Army Educational Outreach Program

Gains in the Education of Mathematics & Science

2016 Annual Program Evaluation Report

ARMY EDUCATIONAL OUTREACH PROGRAM

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Executive Summary

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

In 2016, GEMS provided outreach to 2,427 students and 100 Near-Peer Mentors. Fourteen Army research laboratory and engineering centers were involved across 11 different GEMS sites. The number of GEMS students in 2016 represents a 6% increase in enrollment over the 2,270 student participants in 2015. 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 FY16 GEMS program. The evaluation addressed questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and program objectives. The assessment strategy for GEMS included questionnaires for students and mentors, 3 focus groups with students, 3 focus groups with mentors, and an annual program report compiled by NSTA.

2016 GEMS Fast Facts	
Description	GEMS is an AEOP STEM-enrichment program hosted by U.S. Army research laboratories research laboratories and engineering centers where local students are invited to participate in a one-week curriculum led by Army scientists and egnineers, resource teachers and near peer mentors.
Participant Population	5th through 12th Grade
No. of Applicants/Students	4,414
No. of Students	2,427
Placement Rate	55%
Submission Completion Rate	N/A
Number of Adults (Team Advisors and Volunteers – including S&Es, Near Peer Mentors, and Teachers)	345
Number of Army S&Es	215
Number of Army/DoD Research Laboratories	14
Total number of K–12 Teachers (including preservice and DoDEA)	30
Total number of K–12 Schools (Home, Private, Public, DoDEA)	907
Number of K–12 Schools — Title I	230
Number of Colleges/Universities	50
Number of DoDEA Students	26
Number of DoDEA Teachers	6
Number of DoDEA Schools	5
Number of Other Collaborating Organizations	1
Total Cost	$1,010,121
Cost Per Student Participant – total cost/# of student participants	$416

Summary of Findings

The FY16 evaluation of GEMS collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the following table.

2016 GEMS Evaluation Findings	
Participant Profiles	
GEMS served students from populations historically underrepresented in STEM at rates similar to previous years.	In FY16, 46% of enrolled participants were female, indicating that GEMS successfully attracted participation from female students, a population historically underrepresented in engineering fields; this participation rate is comparable to the FY15 female participation rate of 45% and the FY14 rate of 44%.
	Students from historically underrepresented and underserved minority race/ethnicity and low-income groups participated in GEMS comparably to previous years. In FY16, 23% of participating students identified themselves as Black or African American, a rate comparable to this group's participation in FY15 (22%). Participation for students identifying themselves as Hispanic or Latino was 8%, comparable to the 9%, of students identifying with this group in FY15. A small proportion (10% in FY16 versus 11% in FY15 and 12% in FY14) of students continued to report qualifying for free or reduced-price lunch (FRL) – a common indicator of low-income status.
	GEMS served students across a range of school contexts, although more than half (60%) of participants identified their school setting as suburban.
GEMS attracted more applicants and served more students in FY16 as compared to previous years.	GEMS met and exceeded its FY16 target of receiving 3,750 applications (4,414 applications were received in FY16, an increase of 6% over the 4,161 applications in FY15). Although the program failed to meet its FY16 goal for student participation of 2,600, there was a 6% increase in student enrollment from FY15 to FY16, continuing an upward trend in enrollment over the past three program years.
Actionable Program Evaluation	
GEMS marketed the program in a number of ways, however reaching schools and organizations serving groups historically under-represented in STEM is an area for growth.	While NSTA and GEMS sites employed multiple strategies to disseminate information about the GEMS program, few of these efforts were targeted specifically to reaching underserved and underrepresented populations.
	Students most frequently learned about the GEMS through personal connections including past participants, friends, and DoD employees.

GEMS students reported being motivated to participate in the program by an interest in STEM and the learning opportunities GEMS presents.	Students were most frequently motivated to participate in GEMS by their interest in STEM and a desire to learn something new and interesting. Other motivators cited by most students included learning in ways not possible in school and the opportunity to used advanced laboratory technology.
GEMS students reported engaging in meaningful STEM learning through team-based and hands-on activities.	Students reported engaging in a number of STEM activities on most days or every day of their GEMS experience. Over three-quarters of students reported learning about STEM topics new to them, communicating with other students about STEM, and learning about careers on most days or every day of their GEMS experience.
	Students reported engaging in a variety of STEM practices during their GEMS experience, with nearly all students reporting working as part of a team most days or every day. Large majorities of students (76%) also reported engaging in practices such as participating in hands-on STEM activities and using laboratory procedures or tools on most days or every day of their GEMS experience.
	Students reported that they had more opportunities to learn about STEM and engage in STEM practices in their GEMS experience than they typically have in school.
	Mentors reported using strategies to help make learning activities relevant to students, support the needs of diverse learners, develop students' collaboration and interpersonal skills, engage students in "authentic" STEM activities, and support students' STEM educational and career pathways.
GEMS informed students about STEM careers in general and, to a lesser extent, about DoD STEM careers specifically.	Nearly all students (97%) reported learning about 1 or more STEM careers during GEMS and over three-quarters learned about 3 or more STEM careers. Slightly fewer students (84%) reported learning about 1 or more DoD STEM career and slightly more than half reported learning about 3 or more.
	All responding mentors reported asking students about their educational and career interests and nearly all reported providing guidance about educational pathways that will prepare students for STEM careers. Most mentors also discussed STEM career opportunities within the DoD or other government agencies.
	Other than simply participating in GEMS, students reported that participating in GEMS, their GEMS mentors and invited speakers or career events during GEMS were resources that impacted their awareness of DoD STEM careers. Most students had not experienced AEOP resources such as the website, brochure, social media, and It Starts Here! magazine.

