attention by program coordinators and mentors during GEMS program activities, especially since the existing GEMS-SEAP-CQL pipeline cannot accommodate the considerable unmet need. Other AEOPs may be able to provide greater geographical and demographic reach where GEMS sites are simply unable. Continued guidance by ASEE is needed to ensure coordinators and mentors alike are knowledgeable of AEOP opportunities at and beyond the Army research labs, and have reasonable plans and strategies for exposing students to these opportunities before, during, and after program activities.

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

[40] Maltese, A.V. & Tai, R. H. (2011) Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education Policy* 98, 877-906

Appendices

Appendix A:
FY13 GEMS Evaluation Plan

Key Evaluation Questions

The GEMS evaluation gathered information from GEMS student and mentor participants, and site program coordinators (through site program reports) about GEMS processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives:

- What aspects of GEMS programs motivate participation?
- What aspects of GEMS program structure and processes are working well?
- What aspects of GEMS programs could be improved?
- Did participation in GEMS programs:
    - Increase students' STEM competencies?
    - Increase students' interest in future engagement?
    - Increase students' awareness of and interest in other AEOP opportunities?
    - Increase students' awareness of and interest in Army/DoD STEM careers?

Methods and Instruments

The FY2013 evaluation used a mixed methods approach[1] to allow for broad generalization and for deeper focusing of the evaluation. This mixed methods approach employed quantitative measures to assess level of agreement or satisfaction, as well as qualitative measures, such as open or constructed-response items in surveys and focus groups that provided less structured items assessing perceived value, satisfaction, or suggestions for improvement.

The assessment strategy for GEMS included pre- and post-GEMS student questionnaires, onsite focus groups with student and mentor participants at three sites, and site program reports collected by TSA from sites, which were provided to Virginia Tech.

Data Collection and Sampling

Data collection efforts for 2013 occurred from June to August, during GEMS program activities. On-site focus groups were conducted with students and mentors at 3 of 13 GEMS sites. Evaluators provided program staff with guidelines for purposive sampling of students—equal representation of males and females and a range of age/grade levels, race/ethnicity demographics, and STEM interests—when assembling focus groups where large numbers of students were available. Convenience sampling was employed for mentor focus groups—any mentor participants providing appropriate permissions were invited to join the focus group, without regard to diversity represented by the group—to maximize participation in focus groups. Program staff administered pre- and post-program surveys to students in paper and pencil form on the first and last days of program activities. Alternatively, students could complete the same surveys in an online format. Student questionnaires also employed convenience sampling. Online questionnaires were opened for data collection for a minimum of 10 days after program activities concluded.

[1] Creswell, 2003; Quinn 2001; Greene & Caracelli, 1997

Appendix A:
FY13 GEMS Evaluation Plan

The evaluation included focus groups with students and mentors at three sites in the Eastern U.S. Mentor focus groups included 17 mentors (8 females, 9 males). Mentor focus groups included Army S&Es (4), Near Peer Mentors (8), and local teachers (5). Student focus groups included 44 students (21 females, 23 males). Student focus groups included students ranging from grades 5 to 12 and participating in Beginner/GEMS-I, Intermediate/GEMS-II, and Advanced/GEMS-III levels. Two sites were at Army research labs in the National Capitol Region. One site was a university site. Evaluators also visited a fourth site—at a local high school—but were unable to conduct focus groups during that visit.

Data Analyses

Quantitative and qualitative data were compiled and analyzed after all data collection concluded.

Evaluators summarized quantitative data with descriptive statistics such as numbers of respondents, frequencies and proportions of responses, average response when responses categories are assigned to a 6-point scale (e.g., 1 = "Strongly Disagree" to 6 = "Strongly Agree"), and standard deviations.

All pre- and post-GEMS data collected from students are summarized in Appendices B and C. Charts used within this report narrative provide visual representations and comparisons of these data, unless otherwise noted. This allows the reviewer to easily apply the determined margin of error for each participant groups' questionnaire responses. For visual simplicity of charts, "Somewhat Disagree" and "Somewhat Agree" (and similar categories) are aggregated as "Neutral" responses.

Evaluators conducted inferential statistics on matched cases to study any changes in participants or participant groups (e.g., at the site level) that could demonstrate the potential effect of their participation in GEMS. Matched pairs refers to students completing both pre- and post-GEMS questionnaires and with sufficient information to match their pre- and post- data. Pre- to post-GEMS comparisons of matched are summarized in Appendix D—at the program level and for three cases composed of a GEMS site-level-curricular topic. Tables used within the report narrative generally summarize program level matched pairs comparisons and report the results of significance testing[2] for identifying statistically and practically significant changes.

Statistical significance indicates whether a result is different than chance alone. Statistical significance is determined with t, McNemar, ANOVA, or Tukey's tests, with significance defined at $p < 0.05$. Practical significance, also known as effect size, indicates how weak or strong an effect is and is usually studied in relation to statistical significance. Practical significance is determined with Cohen's *d* or Pearson's *r*, with *d* or *r* of .250, which is considered weak but "substantively important" at $p < 0.05$.[3] Statistically and/or practically significant findings are noted as "statistical" or "significant" in the report narrative with footnotes providing details about results of statistical tests. Significant case-level findings contributing to

[2] 2012 evaluation reports did not conduct significance testing on changes. The word "significant" was used incorrectly to describe changes that were perceived to be large. However, without significance testing, we cannot be sure which changes were real or due to chance, nor can we assess the strength of the effect causing the real changes.

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

program-level findings are described. However, given the small number of respondents at any given site (7-26) and the complexity of GEMS programs, these findings should be taken as potential indicators of effect and potentially promising activities for sites to explore in more depth; they should not be taken as a rigorous measure of the effectiveness of any one programs' structures, processes, or activities.

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

To the extent possible, findings were triangulated across data sources (students, mentors), data types (quantitative survey data and qualitative data from questionnaires, and focus groups), and different evaluators conducting the analyses and reporting (including an independent study conducted on the Near Peer Mentors Program). This triangulation enhances the credibility of findings synthesized from single data sources or data types. For example, evaluators cite major trends from the qualitative data—emergent themes with high frequencies in respondents addressing them—to provide additional evidence of, explanation for, or illustrations of quantitative data. We have posed plausible explanations when divergence between data sources or data types is evident; any such explanations are worthy of further exploration in the full study and, potentially, in future evaluation efforts. Periodically, less unique perspectives are reported and identified as such when they provide illustration that captures the spirit of GEMS or AEOP objectives.

Appendix B

2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Thank you for your participation in this study about the 2013 Gains in the Education of Math and Science (GEMS) program. The following survey will collect information about you, your experiences in school, and your experiences at GEMS in 2013. The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support GEMS.

About this survey:

- It is CONFIDENTIAL; no one will be able to tell who said what so your comments cannot be held against you.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time.
- If you provide your email address, the AEOP may contact you in the future to ask about your academic and career success.
- We hope that you finish the survey because your responses will give GEMS valuable information for improvement.

By choosing to click the ">>" button below and completing this survey, you are providing assent to participate in this study.

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Artis Hicks, American Society for Engineering Education
GEMS Program Administrator, AEOPCA
(202) 331-3558, a.hicks@asee.org

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Where is your GEMS program located?

- ❍ AFMES; Dover AFB, DE
- ❍ AMRDEC; Huntsville, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ARL-WSMR; White Sands, NM
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ Fort Detrick; Hagerstown Community College, MD
- ❍ Fort Detrick; other (specify): ____________________
- ❍ USAARL; Fort Rucker, AL
- ❍ USAISR; San Antonio, TX
- ❍ USAMRICD; Aberdeen, MD
- ❍ USARIEM; Natick, MA
- ❍ WRAIR; Silver Spring, MD
- ❍ WRAIR; other (specify): ____________________
- ❍ Other (specify): ____________________

Which GEMS program are you enrolled in?

- ❍ Beginning GEMS / GEMS-1
- ❍ Intermediate GEMS / GEMS-2
- ❍ Intermediate Biomedical GEMS
- ❍ Intermediate Engineering GEMS
- ❍ Advanced GEMS / GEMS-3
- ❍ Advanced Biomedical GEMS
- ❍ Advanced Engineering GEMS
- ❍ Battlebots GEMS
- ❍ Robotics GEMS
- ❍ Enviro GEMS
- ❍ Engineering GEMS
- ❍ Other (specify): ____________________

When did your GEMS program start (e.g., June 10th, 2013)? ____________________________________, 2013

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2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Please fill out the personal information below (optional):

First Name: ____

Last Name: ____

Email Address: ____

How old are you (in years)? __________________________________, years

What grade will you start this fall (e.g., 6, 7, 8, etc.)? ____________, grade

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your race / ethnicity?

- ❍ American Indian or Alaskan Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White / Caucasian
- ❍ Some other ethnicity / race : _____________________
- ❍ Choose not to report

What kind of school do you attend?

- ❍ Public
- ❍ Private
- ❍ Home School
- ❍ Other (Please Specify) _____________________

Which of the following best describes your REGULAR SCHOOL?

- ❍ It is in a RURAL setting
- ❍ It is in a SUBURBAN setting
- ❍ It is in an URBAN setting
- ❍ Other (Please Specify) _____________________

Do you qualify for free / reduced lunch at school?

- ❍ Yes
- ❍ No
- ❍ I don't know / choose not to answer

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2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

How did you hear about GEMS?

- ❍ Parent
- ❍ Teacher
- ❍ Friend
- ❍ Email
- ❍ Web-Search
- ❍ Other (specify): ____________________

Have you ever participated in GEMS before?

- ❍ No
- ❍ Yes - this is my 2nd GEMS program
- ❍ Yes - this is my 3rd GEMS program
- ❍ Yes - this is my 4th GEMS program
- ❍ Yes - this is my ______ GEMS program (specify how many) ____________________

Why did you decide to participate in GEMS again this summer? ____
____
____
____

Have you ever participated in a Junior Solar Sprint race?

- ❍ No
- ❍ Yes

Have you ever participated in eCYBERMISSION?

- ❍ No
- ❍ Yes

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2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Use the scale provided to tell us about your Science, Technology, Engineering, or Math (STEM) classes at school.

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I want to study more Science, Technology, Engineering or Math (STEM) after my classes	❍	❍	❍	❍	❍	❍
I would like to join a STEM club outside of school	❍	❍	❍	❍	❍	❍
I enjoy doing the hands-on activities in my STEM classes	❍	❍	❍	❍	❍	❍
I like to share what I learn in my STEM classes with my friends and family	❍	❍	❍	❍	❍	❍
I think about the things I learn in my STEM classes when I'm not at school	❍	❍	❍	❍	❍	❍
After class, I want to learn more about the STEM information that I learned about in class	❍	❍	❍	❍	❍	❍
I learn interesting things in my STEM classes at school	❍	❍	❍	❍	❍	❍

Hands-on STEM learning activities include:

- ***Performing experiments or doing activities yourself***
- ***Trying to find an answer to a question (test a hypothesis)***
- ***Testing your ideas or predictions***
- ***Making observations or drawing conclusions after an activity***

Tell us how often you participate in the following "hands-on" activities during your STEM classes at school.

	NEVER	Once per MONTH	Once per WEEK	2-3 times per WEEK	Every DAY	Multiple times per DAY
How often do you usually get to participate in "hands-on" activities during your STEM classes?	❍	❍	❍	❍	❍	❍
Your teacher demonstrates a STEM experiment or activity - you get to observe it while taking notes	❍	❍	❍	❍	❍	❍
You perform a "hands-on" activity using a set of instructions and questions that are given to you by your teacher	❍	❍	❍	❍	❍	❍
You are given a set of instructions but you get to create your own questions (hypotheses) and draw your own conclusions	❍	❍	❍	❍	❍	❍
You get to decide how to do an experiment or activity to answer your own question or hypothesis. Your teacher offers assistance but you get to perform the experiment or activity yourself	❍	❍	❍	❍	❍	❍

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HOW ACCURATELY DOES EACH STATEMENT DESCRIBE YOU?