GEMS has an opportunity to improve student and mentor awareness of other AEOPs.	The programs mentors most frequently reported discussing with students were GEMS and GEMS Near Peer Mentors. Less than half (15-40%) reported discussing any other AEOPs specifically, although over half reported discussing AEOPs generally but without referencing any specific program.
	Mentors reported that the most useful resources for exposing students to AEOP were participation in GEMS, program administrators or site coordinators, and invited speakers or career events. Over half of mentors had no experience with AEOP on social media or It Starts Here! Magazine as resources to expose students to AEOPs.
Students and mentors value the GEMS experience.	Nearly all students (90-94%) indicated being somewhat or very much satisfied with GEMS program features such as teaching or mentoring, the stipend, and availability of program topics. Students also offered positive comments about their overall satisfaction with the program, focusing on their learning experiences in GEMS and the personal connections they made with mentors and peers.
	Mentors also reported being satisfied with most program features, including the support they received for instruction or mentoring, communication with program organizers, and invited speakers and career events.
Outcomes Evaluation	
GEMS students reported positive impacts on their STEM knowledge and competencies.	Students reported gains in their STEM knowledge as a result of participating in GEMS. These gains were reported in areas such as in depth knowledge of a STEM topic, knowledge of how scientists and engineers work on real problems in STEM, and knowledge of what everyday research work is like in STEM. Females reported significantly higher impacts in these areas than males, however there were no differences across races/ethnicities.
	Students also reported impacts on their abilities in various STEM competencies, including science and engineering practices. Participants reported some to large gain in their science practices (65%) and engineering practices (50%) after participating in GEMS. These gains were reported in abilities such as supporting an explanation for an observation with data from experiments, communicating about experiments and explanations in different ways, and using knowledge and creativity to propose a testable solution for a problem. Female students and students identifying with racial/ethnic minority groups reported significantly higher gains than males and non-minority students.
GEMS participants reported gains in students' 21st Century Skills.	A large majority of students (81%) reported gains in their 21st Century Skills as a result of participating in GEMS. These gains were reported in areas such as their ability to work well with students of all backgrounds, communicating effectively with others, making changes when things do not go as planned, and sticking with a task until it is finished. Female

	students reported significantly more gains than male students although there were no significant differences across races/ethnicities.
GEMS participants reported gains in their confidence and identity in STEM, and in their interest in engaging in STEM in the future.	A large majority of students (79%) reported gains in areas related to their STEM identity, defined as confidence in one's ability to succeed in STEM. These gains were reported in areas such as students' sense of accomplishing something in STEM, feeling prepared for more challenging STEM activities, and thinking creatively about a STEM project or activity. Females reported significantly higher gains in STEM identity and confidence than males although there were no significant differences across races/ethnicities.
	Students also reported gains in the likelihood that they would engage in STEM activities in the future after participating in GEMS. For example, most students indicated that, as a result of GEMS, they were more likely to participate in a STEM camp, club, or competition; work on a STEM project or experiment in a university or professional setting; and take an elective STEM class. Females reported significantly higher perceptions of their likeliness to engage in STEM Activities compared to males, and White students reported being more likely to engage in STEM activities in comparison to minority students.
Students reported higher education aspirations after participating in GEMS, although their career aspirations showed little change.	After participating in GEMS, students reported an upward shift in their educational aspirations evidenced by an increase in the number of students who aspired to continue their education after college (from 55% before GEMS to 67% after).
	Most responding students expressed interest in STEM-related careers both before and after participating in GEMS. There was, however, a shift in student interest in careers in engineering and architectures (17% of students aspiring to these careers before GEMS and 22% after participating in GEMS) and in careers as scientists or researchers (8% of students aspiring to these careers before GEMS and how 12% after participating in GEMS).
Although GEMS students have limited awareness of other AEOP initiatives, students showed interest in future AEOP opportunities.	Around half or more of responding students had not heard of AEOP initiatives other than GEMS and GEMS Near Peer Mentors. In spite of this, between a third and a half of students indicated interest in participating in future AEOPs other than GEMS. For example, approximately half (49%) of students indicated interest in participating in SEAP in the future and over a third (36%) expressed interest in participating in JSHS. Students credited participating in GEMS, their mentors, and invited speakers or career events with increasing their interest in participating in other AEOPs. Over half of students had not experienced AEOP on social media as a resource for learning about AEOPs and 21% and 18% respectively reported not having experienced the AEOP website and AEOP brochure as a resource for learning about AEOPs.

GEMS participants reported positive opinions of DoD research and DoD researchers and reported increases in their awareness of their interest in pursuing a STEM career with the DoD.	Students had overwhelmingly positive opinions of DoD research and researchers and the value of DoD research. For example, large majorities of students agreed that DoD research is valuable to society and that DoD researchers advance science and engineering fields.
	Large majorities of students reported that GEMS contributed to their awareness of DoD STEM research and careers and to a greater appreciation of Army and DoD STEM research. Over half of students also indicated that they are more interested in pursuing a STEM career with the Army or DoD after participating in GEMS.

Responsiveness to FY14 and FY15 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY15 to programs and summarize efforts and outcomes reflected in the FY16 APR toward these areas.

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

Finding: The large number of applications the program receives provides some evidence that the GEMS program could successfully be expanded to accommodate the considerable amount of unmet need and interest that persist with qualified students. It is recommended that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interests in more communities.

> **GEMS FY16 Efforts and Outcomes:** The student placement rate for FY16 remained at FY15 levels (55%), however, 8 out of 11 GEMS sites grew in enrollment. For example the program at Adelphi added 71 student participants, Fort Rucker added 31, and San Antonio added 27. Program staff reported that 9 of the 11 sites were at or near capacity in FY16, indicating that space and staffing will need to be expanded for significant program growth. There was no RFP process to expand sites in FY16, however the program did maintain the 11 sites that transitioned into the consortium in FY16. The next RFP to add a location is scheduled for FY17.

Finding: It is likely that GEMS will need to expand targeted marketing while implementing more aggressive marketing and recruitment practices. The program may wish to particularly consider targeting outreach to low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations.

GEMS FY16 Efforts and Outcomes: Participation by females and participants identifying as Black or African American and Hispanic or Latino and those remained essentially constant (changes of < 2%) since FY15. Due to a change in the definition of underserved/underprivileged students in FY16, the rate of participation of these students was reported in the annual program report at 10% although it should be noted that 23% of enrolled students were Black or African American, 8% were Hispanic or Latino, and 10% reported receiving free or reduced price lunch. Facebook advertising was used more aggressively in FY16 and low-income schools were targeted by local program coordinators (LPCs) in areas around their sites. Furthermore, the addition of strategic partners such as the Society for Women Engineers and the Tiger Woods Foundation will provide further opportunities to reach underserved and/or underrepresented populations of students.

Finding: The program and individual GEMS sites may need to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes.

GEMS FY16 Efforts and Outcomes: Transportation to and from sites was an issue again in FY16. While White Sands Missile Range was provided transportation with GEMS funding, other locations did not receive this support. The major limiting factor was the increased liability to damages during student transport. White Sands Missile Range avoided this issue by hiring a vendor, but that option seemed cost prohibitive at other locations. Student stipends are designed to compensate for increased cost of transportation, however stipends are often seen as a reward for participation. This unintentional mixed message diverted focus away from stipends as a potential solution for participants.

Finding: Given the large proportion of students who reported learning about GEMS through personal connections, it is recommended that the program consider strategies to ensure that students without a personal connection to sites have access to the GEMS program.

GEMS FY16 Efforts and Outcomes: In FY16, personal relationships continued to be a factor in choosing a student for participation. Program administrators reported that LPCs choose participants with a variety of methods. "Connected" selections are still a potential issue, but it is unclear which selection methods increase risk. The program focused on including U/U participants in FY 16 as a way to offset the number of connected participants. The program used target marketing, such as Facebook advertising, to expand the possible pool of applicants beyond personal connections.

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

Finding: The programs' ability to serve increasing numbers of students is limited by the number of mentors available, and therefore strategies to recruit additional RTs and NPMs should be considered.

GEMS FY16 Efforts and Outcomes: There was no FY16 goal for Near-Peer Mentor (NPM) and Resource Teacher (RT) involvement; however, NSTA observed a best practice for staff ratios during site visits. Sites that were closer to this ratio had observably higher student engagement. This ratio was one RT for every four NPMs, and one NPM for every six to eight students.

Finding: Mentors should be provided with more comprehensive information about AEOP initiatives. The program may therefore wish to incorporate information about other AEOPs into the mentor orientation materials.

GEMS FY16 Efforts and Outcomes: GEMS participant awareness of other AEOP opportunities was above the target of 60% for FY16. GEMS locations were given AEOP collateral to support staff training. Also, Widmeyer created a presentation of program overviews that were provided to LPC for staff orientations. ERDC-CERL and WRAIR reported using SEAP and/or CQL students as Near Peer Mentors in program to increase awareness.

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

Finding: The program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs.