	Nothing like me	Not like me	Not much like me	Somewhat like me	Like me	Exactly like me
I know how to clean, handle, and care for equipment in a science or engineering lab	❍	❍	❍	❍	❍	❍
I know laboratory techniques that are used in scientific or engineering experiments	❍	❍	❍	❍	❍	❍
I know how to create a testable hypotheses using science or engineering principles	❍	❍	❍	❍	❍	❍
I know how to explain experimental results	❍	❍	❍	❍	❍	❍
I am good at communicating science or engineering concepts to others	❍	❍	❍	❍	❍	❍
I can draw conclusions from the results of an experiment	❍	❍	❍	❍	❍	❍
I know how and where to find STEM research information using library resources	❍	❍	❍	❍	❍	❍

HOW ACCURATELY DOES EACH STATEMENT DESCRIBE YOU?

	Nothing like me	Not like me	Not much like me	Somewhat like me	Like me	Exactly like me
I am confident that I can effectively use a science or engineering laboratory	❍	❍	❍	❍	❍	❍
I am confident that I can perform a variety of laboratory techniques during an experiment	❍	❍	❍	❍	❍	❍
I am confident in my ability to create useful hypotheses	❍	❍	❍	❍	❍	❍
I am confident in my ability to interpret the results of an experiment	❍	❍	❍	❍	❍	❍
I am confident that I can communicate science or engineering concepts to other people	❍	❍	❍	❍	❍	❍
In am confident in the conclusions that I draw from the results of an experiment	❍	❍	❍	❍	❍	❍
I am confident that I can find STEM research information using library resources	❍	❍	❍	❍	❍	❍

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2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

What are the chances that you will participate in the following activities?

	No Chance Whatsoever	Hardly Any Chance	A Little Chance	Some Chance	A Good Chance	An Extremely Good Chance	I Don't Know
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	❍	❍	❍	❍	❍	❍	❍
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	❍	❍	❍	❍	❍	❍	❍
Go to COLLEGE and study a STEM subject	❍	❍	❍	❍	❍	❍	❍
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	❍	❍	❍	❍	❍	❍	❍
Work as a STEM INTERN or APPRENTICE	❍	❍	❍	❍	❍	❍	❍
Pursue a JOB or a CAREER in a STEM related field	❍	❍	❍	❍	❍	❍	❍

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:
Tanner Bateman – tbateman@vt.edu or Rebecca Kruse – rkruse75@vt.edu

*****PLEASE HAND THE COMPLETED FORM TO THE NEAREST GEMS REPRESENTATIVE*****

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Where is your GEMS program located?		
	Freq.	**%**
AFMES; Dover AFB, DE	91	6%
ARL-APG; Aberdeen, MD	192	13%
ARL-WSMR; White Sands, NM	39	3%
ERDC-CERL; Champaign, IL	28	2%
ERDC-MS; Vicksburg, MS	78	5%
Fort Detrick; Hood College	364	25%
USAARL; Fort Rucker, AL	117	8%
USAISR; San Antonio, TX	67	5%
WRAIR; Silver Spring, MD	324	23%
WRAIR; Wheaton College, IL	137	10%
Total	**1437**	**100%**

Which GEMS program are you enrolled in?		
	Freq.	**%**
Beginning GEMS / GEMS-1	441	31%
Beginning Engineering GEMS	55	4%
Beginning CSI GEMS	74	5%
Intermediate GEMS / GEMS-2	222	15%
Intermediate Biomedical GEMS	136	9%
Intermediate Engineering GEMS	60	4%
Intermediate CSI GEMS	69	5%
Advanced GEMS / GEMS-3	62	4%
Advanced Biomedical GEMS	117	8%
Advanced Engineering GEMS	22	2%
Battlebots GEMS	47	3%
Robotics GEMS	42	3%
Enviro GEMS	75	5%
Alternative Energy GEMS	12	1%
Total	**1434**	**100%**

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How old are you (in years)?		
	Freq.	**%**
9	6	<1%
10	93	7%
11	129	10%
12	240	18%
13	259	20%
14	252	19%
15	158	12%
16	119	9%
17	43	3%
Total	**1299**	**100%**

Note. Average age = 13.2 years

What grade will you start this fall?		
	Freq.	**%**
4th	1	<1%
5th	70	5%
6th	123	9%
7th	219	17%
8th	256	20%
9th	258	20%
10th	172	13%
11th	136	10%
12th	63	5%
Total	**1298**	**100%**

Gender		
	Freq.	**%**
Male	742	53%
Female	642	46%
Choose not to report	5	<1%
Total	**1389**	**100%**

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2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Which of the following best describes your race / ethnicity?		
	Freq.	**%**
American Indian or Alaskan Native	16	1%
Asian or Pacific Islander	215	15%
Black or African American	336	24%
Hispanic or Latino	97	7%
White/Caucasian	570	41%
Multiracial	81	6%
Middle Eastern	3	<1%
Caribbean	2	<1%
Choose not to report	65	5%
Total	**1385**	**100%**

What kind of school do you attend?		
	Freq.	**%**
Public	1098	79%
Private	180	13%
Home School	84	6%
Charter	16	1%
Magnet	4	<1%
Catholic	3	<1%
Boarding	2	<1%
Prep School	1	<1%
Online Classes	1	<1%
Total	**1389**	**100%**

Which of the following best describes your regular school?		
	Freq.	**%**
Rural	198	15%
Suburban	847	64%
Urban	268	20%
Home Schooled	10	1%
Military Base	1	<1%
College Campus	1	<1%
Unsure	6	<1%
Total	**1331**	**100%**

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Do you qualify for free/reduced lunch at school?		
	Freq.	**%**
No	846	61%
Yes	165	12%
I don't know / choose not to answer	371	27%
Total	**1382**	**100%**

How did you hear about GEMS?						
	Freq.	**%**			**Freq.**	**%**
Parent	709	51%		**Newspaper/Flyer**	10	1%
Teacher	230	17%		**Program not hosted by school**	8	1%
Friend	221	16%		**Parent's friend/workplace**	8	1%
Web-Search	46	3%		**Unspecified/Unsure**	7	1%
Family member other than parent	43	3%		**Science convention**	6	1%
Multiple sources	38	3%		**Previously participated**	5	<1%
School or school hosted program/function	34	2%		**Invited to participate**	3	<1%
				Total	**1388**	**100%**

Have you ever participated in GEMS before?		
	Freq.	**%**
No	1001	70%
Yes- this is my 2nd GEMS program	270	19%
Yes- this is my 3rd GEMS program	111	8%
Yes- this is my 4th GEMS program	30	2%
Yes- this is my 5th GEMS program	7	<1%
Yes- this is my 6th+ GEMS program	3	<1%
Total	**1422**	**100%**

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

If you have participated in GEMS before, why did you decide to participate in GEMS again this summer? (n = 65)			
Broad Theme	**Narrow Theme(s)**	**Freq.**	**Example Response(s)**
General Satisfaction		**47**	
	Had fun	23	• "I had fun doing this last year." • "It was a fun program."
	Enjoyed the program	12	• "I enjoyed learning about the subject last year so I thought I would enjoy it this year." • "…it was an enjoyable experience, and I wanted to come back and do it again."
	Liked/loved the program	5	• "I've done engineering last two years and loved it."
	Found material interesting	4	• "It was interesting to learn, sometimes you would forget you were even learning."
	It was amazing/awesome	2	• "GEMS last year was absolutely amazing!" • "Because it was awesome!"
	Had a great time	1	• "I have had a wonderful time learning about science, math, and technology."
Academic Research Activities		**17**	
	It was a positive learning experience	14	• "It's a great learning experience." • "So I can learn more about science before I start school."
	Provided novel experiences	2	• "I joined this summer to see what was different and experience new things."
	Able to meet new people	1	• "It is a good chance to learn […] while working with new people."
Program Characteristics		**15**	
	Upcoming GEMS program was interesting	4	• "I was really interested in the topics that would be covered during this session." • "[I] was very interested in building and programming a robot."
	GEMS has a variety of information	4	• "I decided to come back was because there were so many enriching things I learned during the GEMS program." • "It was interesting when we did different labs."
	GEMS is educational	4	• "[It is a] great place to learn about science and study my favorite subjects for a whole week."
	GEMS is challenging	1	• "To join the battle bots, and test my skills in robotics."
	GEMS material is easy to understand	1	• "It made learning understandable."
	GEMS is helpful	1	• "It was helpful."
Hands-on/Laboratory Research Activities		**7**	
	Hands-on activities	7	• "I completed great experiments and activities."

			• "I liked doing work in a lab setting and thought the activities were interesting."
STEM Pathway		**5**	
	STEM Pathway	3	• "I learned a lot of new things which helped determine what I want to do in the future." • "I think that this might help me achieve my goal of being a doctor."
	Provides opportunity for development	1	• "I feel that it will widen my horizon."
	It was the next step	1	• "I felt that, having completed beginning GEMS, intermediate was a logical step forward."
Effective Mentorship		**3**	
	Other(s) suggested the program	2	• "My mom suggested I participate again and I agreed."
	Signed up by other(s)	1	• "My mom signed me up."
Other		**2**	
	Monetary benefit	2	• "…why wouldn't I come out here for a week and get paid to build robots for a week?" • "[It is] money."

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Have you ever participated in Junior Solar Sprint race?		
	Freq.	**%**
No	1412	99%
Yes	12	1%
Total	**1424**	**100%**

Have you ever participated in eCYBERMISSON?		
	Freq.	**%**
No	1392	98%
Yes	29	2%
Total	**1421**	**100%**

Use the scale provided to tell us about your Science, Technology, Engineering, or Math (STEM) classes at school.									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I want to study more Science, Technology, Engineering or Math (STEM) after my classes.	17 (1%)	30 (2%)	65 (5%)	326 (23%)	491 (34%)	497 (35%)	1257	**4.92**	1.06
I would like to join a STEM club outside of school.	39 (3%)	124 (9%)	192 (14%)	454 (32%)	363 (26%)	249 (18%)	1255	**4.21**	1.28
I enjoy doing the hands-on activities in my STEM classes.	11 (1%)	11 (1%)	35 (2%)	131 (9%)	459 (32%)	774 (54%)	1255	**5.35**	0.90
I like to share what I learn in my STEM classes with my friends and family.	30 (2%)	54 (4%)	99 (7%)	383 (27%)	462 (33%)	390 (28%)	1253	**4.67**	1.18
I think about the things I learn in my STEM classes when I'm not at school.	27 (2%)	88 (6%)	126 (9%)	408 (29%)	441 (31%)	328 (23%)	1252	**4.50**	1.22
After class, I want to learn more about the STEM information that I learned about in class.	27 (2%)	63 (4%)	124 (9%)	430 (30%)	462 (33%)	313 (22%)	1253	**4.53**	1.17
I learn interesting things in my STEM classes at school.	44 (3%)	39 (3%)	54 (4%)	258 (18%)	464 (33%)	559 (39%)	1259	**4.93**	1.21

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = "*Somewhat Disagree,*" **4** = "*Somewhat Agree*," **5** = "*Agree*," **6** = "*Strongly Agree*".