GEMS FY16 Efforts and Outcomes: GEMS awareness of other AEOP opportunities was above the target of 60% in FY16. LPC and regional Camp Invention (CI) leaders met and conducted cross-program site visits in FY16 to increase recruitment of CI into GEMS. Some locations also used SEAP and CQL students in curriculum to increase awareness.

Finding: Familiarize mentors with resources available to expose students to DoD STEM careers.

GEMS FY16 Efforts and Outcomes: The program relied heavily on scientists and engineers (S&E) for the majority of the Department of Defense (DoD) and STEM career influence. A large majority of participants reported learning about at least one DoD STEM career.

Finding: It may also be useful to familiarize mentors with strategies to increase the likelihood that the program will have a long-term impact on students' decisions to pursue STEM.

GEMS FY16 Efforts and Outcomes: Specific mentor skill training was not provided to LPCs by the IPA. Some sites may have training that wasn't reported to the IPA.

Finding: The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities.

GEMS FY16 Efforts and Outcomes: Time was set-aside during the program for students to complete evaluations. A lack of reliable Internet access challenged the viability of internet-based evaluation instruments. Paper was provided at many locations to offset this challenge, but logistics problems created some delays in paper implementation.

Recommendations

Evaluation findings indicate that FY16 was a successful year overall for the GEMS program. Notable successes for the year include continued increases in participant applications and enrollment, continued participation by groups traditionally under-represented in STEM fields, and high levels of mentor and student satisfaction with the programs. Both students and mentors reported gains in students' STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the GEMS experience, and students emerged from the program more aware of other AEOPs and of Army and DoD STEM careers.

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

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

1. GEMS served 2,427 students in FY16, a 6% increase over FY15. The continued upward trends in applications and enrollment provides some indication that the program attended to previous evaluator recommendations that existing sites expand their capacity to accommodate more students in order to meet existing needs and interest in communities that are already served by GEMS programs. The placement rate of 55% remained constant from FY15 to FY16 however; indicating significant continued unmet need in the program. Therefore, the FY14 and FY15 recommendation that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interest in more communities is repeated. Program administrators noted that there was no RFP for a new site in FY16, precluding an expansion in the number of sites, although the program did maintain the 11 sites that transitioned into the consortium in FY16. The next RFP to add a location is scheduled for FY17, and it is recommended that the program evaluate existing sites' ability to expand their capacity as well as consider adding new locations in the coming years. In order to expand the capacity of existing sites, the program should consider ways of increasing administrative support, teaching staff, physical infrastructure, and mentor participation to meet the needs and interest of potential GEMS participants.

2. There was little change in participation of groups underserved and underrepresented in STEM from FY14 to FY16. In FY15 and FY16 there was little evidence of targeted outreach to organizations that serve groups historically underserved and underrepresented in STEM. It is likely that in order to engage increasing numbers of students underserved and underrepresented in STEM, GEMS will need to expand targeted marketing while implementing more aggressive marketing and recruitment practices. The inclusion of organizations such as the Society for Women Engineers (SWE) and the Tiger Woods Foundation as strategic partners of the AEOP presents opportunities for marketing targeted toward theses underserved and underrepresented groups. In addition, the more aggressive use of Facebook marketing implemented in FY16 should be continued, although program administrators should be mindful that only a very small percentage (3%) of students reported learning about AEOP via social media. Due to the perception of mentors that travel barriers preclude participation of some groups of students, the program and

individual GEMS sites may wish to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes.

3. Students continue to report that their primary source of information about GEMS was personal connections which emphasizes the quality of experience that students have in the program that motivates them to tell others about the program. However, this does exclude students who may not have connections to current or past participants. Given the large proportions of students who learned about GEMS through family, friends, and past participants of the program, the recommendation is repeated for FY16 to take measures to diversify the applicant and participant pool and to ensure that students without personal connections to sites have access to the GEMS program.

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

1. Since the program's ability to serve increasing numbers of students is limited by the number of mentors available, strategies to recruit additional RTs and NPMs and should be considered. Mentors noted in focus groups that they felt that additional support for mentors in terms of overhead funding, support for mentoring from superiors, and assistance in recruiting students for the program would be beneficial in retaining existing mentors and would increase the likelihood that Army S&Es would volunteer to act as GEMS mentors.

2. Since a majority of students identified their mentors as a key resource for information about AEOP opportunities, mentors should be provided with more comprehensive information about AEOP initiatives. Many mentors reported having no experience with AEOP resources. The program noted that in FY16 a presentation highlighting the AEOP portfolio was created for LPCs for use during staff orientation. Program administrators should take measures to ensure that this, and other AEOP resources, is utilized at sites during mentor orientation or informational sessions.

3. Late stipend payments were a concern for NPMs. In order to retain highly skilled NPMs and recruit new NPMs, it is recommended that the program take measures to ensure that stipend payments are made on a regular, timely basis.

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

1. Due to continued low rates of student awareness of AEOPs other than GEMS, the FY15 recommendation is repeated for the program to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. Since students reported that their mentors were key resources for learning about AEOPs, the program should ensure that AEOP informational materials, including the presentation created in FY16 highlighting the AEOP portfolio, reach mentors.