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

Tell us how often you participate in the following "hands-on" activities during your STEM classes at school:	1	2	3	4	5	6	n	Avg.	SD
How often do you usually get to participate in "hands-on" activities during your STEM classes?	104 (7%)	308 (22%)	393 (28%)	374 (26%)	158 (11%)	80 (6%)	1258	**3.29**	1.28
Your teacher demonstrates a STEM experiment or activity - you get to observe it while taking notes.	228 (16%)	260 (18%)	345 (25%)	306 (22%)	188 (13%)	80 (6%)	1243	**3.15**	1.44
You perform a "hands-on" activity using a set of instructions and questions that are given to you by your teacher.	86 (6%)	301 (21%)	383 (27%)	367 (26%)	193 (14%)	75 (5%)	1240	**3.36**	1.27
You are given a set of instructions but you get to create your own questions (hypotheses) and draw your own conclusions.	194 (14%)	362 (26%)	314 (22%)	293 (21%)	171 (12%)	77 (5%)	1247	**3.08**	1.41
You get to decide how to do an experiment or activity to answer your own question or hypothesis. Your teacher offers assistance but you get to perform the experiment or activity yourself.	381 (27%)	423 (30%)	234 (17%)	188 (13%)	126 (9%)	53 (4%)	1241	**2.58**	1.43

Note. Response scale: **1** = "*Never,*" **2** = "*Once per month,*" **3** = "*One per week,*" **4** = "*2-3 times per week,*" **5** = "*Every day,*" **6** = "*Multiple times per day*".

How accurately does each statement describe you?	1	2	3	4	5	6	n	Avg.	SD
I know how to clean, handle, and care for equipment in a science or engineering lab.	23 (2%)	32 (2%)	79 (6%)	343 (24%)	599 (42%)	355 (25%)	1260	**4.77**	1.06
I know laboratory techniques that are used in scientific or engineering experiments.	49 (3%)	81 (6%)	228 (16%)	481 (34%)	399 (28%)	189 (13%)	1261	**4.17**	1.22
I know how to create a testable hypotheses using science or engineering principles.	31 (2%)	61 (4%)	127 (9%)	403 (28%)	504 (35%)	297 (21%)	1260	**4.53**	1.17
I know how to explain experimental results	27 (2%)	37 (3%)	115 (8%)	391 (28%)	508 (36%)	342 (24%)	1250	**4.65**	1.12
I am good at communicating science or engineering concepts to others.	27 (2%)	56 (4%)	158 (11%)	451 (32%)	439 (31%)	293 (21%)	1255	**4.47**	1.16
I can draw conclusions from the results of an experiment.	12 (1%)	21 (1%)	63 (4%)	296 (21%)	617 (43%)	414 (29%)	1252	**4.92**	0.97
I know how and where to find STEM research information using library resources.	50 (4%)	95 (7%)	217 (15%)	390 (27%)	407 (29%)	266 (19%)	1263	**4.27**	1.30

Note. Response scale: **1** = "*Nothing like me,*" **2** = "*Not like me,*" **3** = "*Not much like me,*" **4** = "*Somewhat like me,*" **5** = "*Like me,*" **6** = "*Exactly like me*".

Appendix B
2013 GEMS Pre-GEMS Student Questionnaire and Data Summary

How accurately does each statement describe you?									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I am confident that I can effectively use a science or engineering laboratory.	19 (1%)	32 (2%)	99 (7%)	317 (22%)	573 (40%)	378 (27%)	1255	**4.78**	1.07
I am confident that I can perform a variety of laboratory techniques during an experiment.	22 (2%)	36 (3%)	121 (9%)	351 (25%)	555 (39%)	333 (23%)	1248	**4.68**	1.09
I am confident in my ability to create useful hypotheses.	17 (1%)	20 (1%)	84 (6%)	359 (25%)	583 (41%)	352 (25%)	1246	**4.79**	1.01
I am confident in my ability to interpret the results of an experiment.	13 (1%)	26 (2%)	91 (6%)	352 (25%)	557 (39%)	374 (26%)	1244	**4.79**	1.02
I am confident that I can communicate science or engineering concepts to other people.	23 (2%)	39 (3%)	165 (12%)	401 (28%)	492 (35%)	294 (21%)	1253	**4.54**	1.12
I am confident in the conclusions that I draw from the results of an experiment.	21 (1%)	25 (2%)	78 (6%)	351 (25%)	595 (42%)	340 (24%)	1250	**4.77**	1.03
I am confident that I can find STEM research information using library resources.	45 (3%)	65 (5%)	202 (14%)	357 (25%)	440 (31%)	300 (21%)	1249	**4.41**	1.27

Note. Response scale: **1** = "*Nothing like me,*" **2** = "*Not like me,*" **3** = *"Not much like me,"* **4** = "*Somewhat like me*," **5** = "*Like me*," **6** = "*Exactly like me*".

What are the chances that you will participate in the following activities?										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**n**	**Avg.**	**SD**
Participate in a science fair or science competition.	72 (5%)	109 (8%)	159 (11%)	250 (18%)	425 (30%)	351 (25%)	56 (4%)	1280	**4.39**	1.45
Participate in a summer program related to STEM (e.g., club, camp, etc.).	36 (3%)	33 (2%)	97 (7%)	201 (14%)	477 (34%)	537 (38%)	38 (3%)	1271	**4.93**	1.20
Go to college and study a STEM subject.	34 (2%)	32 (2%)	92 (6%)	168 (12%)	341 (24%)	694 (49%)	56 (4%)	1277	**5.08**	1.23
Take advanced high school classes in STEM (e.g., AP courses, dual enrollment, etc.).	28 (2%)	27 (2%)	62 (4%)	141 (10%)	311 (22%)	791 (56%)	61 (4%)	1278	**5.24**	1.15
Work as a STEM intern or apprentice.	53 (4%)	60 (4%)	157 (11%)	294 (21%)	402 (28%)	357 (25%)	98 (7%)	1272	**4.51**	1.33
Pursue a job or a career in a STEM related field.	46 (3%)	45 (3%)	114 (8%)	205 (14%)	333 (23%)	594 (42%)	84 (6%)	1272	**4.88**	1.33

Note. Response scale: **1** = "*No Chance Whatsoever,*" **2** = "*Hardly Any Chance,*" **3** = *"A Little Chance,"* **4** = "*Some Chance*," **5** = "*A Good Chance*," **6** = "*An Extremely Good Chance,*" **7** = "*I Don't Know*". **Avg.** and **SD** calculated without "**7**" included.

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Thank you for your participation in this study about the 2013 Gains in the Education of Math and Science (GEMS) program. The following survey will collect information about you, your experiences in school, and your experiences at GEMS in 2013. The results of this survey will be used to help us improve our program and to create evaluation reports for the organizations that support GEMS.

About this survey:

- It is CONFIDENTIAL; no one will be able to tell who said what so your comments cannot be held against you.
- It is completely VOLUNTARY; you are not required to participate and you can withdraw at any time.
- If you provide your email address, the AEOP may contact you in the future to ask about your academic and career success.
- We hope that you finish the survey because your responses will give GEMS valuable information for improvement.

By choosing to click the ">>" button below and completing this survey, you are providing assent to participate in this study.

If you have any additional questions or concerns, please contact one of the following people:

Tanner Bateman, Virginia Tech
Senior Project Associate, AEOPCA
(540) 231-4540, tbateman@vt.edu

Rebecca Kruse, Virginia Tech
Evaluation Director, AEOPCA
(540) 315-5807, rkruse75@vt.edu

Artis Hicks, American Society for Engineering Education
GEMS Program Administrator, AEOPCA
(202) 331-3558, a.hicks@asee.org

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Where is your GEMS program located?

- ❍ AFMES; Dover AFB, DE
- ❍ AMRDEC; Huntsville, AL
- ❍ ARL-A; Adelphi, MD
- ❍ ARL-APG; Aberdeen, MD
- ❍ ARL-WSMR; White Sands, NM
- ❍ ERDC-CERL; Champaign, IL
- ❍ ERDC-MS; Vicksburg, MS
- ❍ Fort Detrick; Hagerstown Community College, MD
- ❍ Fort Detrick; other (specify): ____________________
- ❍ USAARL; Fort Rucker, AL
- ❍ USAISR; San Antonio, TX
- ❍ USAMRICD; Aberdeen, MD
- ❍ USARIEM; Natick, MA
- ❍ WRAIR; Silver Spring, MD
- ❍ WRAIR; other (specify): ____________________
- ❍ Other (specify): ____________________

Which GEMS program are you enrolled in?

- ❍ Beginning GEMS / GEMS-1
- ❍ Intermediate GEMS / GEMS-2
- ❍ Intermediate Biomedical GEMS
- ❍ Intermediate Engineering GEMS
- ❍ Advanced GEMS / GEMS-3
- ❍ Advanced Biomedical GEMS
- ❍ Advanced Engineering GEMS
- ❍ Battlebots GEMS
- ❍ Robotics GEMS
- ❍ Enviro GEMS
- ❍ Engineering GEMS
- ❍ Other (specify): ____________________

When does your GEMS program end (e.g., June 14th, 2013)? ___________________________________, 2013

Appendix C
2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Please fill out the personal information below (optional):

First Name: ____

Last Name: ____

Email Address: ____

How old are you (in years)? ________________________________, years

What grade will you start this fall (e.g., 6, 7, 8, etc.)? ______________, grade

Which of the following best describes you?

- ❍ Male
- ❍ Female
- ❍ Choose not to report

Which of the following best describes your race / ethnicity?

- ❍ American Indian or Alaskan Native
- ❍ Asian or Pacific Islander
- ❍ Black or African American
- ❍ Hispanic or Latino
- ❍ White / Caucasian
- ❍ Some other ethnicity / race : ____________________
- ❍ Choose not to report

What kind of school do you attend?

- ❍ Public
- ❍ Private
- ❍ Home School
- ❍ Other (Please Specify) ____________________

Which of the following best describes your REGULAR SCHOOL?

- ❍ It is in a RURAL setting
- ❍ It is in a SUBURBAN setting
- ❍ It is in an URBAN setting
- ❍ Other (Please Specify) ____________________

Do you qualify for free / reduced lunch at school?

- ❍ Yes
- ❍ No
- ❍ I don't know / choose not to answer

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Use the scale provided to tell us about your Science, Technology, Engineering, or Math (STEM) lessons at GEMS.

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
I want to study more Science, Technology, Engineering or Math (STEM) after participating in GEMS	❍	❍	❍	❍	❍	❍
After doing GEMS, I want to join a STEM-related club	❍	❍	❍	❍	❍	❍
I enjoyed doing the hands-on activities at GEMS	❍	❍	❍	❍	❍	❍
I like to share what I learn in GEMS with my friends and family	❍	❍	❍	❍	❍	❍
I think about the things I learn in GEMS even when I'm not at the GEMS site	❍	❍	❍	❍	❍	❍
After GEMS, I want to learn more about the STEM information that I have learned	❍	❍	❍	❍	❍	❍
I learned interesting during the STEM activities at GEMS	❍	❍	❍	❍	❍	❍

Please tell us how much you agree or disagree with the following statements about your GEMS INSTRUCTOR(S):

	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
Our GEMS instructor(s) cared about our learning	❍	❍	❍	❍	❍	❍
Our GEMS instructor(s) were easy to learn from	❍	❍	❍	❍	❍	❍
Our GEMS instructor(s) were excited to do "hands-on" activities with us	❍	❍	❍	❍	❍	❍
Our GEMS instructor(s) encouraged us to ask questions	❍	❍	❍	❍	❍	❍
Our GEMS instructor(s) enjoyed the "hands-on" activities as much as we did	❍	❍	❍	❍	❍	❍
Our GEMS instructor(s) explained difficult ideas very clearly	❍	❍	❍	❍	❍	❍
I liked learning from our GEMS instructor(s) because they were just as interested and excited as we were	❍	❍	❍	❍	❍	❍

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Hands-on STEM learning activities include:

- ***Performing experiments or doing activities yourself***
- ***Trying to find an answer to a question (test a hypothesis)***
- ***Testing your ideas or predictions***
- ***Making observations or drawing conclusions after an activity***

Tell us how often you participate in the following "hands-on" activities during GEMS.

	NEVER	Once per MONTH	Once per WEEK	2-3 times per WEEK	Every DAY	Multiple times per DAY
How often do you usually get to participate in "hands-on" activities at GEMS?	❍	❍	❍	❍	❍	❍
Your GEMS instructors demonstrate the experiment or activity – you get to observe it while taking notes.	❍	❍	❍	❍	❍	❍
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	❍	❍	❍	❍	❍	❍
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	❍	❍	❍	❍	❍	❍
You get to decide how to do an experiment or activity to answer a hypothesis. Your GEMS instructors offer assistance but you try to perform the experiment or activity yourself.	❍	❍	❍	❍	❍	❍

HOW ACCURATELY DOES EACH STATEMENT DESCRIBE YOU?

	Nothing like me	Not like me	Not much like me	Somewhat like me	Like me	Exactly like me
I know how to clean, handle, and care for equipment in a science or engineering lab	❍	❍	❍	❍	❍	❍
I know laboratory techniques that are used in scientific or engineering experiments	❍	❍	❍	❍	❍	❍
I know how to create a testable hypotheses using science or engineering principles	❍	❍	❍	❍	❍	❍
I know how to explain experimental results	❍	❍	❍	❍	❍	❍
I am good at communicating science or engineering concepts to others	❍	❍	❍	❍	❍	❍
I can draw conclusions from the results of an experiment	❍	❍	❍	❍	❍	❍
I know how and where to find STEM research information using library resources	❍	❍	❍	❍	❍	❍

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

HOW ACCURATELY DOES EACH STATEMENT DESCRIBE YOU?

	Nothing like me	Not like me	Not much like me	Somewhat like me	Like me	Exactly like me
I am confident that I can effectively use a science or engineering laboratory	❍	❍	❍	❍	❍	❍
I am confident that I can perform a variety of laboratory techniques during an experiment	❍	❍	❍	❍	❍	❍
I am confident in my ability to create useful hypotheses	❍	❍	❍	❍	❍	❍
I am confident in my ability to interpret the results of an experiment	❍	❍	❍	❍	❍	❍
I am confident that I can communicate science or engineering concepts to other people	❍	❍	❍	❍	❍	❍
In am confident in the conclusions that I draw from the results of an experiment	❍	❍	❍	❍	❍	❍
I am confident that I can find STEM research information using library resources	❍	❍	❍	❍	❍	❍

What are the chances that you will participate in the following activities?

	No Chance Whatsoever	Hardly Any Chance	A Little Chance	Some Chance	A Good Chance	An Extremely Good Chance	I Don't Know
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	❍	❍	❍	❍	❍	❍	❍
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	❍	❍	❍	❍	❍	❍	❍
Go to COLLEGE and study a STEM subject	❍	❍	❍	❍	❍	❍	❍
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	❍	❍	❍	❍	❍	❍	❍
Work as a STEM INTERN or APPRENTICE	❍	❍	❍	❍	❍	❍	❍
Pursue a JOB or a CAREER in a STEM related field	❍	❍	❍	❍	❍	❍	❍

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

During GEMS, how many jobs in Science, Technology, Engineering or Math (STEM) did you learn about?

- ❍ None, I did not learn about any STEM jobs / careers
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5 or more

During GEMS, how many Army jobs in STEM did you learn about?

- ❍ None, I did not learn about jobs at Army Labs
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5 or more

Which STEM job with the Army do you think is the most interesting? Why?

What job are you interested in pursuing? (What job do you want to have when you grow up?)

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Do you want to participate in any of the following Army Educational Outreach (AEOP) programs?

	Yes - I want to participate	No - I am not interested
Intermediate GEMS / GEMS II	❍	❍
Advanced GEMS / GEMS III	❍	❍
eCYBERMISSION: a web-based science, technology, engineering, and mathematics (STEM) competition for 6th - 9th grade	❍	❍
Junior Science and Humanities Symposium (JSHS): a high school STEM research competition	❍	❍
UNITE: an engineering summer program for high school students from underserved groups	❍	❍
West Point Bridge Contest: a computer-based engineering design competition for 6th - 12th grade	❍	❍
High School Internships: internships in Army laboratories through the Science & Engineering Apprenticeship Program (SEAP) and in laboratories at colleges throughout the country (REAP and HSAP)	❍	❍
College Internships: internships in Army laboratories through College Qualified Leaders (CQL) and in laboratories at colleges throughout the country (URAP)	❍	❍

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Besides GEMS, do you participate in any other Science, Technology, Engineering or Math (STEM) programs? Which ones?

Given the chance, would you participate in this GEMS program again? Why or why not?

Thank you for your input and remember that your responses are completely confidential.

If you have any questions or concerns, please email:
Tanner Bateman – tbateman@vt.edu or Rebecca Kruse – rkruse75@vt.edu

*****PLEASE HAND THE COMPLETED FORM TO THE NEAREST GEMS REPRESENTATIVE*****

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Where is your GEMS program located?		
	Freq.	**%**
AFMES; Dover AFB, DE	91	6%
ARL-APG; Aberdeen, MD	297	20%
ARL-WSMR; White Sands, NM	37	2%
ERDC-CERL; Champaign, IL	28	2%
ERDC-MS; Vicksburg, MS	73	5%
Fort Detrick; Hood College	361	24%
USAARL; Fort Rucker, AL	117	8%
USAISR; San Antonio, TX	65	4%
WRAIR; Silver Spring, MD	299	20%
WRAIR; Wheaton College, IL	133	9%
Total	**1501**	**100%**

Which GEMS program are you enrolled in?		
	Freq.	**%**
Beginning GEMS / GEMS-1	416	28%
Beginning Engineering GEMS	52	3%
Beginning CSI GEMS	75	5%
Intermediate GEMS / GEMS-2	285	19%
Intermediate Biomedical GEMS	128	9%
Intermediate Engineering GEMS	58	4%
Intermediate CSI GEMS	68	5%
Advanced GEMS / GEMS-3	106	7%
Advanced Biomedical GEMS	98	7%
Advanced Engineering GEMS	23	2%
Battlebots GEMS	48	3%
Robotics GEMS	41	3%
Enviro GEMS	76	5%
Alternative Energy GEMS	27	2%
Total	**1501**	**100%**

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

How old are you (in years)?		
	Freq.	**%**
9	6	<1%
10	95	7%
11	119	9%
12	228	17%
13	270	21%
14	265	20%
15	169	13%
16	124	9%
17	32	2%
Total	**1308**	**100%**

Note. Average age = 13.4 years

What grade will you start this fall?		
	Freq.	**%**
4th	2	<1%
5th	70	5%
6th	119	9%
7th	205	16%
8th	259	20%
9th	270	21%
10th	193	15%
11th	140	11%
12th	56	4%
Total	**1314**	**100%**

Gender		
	Freq.	**%**
Male	765	52%
Female	691	47%
Choose not to report	21	1%
Total	**1477**	**100%**

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Which of the following best describes your race / ethnicity?		
	Freq.	**%**
American Indian or Alaskan Native	16	1%
Asian or Pacific Islander	222	15%
Black or African American	339	23%
Hispanic or Latino	97	7%
White/Caucasian	637	43%
Multiracial	77	5%
Middle Eastern	6	<1%
Caribbean	3	<1%
Choose not to report	75	5%
Total	**1472**	**100%**

What kind of school do you attend?		
	Freq.	**%**
Public	1162	79%
Private	195	79%
Home School	88	79%
Charter	16	1%
Magnet	8	1%
Catholic	3	<1%
Boarding	2	<1%
Prep School	1	<1%
Online Classes	1	<1%
Total	**1476**	**100%**

Which of the following best describes your regular school?		
	Freq.	**%**
Rural	209	15%
Suburban	921	15%
Urban	277	15%
Home Schooled	11	1%
Military Base	1	<1%
College Campus	1	<1%
Unsure	4	<1%
Total	**1424**	**100%**

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Do you qualify for free/reduced lunch at school?		
	Freq.	**%**
No	922	63%
Yes	179	12%
I don't know / choose not to answer	369	25%
Total	**1470**	**100%**

Use the scale provided to tell us about your Science, Technology, Engineering, or Math (STEM) classes at GEMS.									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
I want to study more Science, Technology, Engineering or Math (STEM) after participating in GEMS.	13 (1%)	19 (1%)	42 (3%)	258 (17%)	512 (34%)	652 (44%)	1496	**5.13**	0.98
After doing GEMS, I would like to join a STEM-related club.	22 (1%)	83 (6%)	131 (9%)	457 (31%)	419 (28%)	379 (25%)	1491	**4.55**	1.20
I enjoyed the hands-on activities at GEMS.	5 (0%)	9 (1%)	26 (2%)	111 (7%)	401 (27%)	932 (63%)	1485	**5.49**	0.80
I like to share what I learn in GEMS with my friends and family.	21 (1%)	35 (2%)	63 (4%)	268 (18%)	511 (34%)	592 (40%)	1490	**5.01**	1.09
I think about the things I learn in GEMS even when I'm not at the GEMS site.	22 (1%)	46 (3%)	96 (6%)	357 (24%)	515 (35%)	449 (30%)	1485	**4.78**	1.13
After GEMS, I want to learn more about the STEM information that I have learned.	19 (1%)	31 (2%)	87 (6%)	348 (23%)	495 (33%)	509 (34%)	1489	**4.88**	1.09
I learned interesting during the STEM activities at GEMS.	13 (1%)	10 (1%)	17 (1%)	111 (7%)	432 (29%)	906 (61%)	1489	**5.46**	0.85

Note. Response scale: **1** = "*Strongly Disagree,*" **2** = "*Disagree,*" **3** = *"Somewhat Disagree,"* **4** = "*Somewhat Agree,*" **5** = "*Agree,*" **6** = "*Strongly Agree*".

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2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Please tell us how much you agree or disagree with the following statements about your GEMS instructor(s):									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
Our GEMS instructor(s) cared about our learning.	8 (1%)	3 (0%)	16 (1%)	83 (6%)	457 (31%)	922 (62%)	1489	**5.51**	0.75
Our GEMS instructor(s) were easy to learn from.	11 (1%)	11 (1%)	37 (2%)	223 (15%)	544 (37%)	659 (44%)	1485	**5.19**	0.92
Our GEMS instructor(s) were excited to do "hands-on" activities with us.	7 (0%)	12 (1%)	29 (2%)	146 (10%)	471 (32%)	821 (55%)	1486	**5.37**	0.86
Our GEMS instructor(s) encouraged us to ask questions.	9 (1%)	11 (1%)	33 (2%)	177 (12%)	504 (34%)	754 (51%)	1488	**5.30**	0.89
Our GEMS instructor(s) enjoyed the "hands-on" activities as much as we did.	8 (1%)	9 (1%)	38 (3%)	208 (14%)	544 (37%)	675 (46%)	1482	**5.22**	0.89
Our GEMS instructor(s) explained difficult ideas very clearly.	11 (1%)	25 (2%)	64 (4%)	282 (19%)	510 (34%)	594 (40%)	1486	**5.04**	1.02
I liked learning from our GEMS instructor(s) because they were just as interested and excited as we were.	13 (1%)	11 (1%)	47 (3%)	187 (13%)	481 (32%)	749 (50%)	1488	**5.26**	0.95

Note. Response scale: **1** = *"Strongly Disagree,"* **2** = *"Disagree,"* **3** = *"Somewhat Disagree,"* **4** = *"Somewhat Agree,"* **5** = *"Agree,"* **6** = *"Strongly Agree"*.