2. The FY16 GEMS participation in the evaluation questionnaire is an area for concern. While the response rates for students were at an acceptable level, it was lower than in FY15. The ongoing low response rates for mentors raise questions about the representativeness of the results. Continued efforts should be undertaken to increase completion of the questionnaire, particularly for mentors. The program should emphasize the importance of evaluations with individual program sites and communicate expectations for evaluation activities. Because of issues with Internet access at GEMS sites, alternative means of questionnaire access for students should be considered. In addition, the evaluation instruments may need to be streamlined as perceived response burden could affect participation.

Introduction

The Army Educational Outreach Program (AEOP) vision is to develop a diverse, agile, and highly competent STEM talent pool. AEOP seeks to fulfill this mission by providing students and teachers nationwide 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. AEOP provides this portfolio of programs via a consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), that engages non-profit, industry, and academic partners with aligned interests. The consortium provides 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.

AEOP Goals

Goal 1: STEM Literate Citizenry.

- Broaden, deepen, and diversify 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.

This report documents the evaluation study of one of the AEOP elements, Gains in the Education of Mathematics and Science (GEMS). The National Science Teachers Association (NSTA) administered the GEMS program in FY16. The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

GEMS, administered in FY16 by the NSTA on behalf of the Army 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). The following overarching mission drives the GEMS program: 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 U.S. Army research laboratories. The various GEMS sites are run independently, with NSTA 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 may set, in addition to the overall program goals, individual laboratory goals. Instead of

prescribing a specific program-wide model and curriculum, individual sites are able to design curricula (using the hands-on, experiment-based model) and procedures that make sense considering the specialties of the facility and available resources. GEMS programs run from one to four weeks in length.

The mentorship model also varies by GEMS site. Many of the GEMS sites use Army scientists and engineers (Army S&Es) to lead GEMS educational activities while other sites use Near Peer Mentors (NPMs) as a key element in their instructional model. NPMs are developing scientists and engineers (college and high school students) 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). RTs assist Army S&Es and NPMs in translating STEM research, STEM concepts, and STEM practices into educational curricula as well as provide coaching and instructional supervision to 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 roles and 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 participants;
3. To implement STEM-enrichment experiences using 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 increase the number of 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 sites involved 14 Army research centers and laboratories operating in 7 states (see Table 1). In 2016, GEMS provided outreach to 2,427 students at 11 different sites. This number represents a 6% increase in enrollment from 2015 when 2,270 students participated in GEMS and a 14% increase from 2014 when 2,095 students participated in GEMS. GEMS sites continued to receive applications from more qualified students than they could serve. A total of 4,414 applications were submitted in 2016, an increase of 6% from 2015 when 4,161 GEMS applications were submitted. This represents an increase of 24% over the 3,343 applications submitted in 2014. Table 2 provides the application and participation data by GEMS site for 2016. In addition to student participants, there were 345 adults working in the program across the various sites.

Table 1. 2016 GEMS Sites		
Laboratory	**Command***	**Location**
U.S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC)	RDECOM	Huntsville, AL
U.S. Army Research Laboratory (ARL-APG)/ US Army Medical Research Institute of Chemical Defense (USAMRICD)/ U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC)	RDECOM/USAMRMC	Aberdeen, MD
U.S. Army Research Laboratory- Adelphi (ARL-Adelphi)	RDECOM	Adelphi, MD
U.S. Army Research Laboratory- White Sands Missile Range (ARL-WSMR) and (Army Test and Evaluation Command - WSMR)	RDECOM / ATEC	White Sands, NM
U.S. Army Aeromedical Research Laboratory (USAARL)	USAMRMC	Fort Rucker, AL
U.S. Army Medical Research and Material Command at Fort Detrick (USAMRMC-Ft. Detrick)	USAMRMC	Fort Detrick, MD
U.S. Army Research Institute for Surgical Research (USAISR)	USAMRMC	Fort Sam Houston, TX
U.S. Army Research Institute for Environmental Medicine (USARIEM) U.S. Army Natick Soldier Research, Development & Engineering Center (NSRDEC)	USAMRMC / RDECOM	Natick, MA
Walter Reed Army Institute of Research (WRAIR)	USAMRMC	Silver Spring, MD
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: "USAMRMC" is the Medical Research and Materiel Command, "RDECOM" is the Research Development and Engineering Command, and "USACE" is the U.S. Army Corps of Engineers.

Table 3 displays demographic information for enrolled GEMS participants in 2016. Overall demographics for 2016 are similar to those of 2015, although enrollment grew from 2,270 to 2,427, an increase of 6%. The percentage of females in 2016 was 45%, compared with 45% in 2015, and 23% of participants identified as Black or African American compared with 22% in 2015. There was little change in enrollment of students identifying themselves as Hispanic or Latino (9% in 2015 and 8% in 2016). The proportion of students receiving free or reduced price lunch was also similar (11% in 2015 and 10% in 2016).