Tell us how often you participate in the following "hands-on" activities during GEMS.									
	1	**2**	**3**	**4**	**5**	**6**	**n**	**Avg.**	**SD**
How often do you usually get to participate in "hands-on" activities at GEMS?	43 (3%)	58 (4%)	46 (3%)	105 (7%)	332 (22%)	911 (61%)	1495	**5.25**	1.25
Your GEMS instructors demonstrate the experiment or activity – you get to observe it while taking notes.	161 (11%)	28 (2%)	108 (7%)	221 (15%)	512 (34%)	456 (31%)	1486	**4.52**	1.56
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	55 (4%)	39 (3%)	80 (5%)	183 (12%)	514 (35%)	610 (41%)	1481	**4.95**	1.26
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions.	145 (10%)	50 (3%)	173 (12%)	289 (19%)	506 (34%)	326 (22%)	1489	**4.30**	1.50
You get to decide how to do an experiment or activity to answer a hypothesis. Your GEMS instructors offer assistance but you try to perform the experiment or activity yourself.	159 (11%)	50 (3%)	177 (12%)	216 (15%)	488 (33%)	395 (27%)	1485	**4.35**	1.58

Note. Response scale: **1** = *"Never,"* **2** = *"Once per month,"* **3** = *"One per week,"* **4** = *"2-3 times per week,"* **5** = *"Every day,"* **6** = *"Multiple times per day"*.

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

How accurately does each statement describe you?	1	2	3	4	5	6	n	Avg.	SD
I know how to clean, handle, and care for equipment in a science or engineering lab.	4 (0%)	15 (1%)	52 (3%)	206 (14%)	629 (42%)	590 (39%)	1496	**5.15**	0.89
I know laboratory techniques that are used in scientific or engineering experiments.	15 (1%)	17 (1%)	65 (4%)	332 (22%)	579 (39%)	486 (33%)	1494	**4.94**	0.99
I know how to create a testable hypotheses using science or engineering principles.	21 (1%)	19 (1%)	69 (5%)	293 (20%)	564 (38%)	526 (35%)	1492	**4.97**	1.04
I know how to explain experimental results	15 (1%)	14 (1%)	61 (4%)	301 (20%)	585 (39%)	514 (34%)	1490	**4.99**	0.98
I am good at communicating science or engineering concepts to others.	19 (1%)	24 (2%)	98 (7%)	358 (24%)	516 (35%)	476 (32%)	1491	**4.85**	1.07
I can draw conclusions from the results of an experiment.	10 (1%)	11 (1%)	48 (3%)	228 (15%)	615 (41%)	581 (39%)	1494	**5.12**	0.91
I know how and where to find STEM research information using library resources.	44 (3%)	37 (2%)	147 (10%)	325 (22%)	470 (32%)	466 (31%)	1489	**4.70**	1.24

Note. Response scale: **1** = “*Nothing like me,*” **2** = “*Not like me,*” **3** = *“Not much like me,”* **4** = “*Somewhat like me*,” **5** = “*Like me*,” **6** = “*Exactly like me*”.

How accurately does each statement describe you?	1	2	3	4	5	6	n	Avg.	SD
I am confident that I can effectively use a science or engineering laboratory.	9 (1%)	13 (1%)	55 (4%)	280 (19%)	578 (39%)	557 (37%)	1492	**5.06**	0.94
I am confident that I can perform a variety of laboratory techniques during an experiment.	5 (0%)	18 (1%)	58 (4%)	295 (20%)	587 (39%)	528 (35%)	1491	**5.03**	0.93
I am confident in my ability to create useful hypotheses.	9 (1%)	6 (0%)	54 (4%)	295 (20%)	621 (42%)	500 (34%)	1485	**5.03**	0.90
I am confident in my ability to interpret the results of an experiment.	6 (0%)	14 (1%)	52 (3%)	275 (18%)	617 (41%)	525 (35%)	1489	**5.05**	0.91
I am confident that I can communicate science or engineering concepts to other people.	13 (1%)	16 (1%)	91 (6%)	331 (22%)	569 (38%)	468 (31%)	1488	**4.90**	1.00
I am confident in the conclusions that I draw from the results of an experiment.	10 (1%)	9 (1%)	60 (4%)	293 (20%)	612 (41%)	501 (34%)	1485	**5.01**	0.93
I am confident that I can find STEM research information using library resources.	32 (2%)	46 (3%)	121 (8%)	333 (22%)	496 (33%)	458 (31%)	1486	**4.74**	1.19

Note. Response scale: **1** = “*Nothing like me,*” **2** = “*Not like me,*” **3** = *“Not much like me,”* **4** = “*Somewhat like me*,” **5** = “*Like me*,” **6** = “*Exactly like me*”.

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

What are the chances that you will participate in the following activities?										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**n**	**Avg.**	**SD**
Participate in a science fair or science competition.	70 (5%)	108 (7%)	136 (9%)	266 (18%)	408 (27%)	459 (31%)	47 (3%)	1494	**4.53**	1.45
Participate in a summer program related to STEM (e.g., club, camp, etc.).	15 (1%)	33 (2%)	75 (5%)	182 (12%)	429 (29%)	714 (48%)	42 (3%)	1490	**5.15**	1.08
Go to college and study a STEM subject.	27 (2%)	34 (2%)	68 (5%)	158 (11%)	354 (24%)	794 (53%)	58 (4%)	1493	**5.20**	1.15
Take advanced high school classes in STEM (e.g., AP courses, dual enrollment, etc.).	23 (2%)	33 (2%)	58 (4%)	126 (8%)	309 (21%)	877 (59%)	68 (5%)	1494	**5.31**	1.11
Work as a STEM intern or apprentice.	35 (2%)	54 (4%)	108 (7%)	249 (17%)	420 (28%)	544 (36%)	82 (5%)	1492	**4.84**	1.26
Pursue a job or a career in a STEM related field.	35 (2%)	58 (4%)	89 (6%)	176 (12%)	344 (23%)	704 (47%)	83 (6%)	1489	**5.03**	1.28

Note. Response scale: **1** = *"No Chance Whatsoever,"* **2** = *"Hardly Any Chance,"* **3** = *"A Little Chance,"* **4** = *"Some Chance,"* **5** = *"A Good Chance,"* **6** = *"An Extremely Good Chance,"* **7** = *"I Don't Know"*.
Avg. and **SD** calculated without "**7**" included.

During GEMS, how many jobs in Science, Technology, Engineering, or Math (STEM) did you learn about?		
	Freq.	**%**
None	37	3%
1	41	3%
2	103	7%
3	193	13%
4	197	13%
5 or more	905	61%
Total	**1476**	**100%**

During GEMS, how many Army jobs in STEM did you learn about?		
	Freq.	**%**
None	159	11%
1	135	9%
2	278	19%
3	359	24%
4	176	12%
5 or more	366	25%
Total	**1473**	**100%**

Which STEM job with the Army do you think is the most interesting? (n = 221)					
List	**Freq.**	**%**	**List**	**Freq.**	**%**
Medicine/health-related	38	17%	**Biochemist**	3	1%
Materials engineer	30	14%	**Medical researcher**	3	1%
Researcher (general)	20	9%	**Robotics engineer**	3	1%
DoD (Non-STEM)	15	7%	**All**	2	1%
Biomedical engineer	14	6%	**Aeromedical engineer**	1	<1%
Unsure	14	6%	**Aeronautics**	1	<1%
Audio/Visual production	13	6%	**Aerospace engineer**	1	<1%
Disease researcher	12	5%	**Computer engineer**	1	<1%
Social science	11	5%	**Computer science**	1	<1%
Forensics science	8	4%	**Electrical engineer**	1	<1%
Engineer (general)	7	3%	**Financing**	1	<1%
Mechanical engineer	7	3%	**Flight engineer**	1	<1%
Chemist	5	2%	**Mathematician**	1	<1%
Cyber security	4	2%	**Physicist**	1	<1%
None	4	2%	**Technician**	1	<1%
			Total	**224**	**100%**

Why do you think is the most interesting STEM job with the Army? (n = 221)					
List	**Freq.**	**%**	**List**	**Freq.**	**%**
Able to help people	52	24%	**Serve the country**	3	1%
The job is interesting	48	22%	**Enjoy the work done**	2	1%
Invent/Improve material	17	8%	**Solve crimes**	2	1%
Opportunities for research	7	3%	**Combines army and medicine**	1	<1%
Challenging	5	2%	**Does not involve active duty**	1	<1%
Get to learn about material	5	2%	**Engineering with medical skills**	1	<1%
Vital role in organization	5	2%	**Job is in high demand**	1	<1%
Able to apply scientific ideas	4	2%	**Monetary reasons**	1	<1%
Follows career goals	4	2%	**Novel ideas**	1	<1%
Involves a lot of travelling	4	2%	**Opened eyes to army**	1	<1%
Get to jump out of planes	3	1%	**Get to utilize resources**	1	<1%
Like the job tools	3	1%	**Able to work with mentor**	1	<1%
			Total	**173**	**100%**

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

What job are you interested in pursuing? (What job do you want to have when you grow up?) (n = 228)					
List	**Freq.**	**%**	**List**	**Freq.**	**%**
Medicine / Health-related	71	31%	**Biological science**	7	3%
Engineer (general)	65	29%	**Lawyer**	7	3%
Other Non-STEM	28	12%	**Planetary science**	7	3%
DoD (Non-STEM)	15	7%	**Business**	6	3%
Science (general)	12	5%	**Physical science**	6	3%
Computer science	10	4%	**Research (general)**	6	3%
Social science	9	4%	**Government worker**	3	2%
Sports athlete	8	4%	**Mathematics/Statistics**	2	1%
Teaching	8	4%	**Animal science**	1	<1%
			Total	**228**	**100%**

Do you want to participate in any of the following Army Education Outreach (AEOP) programs?		
	Yes – I want to participate	**No – I am not interested**
Intermediate GEMS or GEMS II	1080 (77%)	317 (23%)
Advanced GEMS or GEMS III	1128 (80%)	287 (20%)
eCYBERMISSION	593 (43%)	801 (57%)
Junior Science and Humanities Symposium	624 (44%)	781 (56%)
UNITE	690 (49%)	710 (51%)
West Point Bridge Contest	695 (49%)	713 (51%)
High School Internships (SEAP; HSAP; REAP)	1055 (74%)	368 (26%)
College Internships (CQL; URAP)	1004 (71%)	415 (29%)

Appendix C
2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Besides GEMS, do you participate in any other Science, Technology, Engineering, or Math (STEM) programs? Which ones? (n = 212)					
List	**Freq.**	**%**	**List**	**Freq.**	**%**
No other programs	144	68%	**Computer club**	1	<1%
Science olympiad	9	4%	**CQL**	1	<1%
Science fair	6	3%	**FCC**	1	<1%
STEM club	6	3%	**Flight school**	1	<1%
Robotics club	5	2%	**FLL**	1	<1%
eCYBERMISSION	5	2%	**HEP C clinic intern**	1	<1%
Biomedical program	4	2%	**HSAP**	1	<1%
Math league	4	2%	**Java programming**	1	<1%
SEAP	4	2%	**Jr NYLC**	1	<1%
Engineering program	3	1%	**Lift program**	1	<1%
West point bridge contest	3	1%	**NASA engineering program**	1	<1%
FTC	2	1%	**National mathematic honor society**	1	<1%
Steam	2	1%	**NSBE**	1	<1%
STEM fair	2	1%	**REAP**	1	<1%
TSA	2	1%	**Residential engineering program**	1	<1%
Ace engineering	1	<1%	**Scholars program**	1	<1%
Aerospace science	1	<1%	**School magnet**	1	<1%
Air Force Jr ROTC	1	<1%	**Science and technology program**	1	<1%
Architecture internship	1	<1%	**Space center**	1	<1%
Avid	1	<1%	**STI**	1	<1%
Best robotics	1	<1%	**Trans tech**	1	<1%
BROADCOM	1	<1%	**USA science and engineering festival**	1	<1%
Cardiac camp	1	<1%	**Virginia junior academy of sciences**	1	<1%
			Total	**212**	**100%**