Table 2. 2016 GEMS Site Applicant and Enrollment Numbers			
Command	**2016 GEMS Site**	**Number of Applicants**	**Number of Enrolled Participants**
RDECOM	Army Aviation and Missile Research Development and Engineering Center (AMRDEC)	204	128
	Aberdeen Proving Ground (ARL-APG) †	618	264
	Army Research Laboratory-Adelphi (ARL-Adelphi)	252	171
	White Sands Missile Range (ARL-WSMR)	162	72
MRMC	Army Aeromedical Research Laboratory (USAARL)	489	383
	Army Medical Research and Material Command at Fort Detrick (USAMRMC-Ft. Detrick)	888	475
	Army Research Institute for Surgical Research (USAISR)	179	110
	Army Research Institute for Environmental Medicine (USARIEM)	363	198
	Walter Reed Army Institute of Research (WRAIR)	1104	521
USACE	Engineer Research & Development Center- Construction Engineering Research Laboratory (ERDC-CERL)	46	32
	Engineer Research & Development Center-Mississippi (ERDC-MS)	109	73
TOTAL		**4,414**	**2,427**

† *The United States Army Medical Research Institute of Chemical Defense (USAMRICD) and the U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC) collaborates with the US Army Research Laboratory (ARL-APG) to host GEMS at Aberdeen Proving Grounds (APG).*

Table 3. 2016 GEMS Enrolled Student Profile		
Demographic Category	GEMS Participants	
Respondent Gender (n=2427)		
Female	1104	46%
Male	1314	54%
Choose not to report	9	<1%
Respondent Race/Ethnicity (n=2427)		
Asian	401	17%
Black or African American	566	23%
Hispanic or Latino	196	8%
Native American or Alaska Native	15	1%
Native Hawaiian or Other Pacific Islander	15	1%
White	1021	42%
Other race or ethnicity	109	4%
Choose not to report	117	5%
School Setting (n=2427)		
Urban (city)	575	24%
Suburban	1,460	60%
Rural (country)	256	11%
Frontier or Tribal School	0	0%
DoDDS/DoDEA School	27	<1%
Home School	105	4%
Online School	4	<1%
Choose not to Report	575	24%
Respondent Eligible for Free/Reduced-Price Lunch (n=2427)		
Yes	250	10%
No	2039	84%
Choose not to report	138	6%

The total cost of the 2016 GEMS program was $1,040,482, which includes administrative costs to NSTA, costs to participating labs for supplies, student stipends and RT and NPM stipends. The cost per GEMS student was $429. Aligned with the rates of similar AEOP initiatives, GEMS provides student participants with a stipend of $100 per week. Table 4 summarizes these and other 2016 GEMS program costs.

Table 4. 2016 GEMS Program Costs	
2016 GEMS Students – Cost Per Participant	
Number of Students	2,427
Total Cost	$1,010,121
Cost Per Participant (Student)	$**416**
2016 GEMS Students, Near-Peer Mentors, and Resource Teachers – Cost Per Participant	
Number of Students	2,427
Number of Adults (Team Advisors and Volunteers – including S&Es and Teachers)	345
Grand Total Participants	2,772
Cost Per Participant	**$319**
2016 GEMS Cost Breakdown	
Participant Stipends (Students, NPMs and RTs)	$706,411
Administration	$159,679
Materials, Supplies, Equipment, and Transportation	$144,031

Evidence-Based Program Change

NSTA developed a set of program objectives for GEMS based upon the AEOP's key priorities. The objectives, and activities undertaken in support of these objectives, include the following:

I. **Increase the number of student applicants and participants – particularly those from underserved and underrepresented populations. (Supports Priority 1, Objectives A, C, & D; Priority 3, Objective B)**

a. 2016 activities to support priority:
   i. Targeted potential students with social media advertising around GEMS locations.
   ii. Provided outreach materials to Local Program Coordinators (LPCs) for distribution at schools and community events.
   iii. Used customer service data to create solutions to registration problems.

b. Outcomes:
   i. FY 16 target participation of 2,600; actual participation of 2,427.
   ii. FY16 target applications of 3,750; actual applications of 4,414.
   iii. FY16 target of underserved and under-represented students of 65%; actual underserved and under-represented students served of 10%.

II. **Increase number of GEMS sites.**

a. Maintained 11 sites through IPA transition (this objective was not part of the FY16 directive).

III. **Increase Camp Invention (CI) Alumni participation in GEMS. (Supports Priority 1, Objectives A, B, C, & D)**

a. 2016 activities to support priority:
   i. Hosted conference calls with 8 of 10 LPCs near AEOP-sponsored location.

ii. CI invited each LPC to conduct site visits at their nearby sponsored location.
iii. Advocated for future selection of CI participants into local GEMS programs.

b. FY16 target participation of 20%; actual of 4%.

IV. **Increase participants' awareness of other AEOP opportunities. (Supports Priority 1, Objective F)**

a. Provided marketing materials, like brochures and a presentation, to LPCs to incorporate in curriculum.
b. Advocated for AEOP programs in locations where they seemed like a good fit (e.g., SEAP to replace a four-week internship that lost funding in Vicksburg).

V. **Increase participants' awareness of Army and DoD STEM Careers. (Supports Priority 1, Objective F)**

a. Local Scientists and Engineers (S&E) interacted with students during GEMS programming.

VI. **Increase participants' interest in future STEM activities. (Supports Priority 1, Objective E)**

a. Conducted hands-on, exploratory activities in GEMS curriculum.

FY16 Evaluation At-A-Glance

Purdue University, in collaboration with NSTA, 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 • NSTA providing oversight of site programming • Operations conducted by 14 Army research laboratories operating at 11 sites in 8 states • 2,427 Students participating in GEMS programs • 345 adults including Army S&Es, Near Peer Mentors, 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 • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• 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 Teachers serving as mentors in GEMS • Number and Title 1 status of schools served through participant engagement • Students, mentors, site coordinators, and NSTA 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' positive attitudes toward STEM?
  - Increase students' interest in future STEM learning?
  - 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 student and mentor questionnaires, 3 focus groups with students and 3 with mentors, and 1 Annual Program Report (APR) prepared by NSTA using data from all GEMS sites. Tables 5-9 outline the information collected in student and mentor questionnaires and focus groups, as well as information from the APR that is relevant to this evaluation report.

Table 5. 2016 Student Questionnaires

Category	Description
Profile	Demographics: Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	Capturing the Student Experience: In-school vs. In-GEMS experience (students)
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of GEMS to gains (impact)
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of GEMS to gains (impact)
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of GEMS, impact of AEOP resources
	Army/DoD STEM: Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of GEMS, impact of AEOP resources
AEOP Goal 2 and 3	Mentor Capacity: Perceptions of mentor/teaching strategies (students respond to a subset)
	Comprehensive Marketing Strategy: How students learn about GEMS, motivating factors for participation, impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 6. 2016 Mentor Questionnaires	
Category	Description
Profile	Demographics: Participant gender, race/ethnicity, 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	Capturing the Student Experience: In-program experiences for students
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of GEMS to gains (impact)
	Transferrable Competencies: Gains in 21st Century Skills
	AEOP Opportunities: Past participation, awareness of other AEOP programs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of GEMS to gains (impact)
	Army/DoD STEM: Attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of GEMS in changing student Army/DoD career metrics (impact)
AEOP Goal 2 and 3	Mentor Capacity: Perceptions of mentor/teaching strategies (mentors)
	Comprehensive Marketing Strategy: How mentors learn about GEMS, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers

Table 7. 2016 Student Focus Groups	
Category	Description
Profile	Gender, race/ethnicity, grade level, past participation in GEMS, past participation in other AEOP programs
Satisfaction & Suggestions	Awareness of GEMS, motivating factors for participation, involvement in other programs in addition to GEMS, satisfaction with and suggestions for improving GEMS programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	Army STEM: AEOP Opportunities – Extent to which students were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers– Extent to which students were exposed to STEM and Army/DoD STEM jobs

Table 8. 2016 Mentor Focus Groups	
Category	Description
Profile	Gender, race/ethnicity, occupation, organization, role in GEMS, past participation in GEMS, past participation in other AEOP programs
Satisfaction & Suggestions	Perceived value of GEMS, benefits to participants, suggestions for improving GEMS programs
AEOP Goal 1 and 2 Program Efforts	Army STEM: AEOP Opportunities – Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in GEMS

Table 9. 2016 Annual Program Report	
Category	Description
Program	Description of course content, activities, and academic level
AEOP Goal 1 and 2 Program Efforts	Underserved Populations: mechanisms for marketing to and recruitment of students from underserved populations
	Army STEM: Army/DoD STEM Careers – Career day exposure to Army STEM research and careers; Participation of Army engineers and/or Army research facilities in career day activities
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

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 are 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. Focus group protocols are provided in Appendices B (students) and C (mentors) and survey instruments are provided in Appendix D (students) and E (mentors). Major trends in data and analyses are reported herein.

Study Sample

Table 10 provides an analysis of student and mentor participation in the GEMS questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). The margin of error for the mentor questionnaire is larger than generally acceptable, indicating that the sample may not be representative of the population of GEMS mentors. The mentor response rate for the 2016 questionnaire is only slightly higher than that of 2015 when 6% of mentors responded. The student response rate for 2016 was satisfactory, although at 74% was lower than the 2015 response rate of 93% and the 2014 response rate of 91%.

Table 10. 2016 GEMS Questionnaire Participation				
Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[1]
Students	1,802	2,427	74%	±1.17%
Mentors	28	345	8%	±17.8%

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

The student questionnaire response rate of 74% and corresponding margin of error of ±1.17% provide evidence that the questionnaire results are generalizable to the population of participants. In contrast, the response rate for the mentor survey was only 8%, with a larger than acceptable margin of error. Because of the small number of responses to the mentor survey, caution is warranted when interpreting these data, as the responses may not be representative of the mentor population participating in the GEMS program.