Appendix C
2013 GEMS Post-GEMS Student Questionnaire and Data Summary

Given the chance, would you participate in this GEMS program again? Why or why not? (n = 229)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
Yes		**213**	
General Satisfaction		**149**	
	Great / fun experience	113	• "It is fun to do every day." • "It is fun doing experiments instead of just learning from teaching." • "This year was very fun."
	Liked / loved the program	23	• "I love GEMs and STEM." • "I participated in GEMS twice, and I loved both experiences."
	Interesting / inspiring experience	13	• "It was very interesting." • "It was inspiring."
Academic Research Activities		**124**	
	Learned a lot of information / Positive learning experience	103	• "I get to learn and experiment with some things that I may want to pursue in the future." • "I enjoy learning about STEM topics." • "I learned a lot more than I thought I could in a week." • "We got to learn so many interesting things."
	Meeting new people/ making friends	19	• "I enjoyed meeting other kids my age interested in science." • "I was able to meet new people who knew more about a subject than me." • "I made a lot of friends."
	Personal Development	2	• "I was motivated and inspired to use the summer as an opportunity to enhance skills that I may not learn in school."
Hands-On Research Activities		**43**	
	Getting hands-on experience in the lab	30	• "I like hands on experiments and we did a lot of those here." • "I really like the hands on aspect of it."
	Doing hands-on research not done in schools	8	• "I enjoyed the hands on experiments that I don't normally have a chance to do at school."
	Developing lab skills/techniques	5	• "I learned very many skills and techniques that would be used in a science lab." • "GEMs taught me lab techniques I would not otherwise have learned in school."

Appendix C

2013 GEMS Post-GEMS Student Questionnaire and Data Summary

CONTINUED - Given the chance, would you participate in this GEMS program again? Why or why not? (n = 229)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
STEM Pathway		**33**	
	Prepares students for the future	16	• "I love to get enough knowledge so I can be ready for a new advanced subject." • "I learned so many things that could help me with my future."
	Aligned with interests or increases interest in STEM jobs	11	• "It was also applicable to the type of jobs/ job I want." • "I get to learn and experiment with some things that I may want to pursue in the future."
	Great opportunity/exposure to opportunities	3	• "It was a very unique and interesting opportunity." • "It exposed me to a lot of programs, opportunities, and internships I could take advantage of."
	Exploration of careers	3	• "[GEMS] expanded my view to other careers." • "It is a good learning experience for me to learn my careers early."
Unsure		**10**	
	Generally unsure	5	• "I might consider it." • "Maybe not."
	Would participate depending on program details	4	• "If it was closer to Tuscaloosa I would." • "If they taught more interesting topics and included experiments that were cooler." • "Perhaps if it was for a longer session. It takes me about a week to warm up to people so I'm not looking forward to another friend-less camp."
	Unsure of future	1	• "I don't know what's in my future."
Program Characteristics		**9**	
	Program is overall great	4	• [GEMS is] a wonderful program. • "It's eye-opening."
	Program is engaging/ educational	3	• "I found the dissection and different chemistry components engaging." • "It is very educational."
	Program demonstrates real world situations	1	• "I enjoyed learning about real-world situations in science."
	Project-based learning	1	• "I liked that we did project based learning other than just lectures and notes."
Other		**9**	
	Getting paid	5	• "…you get paid to have fun doing the experiments." • "You get money by paying attention in class, being quiet, and doing what you are supposed to do."

CONTINUED - Given the chance, would you participate in this GEMS program again? Why or why not? (n = 229)			
Broad Theme	**Narrow Theme**	**Freq.**	**Example Response(s)**
	Positive environment	4	• "Being in an environment where everyone wants to learn is amazing and makes me want to learn even more."
No		**5**	
	Not interested in the materials presented	4	• "I want to take a break from doing stem related activities." • "It is not what I had in mind when I heard the word robotics."
	Not interested in summer programs	1	• "I don't want to do anything "thinky" over the summer."

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Pre-Post STEM Interest:

Comparing pre-GEMS STEM interest to post-GEMS STEM interest: All GEMS programs							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I want to study more Science, Technology, Engineering or Math (STEM) [after my classes / after participating in GEMS]	4.90 (1.07)	5.14 (0.94)	**.250***	0.19 to 0.30	8.85 (1126)	.000	.264
I would like to join a STEM club [outside of school / after participating in GEMS]	4.17 (1.28)	4.58 (1.19)	**.410***	0.35 to 0.47	12.95 (1117)	.000	.387
I enjoy doing the hands-on activities [in my classes / at GEMS]	5.35 (0.90)	5.55 (0.72)	**.200***	0.15 to 0.26	7.19 (1111)	.000	.216
I like to share what I learn [in my STEM classes / in GEMS] **with my friends and family**	4.67 (1.17)	5.06 (1.02)	**.380***	0.32 to 0.45	11.77 (1114)	.000	.352
I think about the things I learn [in my STEM classes / in GEMS] **when I'm not** [at school / in GEMS]	4.49 (1.22)	4.82 (1.08)	**.330***	0.26 to 0.40	9.32 (1112)	.000	.279
After [class / GEMS]**, I want to learn more about the STEM information that I learned about in class**	4.52 (1.16)	4.90 (1.06)	**.380***	0.32 to 0.44	11.85 (1116)	.000	.355
I learn interesting things [in my STEM classes at school / during the STEM activities at GEMS]	4.93 (1.21)	5.51 (0.77)	**.580***	0.50 to 0.65	15.58 (1115)	.000	.466

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Strongly Disagree," **2** = "Disagree," **3** = "Somewhat Disagree," **4** = "Somewhat Agree," **5** = "Agree," **6** = "Strongly Agree".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS STEM interest to post-GEMS STEM interest: USAARL Beginning GEMS-I							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I want to study more Science, Technology, Engineering or Math (STEM) [after my classes / after participating in GEMS]	4.52 (1.18)	4.90 (1.07)	**.380***	0.04 to 0.72	2.26 (62)	.030	.285
I would like to join a STEM club [outside of school / after participating in GEMS]	3.98 (1.34)	4.44 (1.15)	**.460***	0.15 to 0.76	3.01 (60)	.000	.385
I enjoy doing the hands-on activities [in my classes / at GEMS]	5.38 (0.92)	5.62 (0.61)	**.250***	0.01 to 0.48	2.08 (60)	.040	.266
I like to share what I learn [in my STEM classes / in GEMS] **with my friends and family**	4.69 (1.18)	5.23 (0.88)	**.540***	0.24 to 0.84	3.63 (60)	.000	.465
I think about the things I learn [in my STEM classes / in GEMS] **when I'm not** [at school / in GEMS]	4.17 (1.33)	5.10 (0.82)	**.930***	0.61 to 1.26	5.74 (59)	.000	.740
After [class / GEMS]**, I want to learn more about the STEM information that I learned about in class**	4.25 (1.24)	4.70 (1.11)	**.450***	0.12 to 0.78	2.75 (59)	.010	.355
I learn interesting things [in my STEM classes at school / during the STEM activities at GEMS]	4.66 (1.38)	5.52 (0.62)	**.870***	0.53 to 1.21	5.08 (60)	.000	.651

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Strongly Disagree," **2** = "Disagree," **3** = "Somewhat Disagree," **4** = "Somewhat Agree," **5** = "Agree," **6** = "Strongly Agree".

Appendix D
2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS STEM interest to post-GEMS STEM interest: WRAIR Biomedical GEMS-II							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I want to study more Science, Technology, Engineering or Math (STEM) [after my classes / after participating in GEMS]	4.99 (0.96)	5.30 (0.90)	**.310***	0.12 to 0.49	3.34 (100)	.000	.332
I would like to join a STEM club [outside of school / after participating in GEMS]	4.25 (1.07)	4.71 (1.19)	**.460***	0.26 to 0.66	4.51 (99)	.000	.451
I enjoy doing the hands-on activities [in my classes / at GEMS]	5.32 (0.74)	5.59 (0.60)	**.270***	0.12 to 0.42	3.48 (99)	.000	.348
I like to share what I learn [in my STEM classes / in GEMS] **with my friends and family**	4.52 (1.13)	5.01 (1.01)	**.490***	0.26 to 0.73	4.20 (98)	.000	.422
I think about the things I learn [in my STEM classes / in GEMS] **when I'm not** [at school / in GEMS]	4.41 (1.15)	4.90 (1.02)	**.480***	0.29 to 0.68	4.91 (98)	.000	.493
After [class / GEMS]**, I want to learn more about the STEM information that I learned about in class**	4.48 (0.90)	5.09 (0.93)	**.610***	0.42 to 0.81	6.30 (100)	.000	.627
I learn interesting things [in my STEM classes at school / during the STEM activities at GEMS]	4.90 (0.87)	5.51 (0.72)	**.610***	0.40 to 0.82	5.75 (98)	.000	.578

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Strongly Disagree," **2** = "Disagree," **3** = "Somewhat Disagree," **4** = "Somewhat Agree," **5** = "Agree," **6** = "Strongly Agree".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS STEM interest to post-GEMS STEM interest: Ft. Detrick advanced GEMS - Robotics							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I want to study more Science, Technology, Engineering or Math (STEM) [after my classes / after participating in GEMS]	5.22 (0.72)	5.24 (0.83)	**.020**	-0.17 to 0.22	0.26 (40)	.800	.040
I would like to join a STEM club [outside of school / after participating in GEMS]	4.46 (1.32)	4.66 (1.11)	**.200**	-0.08 to 0.47	1.43 (40)	.160	.224
I enjoy doing the hands-on activities [in my classes / at GEMS]	5.37 (0.89)	5.54 (0.71)	**.170**	-0.05 to 0.39	1.55 (40)	.130	.243
I like to share what I learn [in my STEM classes / in GEMS] **with my friends and family**	4.90 (0.97)	5.02 (0.85)	**.120**	-0.20 to 0.44	0.78 (40)	.440	.121
I think about the things I learn [in my STEM classes / in GEMS] **when I'm not** [at school / in GEMS]	4.76 (0.94)	4.78 (1.11)	**.020**	-0.27 to 0.32	0.17 (40)	.870	.026
After [class / GEMS]**, I want to learn more about the STEM information that I learned about in class**	4.68 (1.19)	4.85 (0.95)	**.180**	-0.16 to 0.51	1.07 (39)	.290	.169
I learn interesting things [in my STEM classes at school / during the STEM activities at GEMS]	5.10 (0.94)	5.32 (0.76)	**.220**	-0.13 to 0.57	1.27 (40)	.210	.198

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Strongly Disagree," **2** = "Disagree," **3** = "Somewhat Disagree," **4** = "Somewhat Agree," **5** = "Agree," **6** = "Strongly Agree".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

School vs. GEMS Hands-on Activities:

Comparing School and GEMS hands-on activities: All GEMS programs							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
How often do you usually get to participate in "hands-on" activities [during your STEM classes / at GEMS]?	3.30 (1.27)	5.26 (1.24)	**1.970***	1.87 to 2.07	40.30 (1120)	.000	1.204
Your [teacher / GEMS instructors] **demonstrate the experiment or activity – you get to observe it while taking notes.**	3.14 (1.44)	4.51 (1.60)	**1.370***	1.26 to 1.48	24.33 (1107)	.000	.731
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	3.35 (1.27)	4.97 (1.25)	**1.620***	1.52 to 1.72	32.35 (1102)	.000	.974
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	3.06 (1.41)	4.30 (1.54)	**1.240***	1.13 to 1.35	22.16 (1114)	.000	.664
You get to decide how to do an experiment or activity to answer a hypothesis. Your [teacher / GEMS instructors] **offer assistance but you try to perform the experiment or activity yourself.**	2.55 (1.42)	4.37 (1.59)	**1.820***	1.71 to 1.93	32.08 (1114)	.000	.961

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Never," **2** = "Once per MONTH," **3** = "Once per WEEK," **4** = "2-3 times per WEEK," **5** = "Every DAY," **6** = "Multiple times per DAY".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing School and GEMS hands-on activities: USAARL Beginning GEMS-I							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
How often do you usually get to participate in "hands-on" activities [during your STEM classes / at GEMS]?	3.20 (1.43)	5.34 (1.24)	**2.140***	1.67 to 2.61	9.17 (63)	.000	1.146
Your [teacher / GEMS instructors] **demonstrate the experiment or activity – you get to observe it while taking notes.**	3.14 (1.51)	4.86 (1.47)	**1.710***	1.20 to 2.23	6.66 (62)	.000	.839
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	3.16 (1.30)	5.23 (0.99)	**2.080***	1.69 to 2.47	10.61 (63)	.000	1.327
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	3.00 (1.45)	4.88 (1.19)	**1.880***	1.42 to 2.33	8.20 (63)	.000	1.025
You get to decide how to do an experiment or activity to answer a hypothesis. Your [teacher / GEMS instructors] **offer assistance but you try to perform the experiment or activity yourself.**	2.63 (1.45)	4.92 (1.13)	**2.300***	1.89 to 2.70	11.41 (63)	.000	1.426

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Never," **2** = "Once per MONTH," **3** = "Once per WEEK," **4** = "2-3 times per WEEK," **5** = "Every DAY," **6** = "Multiple times per DAY".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing School and GEMS hands-on activities: WRAIR Biomedical GEMS-II							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
How often do you usually get to participate in "hands-on" activities [during your STEM classes / at GEMS]?	3.12 (1.17)	5.49 (1.13)	**2.370***	2.05 to 2.69	14.76 (99)	.000	1.476
Your [teacher / GEMS instructors] **demonstrate the experiment or activity – you get to observe it while taking notes.**	2.95 (1.54)	4.57 (1.71)	**1.620***	1.21 to 2.03	7.84 (96)	.000	.796
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	3.12 (1.22)	5.03 (1.09)	**1.910***	1.58 to 2.24	11.45 (97)	.000	1.156
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	2.90 (1.27)	4.43 (1.46)	**1.540***	1.22 to 1.86	9.51 (98)	.000	.956
You get to decide how to do an experiment or activity to answer a hypothesis. Your [teacher / GEMS instructors] **offer assistance but you try to perform the experiment or activity yourself.**	2.29 (1.32)	4.31 (1.42)	**2.020***	1.66 to 2.38	11.27 (99)	.000	1.127

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Never," **2** = "Once per MONTH," **3** = "Once per WEEK," **4** = "2-3 times per WEEK," **5** = "Every DAY," **6** = "Multiple times per DAY".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing School and GEMS hands-on activities: Ft. Detrick advanced GEMS - Robotics							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
How often do you usually get to participate in "hands-on" activities [during your STEM classes / at GEMS]?	3.46 (1.21)	4.63 (1.44)	**1.170***	0.72 to 1.62	5.24 (40)	.000	.819
Your [teacher / GEMS instructors] **demonstrate the experiment or activity – you get to observe it while taking notes.**	3.22 (1.41)	3.78 (1.49)	**.560***	0.00 to 1.12	2.02 (40)	.050	.316
You perform a "hands-on" activity using a set of instructions and questions that are given to you.	3.30 (1.09)	4.30 (1.51)	**1.000***	0.43 to 1.57	3.55 (39)	.000	.561
You are given a set of instructions but then you create your own hypotheses and draw your own conclusions	3.05 (1.36)	3.80 (1.71)	**.760***	0.14 to 1.37	2.49 (40)	.020	.388
You get to decide how to do an experiment or activity to answer a hypothesis. Your [teacher / GEMS instructors] **offer assistance but you try to perform the experiment or activity yourself.**	2.73 (1.48)	4.24 (1.56)	**1.510***	0.90 to 2.12	5.03 (40)	.000	.786

Note. *** = $p < .05$; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Never," **2** = "Once per MONTH," **3** = "Once per WEEK," **4** = "2-3 times per WEEK," **5** = "Every DAY," **6** = "Multiple times per DAY".

Appendix D
2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Pre-Post Research Skills:

Comparing pre-GEMS and post-GEMS perceptions of research skills: All GEMS programs							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I know how to clean, handle, and care for equipment in a science or engineering lab	4.75 (1.04)	5.17 (0.87)	**.410***	0.36 to 0.47	14.80 (1132)	.000	.440
I know laboratory techniques that are used in scientific or engineering experiments	4.10 (1.23)	4.94 (1.00)	**.850***	0.78 to 0.91	25.98 (1129)	.000	.773
I know how to create a testable hypotheses using science or engineering principles	4.49 (1.19)	4.96 (1.05)	**.460***	0.40 to 0.53	14.10 (1124)	.000	.420
I know how to explain experimental results	4.61 (1.13)	4.99 (0.97)	**.380***	0.33 to 0.44	13.06 (1123)	.000	.389
I am good at communicating science or engineering concepts to others	4.44 (1.17)	4.85 (1.07)	**.410***	0.35 to 0.47	13.39 (1124)	.000	.399
I can draw conclusions from the results of an experiment	4.88 (0.99)	5.12 (0.92)	**.240***	0.18 to 0.29	8.58 (1126)	.000	.255
I know how and where to find STEM research information using library resources	4.25 (1.29)	4.68 (1.24)	**.430***	0.37 to 0.50	12.82 (1124)	.000	.382

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS perceptions of research skills: USAARL Beginning GEMS-I							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I know how to clean, handle, and care for equipment in a science or engineering lab	4.55 (1.04)	5.06 (0.97)	**.520***	0.28 to 0.75	4.41 (65)	.000	.543
I know laboratory techniques that are used in scientific or engineering experiments	3.77 (1.19)	4.98 (1.05)	**1.210***	0.91 to 1.51	8.14 (65)	.000	1.002
I know how to create a testable hypotheses using science or engineering principles	3.70 (1.43)	4.75 (1.28)	**1.050***	0.66 to 1.43	5.41 (63)	.000	.677
I know how to explain experimental results	4.12 (1.27)	4.83 (1.07)	**.710***	0.41 to 1.01	4.67 (64)	.000	.580
I am good at communicating science or engineering concepts to others	4.06 (1.24)	4.74 (1.22)	**.680***	0.41 to 0.95	5.00 (64)	.000	.620
I can draw conclusions from the results of an experiment	4.36 (1.17)	5.00 (1.05)	**.640***	0.35 to 0.92	4.51 (65)	.000	.556
I know how and where to find STEM research information using library resources	4.16 (1.16)	4.70 (1.26)	**.550***	0.22 to 0.87	3.34 (63)	.000	.418

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Appendix D
2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS perceptions of research skills: WRAIR Biomedical GEMS-II							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I know how to clean, handle, and care for equipment in a science or engineering lab	4.80 (1.01)	5.35 (0.82)	**.550***	0.36 to 0.74	5.68 (99)	.000	.568
I know laboratory techniques that are used in scientific or engineering experiments	4.26 (1.10)	5.31 (0.73)	**1.050***	0.86 to 1.24	10.85 (99)	.000	1.085
I know how to create a testable hypotheses using science or engineering principles	4.71 (1.05)	5.20 (0.80)	**.490***	0.29 to 0.69	4.85 (99)	.000	.485
I know how to explain experimental results	4.74 (0.96)	5.12 (0.83)	**.380***	0.20 to 0.55	4.25 (97)	.000	.429
I am good at communicating science or engineering concepts to others	4.27 (1.00)	4.97 (0.86)	**.700***	0.49 to 0.90	6.83 (98)	.000	.687
I can draw conclusions from the results of an experiment	4.92 (0.94)	5.26 (0.76)	**.340***	0.16 to 0.52	3.68 (99)	.000	.368
I know how and where to find STEM research information using library resources	4.32 (1.20)	4.8 (1.12)	**.470***	0.25 to 0.70	4.19 (98)	.000	.421

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Appendix D
2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS perceptions of research skills: Ft. Detrick advanced GEMS - Robotics							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I know how to clean, handle, and care for equipment in a science or engineering lab	4.83 (1.02)	4.98 (0.99)	**.150**	-0.05 to 0.34	1.52 (40)	.140	.238
I know laboratory techniques that are used in scientific or engineering experiments	4.61 (1.22)	4.83 (1.09)	**.220**	-0.03 to 0.47	1.78 (40)	.080	.278
I know how to create a testable hypotheses using science or engineering principles	4.73 (1.07)	5.00 (1.02)	**.270***	0.07 to 0.47	2.71 (40)	.010	.424
I know how to explain experimental results	4.49 (1.03)	4.76 (1.04)	**.270**	-0.02 to 0.56	1.86 (40)	.070	.291
I am good at communicating science or engineering concepts to others	4.54 (1.12)	4.66 (1.11)	**.120**	-0.10 to 0.35	1.09 (40)	.280	.171
I can draw conclusions from the results of an experiment	4.83 (1.12)	4.98 (0.99)	**.150**	-0.08 to 0.38	1.29 (40)	.200	.201
I know how and where to find STEM research information using library resources	4.39 (1.28)	4.73 (1.12)	**.340***	0.10 to 0.58	2.87 (40)	.010	.448

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Confidence with Research Skills:

Comparing pre-GEMS and post-GEMS confidence with research skills: All GEMS programs							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I am confident that I can effectively use a science or engineering laboratory	4.75 (1.08)	5.07 (0.92)	**.320***	0.27 to 0.38	11.90 (1122)	.000	.355
I am confident that I can perform a variety of laboratory techniques during an experiment	4.65 (1.12)	5.03 (0.93)	**.380***	0.33 to 0.44	13.06 (1118)	.000	.390
I am confident in my ability to create useful hypotheses	4.78 (1.01)	5.02 (0.92)	**.240***	0.18 to 0.29	8.59 (1112)	.000	.257
I am confident in my ability to interpret the results of an experiment	4.76 (1.03)	5.05 (0.92)	**.280***	0.23 to 0.34	10.40 (1114)	.000	.311
I am confident that I can communicate science or engineering concepts to other people	4.51 (1.14)	4.91 (1.00)	**.400***	0.34 to 0.46	13.61 (1114)	.000	.408
In am confident in the conclusions that I draw from the results of an experiment	4.74 (1.04)	5.01 (0.93)	**.270***	0.22 to 0.33	9.72 (1107)	.000	.292
I am confident that I can find STEM research information using library resources	4.40 (1.28)	4.75 (1.18)	**.350***	0.28 to 0.41	10.36 (1108)	.000	.311

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Appendix D
2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS confidence with research skills: USAARL Beginning GEMS-I							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I am confident that I can effectively use a science or engineering laboratory	4.56 (1.08)	4.97 (0.94)	**.410***	0.17 to 0.65	3.35 (65)	.000	.412
I am confident that I can perform a variety of laboratory techniques during an experiment	4.45 (1.06)	4.91 (0.92)	**.450***	0.21 to 0.70	3.65 (65)	.000	.450
I am confident in my ability to create useful hypotheses	4.45 (1.05)	4.95 (0.93)	**.510***	0.26 to 0.75	4.15 (64)	.000	.515
I am confident in my ability to interpret the results of an experiment	4.44 (1.02)	4.89 (0.95)	**.450***	0.18 to 0.72	3.36 (65)	.000	.414
I am confident that I can communicate science or engineering concepts to other people	4.28 (0.99)	4.69 (1.06)	**.420***	0.18 to 0.65	3.52 (64)	.000	.437
In am confident in the conclusions that I draw from the results of an experiment	4.47 (1.02)	4.88 (0.98)	**.410***	0.16 to 0.66	3.24 (63)	.000	.405
I am confident that I can find STEM research information using library resources	4.36 (1.16)	4.83 (1.18)	**.470***	0.18 to 0.75	3.29 (63)	.000	.411

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

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2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS confidence with research skills: WRAIR Biomedical GEMS-II							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I am confident that I can effectively use a science or engineering laboratory	4.65 (1.09)	5.22 (0.82)	**.570***	0.40 to 0.74	6.57 (99)	.000	.657
I am confident that I can perform a variety of laboratory techniques during an experiment	4.65 (1.10)	5.27 (0.76)	**.620***	0.43 to 0.81	6.59 (99)	.000	.659
I am confident in my ability to create useful hypotheses	4.82 (0.88)	5.21 (0.78)	**.400***	0.24 to 0.56	4.95 (97)	.000	.500
I am confident in my ability to interpret the results of an experiment	4.72 (0.89)	5.22 (0.81)	**.500***	0.32 to 0.68	5.53 (99)	.000	.553
I am confident that I can communicate science or engineering concepts to other people	4.33 (0.99)	5.01 (0.91)	**.680***	0.49 to 0.87	7.14 (97)	.000	.721
In am confident in the conclusions that I draw from the results of an experiment	4.70 (0.91)	5.17 (0.79)	**.470***	0.31 to 0.62	5.99 (97)	.000	.605
I am confident that I can find STEM research information using library resources	4.34 (1.20)	4.91 (1.11)	**.570***	0.36 to 0.77	5.40 (98)	.000	.543

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

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2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS confidence with research skills: Ft. Detrick advanced GEMS - Robotics							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
I am confident that I can effectively use a science or engineering laboratory	4.80 (1.04)	4.95 (0.99)	**.150**	-0.05 to 0.35	1.52 (39)	.140	.241
I am confident that I can perform a variety of laboratory techniques during an experiment	4.78 (1.05)	4.98 (1.14)	**.200**	-0.09 to 0.49	1.39 (39)	.170	.219
I am confident in my ability to create useful hypotheses	4.78 (0.97)	4.85 (1.05)	**.070**	-0.15 to 0.30	0.68 (39)	.500	.108
I am confident in my ability to interpret the results of an experiment	4.78 (1.03)	4.98 (0.97)	**.200***	0.01 to 0.39	2.08 (39)	.040	.329
I am confident that I can communicate science or engineering concepts to other people	4.55 (1.04)	4.83 (1.06)	**.280***	0.02 to 0.53	2.22 (39)	.030	.351
In am confident in the conclusions that I draw from the results of an experiment	4.69 (1.06)	5.00 (0.97)	**.310***	0.05 to 0.57	2.40 (38)	.020	.385
I am confident that I can find STEM research information using library resources	4.40 (1.15)	4.73 (1.18)	**.320***	0.09 to 0.56	2.82 (39)	.010	.445

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "Nothing like me," **2** = "Not like me," **3** = "Not much like me," **4** = "Somewhat like me," **5** = "Like me," **6** = "Exactly like me".

Future STEM intentions:

Comparing pre-GEMS and post-GEMS future STEM intentions: All GEMS programs							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	4.36 (1.45)	4.56 (1.45)	**.190***	0.13 to 0.26	6.16 (1067)	.000	.188
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	4.93 (1.19)	5.16 (1.07)	**.230***	0.17 to 0.29	7.29 (1064)	.000	.223
Go to COLLEGE and study a STEM subject	5.08 (1.24)	5.18 (1.16)	**.100***	0.04 to 0.15	3.33 (1043)	.000	.103
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	5.25 (1.17)	5.30 (1.10)	**.060***	0.00 to 0.11	2.01 (1038)	.040	.062
Work as a STEM INTERN or APPRENTICE	4.45 (1.37)	4.82 (1.26)	**.370***	0.30 to 0.44	10.13 (1006)	.000	.319
Pursue a JOB or a CAREER in a STEM related field	4.87 (1.36)	5.00 (1.30)	**.130***	0.06 to 0.19	3.97 (1002)	.000	.125

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "No Chance Whatsoever," **2** = "Hardly Any chance," **3** = "A Little Chance," **4** = "Some Chance," **5** = "A Good Chance," **6** = "An Extremely Good Chance," **7** = "I Don't Know" (excluded from analysis).

Comparing pre-GEMS and post-GEMS future STEM intentions: USAARL Beginning GEMS-I							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	4.21 (1.44)	4.26 (1.64)	**.050**	-0.28 to 0.38	0.30 (60)	.770	.038
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	4.65 (1.28)	4.89 (1.20)	**.240**	-0.05 to 0.54	1.65 (61)	.100	.209
Go to COLLEGE and study a STEM subject	4.93 (1.35)	4.88 (1.48)	**-.050**	-0.33 to 0.22	-0.39 (55)	.700	-.052
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	4.64 (1.38)	4.87 (1.50)	**.240**	-0.07 to 0.54	1.56 (54)	.120	.211
Work as a STEM INTERN or APPRENTICE	3.79 (1.56)	4.38 (1.40)	**.590***	0.20 to 0.97	3.08 (57)	.000	.404
Pursue a JOB or a CAREER in a STEM related field	4.12 (1.56)	4.44 (1.62)	**.320**	-0.03 to 0.67	1.86 (49)	.070	.262

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "No Chance Whatsoever," **2** = "Hardly Any chance," **3** = "A Little Chance," **4** = "Some Chance," **5** = "A Good Chance," **6** = "An Extremely Good Chance," **7** = "I Don't Know" (excluded from analysis).

Appendix D

2013 Pre- to Post-GEMS Matched Pairs and Cases Comparisons

Comparing pre-GEMS and post-GEMS future STEM intentions: WRAIR Biomedical GEMS-II							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	4.58 (1.14)	4.76 (1.26)	**.180**	-0.02 to 0.37	1.79 (90)	.080	.187
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	4.78 (1.19)	5.29 (1.05)	**.510***	0.28 to 0.73	4.37 (96)	.000	.444
Go to COLLEGE and study a STEM subject	5.24 (1.02)	5.30 (1.12)	**.050**	-0.13 to 0.24	0.58 (93)	.570	.059
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	5.43 (0.81)	5.54 (0.89)	**.120**	-0.03 to 0.26	1.58 (93)	.120	.163
Work as a STEM INTERN or APPRENTICE	4.71 (1.31)	5.09 (1.16)	**.380***	0.17 to 0.59	3.62 (89)	.000	.382
Pursue a JOB or a CAREER in a STEM related field	4.99 (1.18)	5.14 (1.18)	**.150**	-0.06 to 0.36	1.45 (92)	.150	.151

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "No Chance Whatsoever," **2** = "Hardly Any chance," **3** = "A Little Chance," **4** = "Some Chance," **5** = "A Good Chance," **6** = "An Extremely Good Chance," **7** = "I Don't Know" (excluded from analysis).

Comparing pre-GEMS and post-GEMS future STEM intentions: Ft. Detrick advanced GEMS - Robotics							
Item	**Pre-GEMS Avg. (SD)**	**Post-GEMS Avg. (SD)**	**Mean Diff.**	**95% C.I.**	***t* (df)**	***p***	***d***
Participate in a SCIENCE FAIR or SCIENCE COMPETITION	4.38 (1.48)	4.70 (1.22)	**.330***	0.08 to 0.57	2.69 (39)	.010	.425
Participate in a SUMMER PROGRAM related to STEM (e.g., club, camp, etc.)	5.15 (1.17)	5.33 (0.83)	**.180**	-0.08 to 0.43	1.36 (39)	.180	.215
Go to COLLEGE and study a STEM subject	5.45 (0.80)	5.42 (0.79)	**-.030**	-0.21 to 0.15	-0.30 (37)	.770	-.048
Take ADVANCED HIGH SCHOOL CLASSES in STEM (e.g., AP courses, dual enrollment, etc.)	5.68 (0.78)	5.54 (0.90)	**-.140**	-0.30 to 0.03	-1.71 (36)	.100	-.281
Work as a STEM INTERN or APPRENTICE	4.95 (1.10)	5.13 (0.95)	**.180**	-0.08 to 0.44	1.42 (38)	.160	.227
Pursue a JOB or a CAREER in a STEM related field	5.36 (1.05)	5.31 (1.01)	**-.060**	-0.30 to 0.19	-0.47 (35)	.640	-.078

Note. *** = p < .05; **Mean Diff. = paired difference Pre-GEMS vs. Post-GEMS; **95% C.I.** = confidence interval around the mean difference; ***t* (df)** = t-value with n-1 degrees of freedom; ***p*** = paired samples t-test (two-tailed); ***d*** = Cohen's *d* (effect size). Frequency scale: **1** = "No Chance Whatsoever," **2** = "Hardly Any chance," **3** = "A Little Chance," **4** = "Some Chance," **5** = "A Good Chance," **6** = "An Extremely Good Chance," **7** = "I Don't Know" (excluded from analysis).

Appendix E:
2013 GEMS Student Focus Group Protocol

1. Who has participated in the following AEOP programs: Junior Solar Sprint, Junior Science and Humanities Symposium, West Point Bridge Contest, eCybermission, summer programs (GEMS/UNITE), apprenticeship programs (SEAP, REAP, HSAP)?

2. Why did you want to participate in GEMS this summer?

3. How did the hands-on activities help you learn about STEM?

4. What other AEOP programs did you learn about during GEMS?
    - Which ones do you want to participate in?

5. What STEM jobs/careers did you learn about during GEMS?

6. What are your future education/career aspirations?
    - How did GEMS better prepare you for future STEM education/career aspirations?

7. Imagine that a friend is thinking about participating in GEMS. What is most important thing that you want your friend to know about GEMS?

Appendix F:

2013 GEMS Mentor Focus Group Protocol

1. Who has mentored in any of these AEOP programs before: Junior Solar Sprint, Junior Science and Humanities Symposium, West Point Bridge Contest, eCYBERMISSION, summer programs (GEMS/UNITE), apprenticeship programs (REAP, SEAP/CQL, HSAP/URAP), scholarship programs (SMART/NDSEG)?

2. Why did you choose to participate in the GEMS this year?
   - How did you learn about the program?

3. Think of a typical day in GEMS and tell me about the mentoring you provided?
   - What did you do to support students?
   - What kind(s) of feedback did you give to students?

4. What do you perceive as the value of GEMS?
   - How have you benefited from participating?
   - How do you think apprentices benefit from participating?

5. How did you educate your apprentice about AEOP initiatives?

6. How did you educate the students about STEM jobs/careers offered by the Army and Department of Defense agencies?
   - What resources do you need to educate students about STEM careers at Army/DoD agencies?

7. What impact do you think you had on your students' future STEM education/career aspirations?

8. If you had one minute to talk to an Army decision maker about GEMS, what would you say?