Three student focus groups were conducted at 3 GEMS sites. Student focus groups included 24 students (11 females, 13 males). Three mentor focus groups were also conducted at 3 sites and included 11 mentors (9 females, 2 males). The participating mentors included 8 NPMs and 3 instructors who were Army S&Es. Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of questionnaire data. They add to the overall narrative of GEMS's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Student demographics. The group of students who responded to the questionnaire were similar in demographic makeup to the population of enrolled participants (see Table 11). For example, 45% of questionnaire respondents were female as compared to 46% of enrolled GEMS participants. Likewise, 22% of questionnaire respondents identified themselves as Black or African American and 8% as Hispanic or Latino compared with 23% and 8% of enrolled participants. Students who responded to the questionnaire also came from similar school settings as did the overall population of enrolled participants (see Table 12). For example, 22% of respondents attended urban schools and 68% urban schools as compared with 24% and 60% of enrolled GEMS participants.

"I am very satisfied with my GEMS experience. I felt I was exposed to STEM topics I had not seen in school. However, what I enjoyed the most was interacting with the near peers and other students. I enjoyed talking about the paths they have taken to pursue STEM and learning more about opportunities in STEM." – GEMS Student

Table 11. 2016 GEMS Student Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 1,802)		
Female	804	44.6%
Male	943	52.3%
Choose not to report	55	3.1%
Respondent Race/Ethnicity (n = 1,802)		
Asian	274	15.2%
Black or African American	399	22.1%
Hispanic or Latino	139	7.7%
Native American or Alaska Native	16	.9%
Native Hawaiian or Other Pacific Islander	7	.4%
White	742	41.2%
Other race or ethnicity	112	6.2%
Choose not to report	113	6.3%
Respondent Grade Level (n = 1,802)		
4th	41	2.3%
5th	118	6.5%
6th	212	11.8%
7th	285	15.8%
8th	315	17.5%
9th	347	19.3%
10th	228	12.7%
11th	160	8.9%
12th	62	3.4%
First-Year College Student	11	.6%
Choose not to report	20	1.2%
Respondent Eligible for Free/Reduced-Price Lunch (n = 408)		
Yes	32	7.8%
No	343	84.1%
Choose not to report	33	8.1%

Table 12. 2016 GEMS Student Respondent School Information		
Demographic Category	Questionnaire Respondents	
Respondent School Location (n = 408)		
Urban (city)	91	22.3%
Suburban	279	68.4%
Frontier or tribal school	0	0.0%
Rural (country)	22	5.4%
Home school	14	3.4%
Online school	2	.5%
Department of Defense school (DoDDS or DoDEA)	0	0%

At enrollment, students were asked how many times they participated in each of the AEOP programs. Table 13 displays the results for participants who provided this information and shows that 38% of responding students reported participating in GEMS at least once. Very few students reported participating in any of the other AEOPs although 23% reported having participated in other STEM programs in the past.

Table 13. Student Participation in AEOP Programs (n=408)

	Response Percent	Response Total
Camp Invention	2.45 %	10
eCYBERMISSION	2.94 %	12
Junior Solar Sprint (JSS)	0.25 %	1
Gains in the Education of Mathematics and Science (GEMS)	37.74 %	154
UNITE	0.25 %	1
Junior Science & Humanities Symposium (JSHS)	0.25 %	1
Science & Engineering Apprenticeship Program (SEAP)	0.00 %	0
Research & Engineering Apprenticeship Program (REAP)	0.00 %	0
High School Apprenticeship Program (HSAP)	0.00 %	0
College Qualified Leaders (CQL)	0.00 %	0
Undergraduate Research Apprenticeship Program (URAP)	0.00 %	0
Science Mathematics & Research for Transformation (SMART)	0.00 %	0
I've never participated in any AEOP programs	47.55 %	194
Other STEM Program	23.05 %	94

Mentor respondents. Table 14 summarizes demographics, occupations, and roles in GEMS for responding mentors. Most mentors who responded to the questionnaire were women (80%) and over half (65%) identified themselves as White, while 25% identified themselves as Black or African American and 10% as Asian. Over half of respondents (60%) were scientists, engineers, or mathematicians in training. Accordingly, 75% of these respondents served as NPMs in the program.

Table 14. 2016 GEMS Mentor Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 20)		
Female	16	80%
Male	4	20%
Respondent Race/Ethnicity (n = 20)		
Asian	2	10%
Black or African American	5	25%
Native American or Alaskan Native	0	0%
Native Hawaiian or other Pacific Islander	0	0%
White or Caucasian	13	65%
Other	0	0%
Respondent Occupation (n = 28)		
Teacher	4	14%
Other school staff	1	4%
University educator	1	4%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	17	60%
Scientist, Engineer, or Mathematics professional	1	4%
Other	4	14%
Respondent Role in GEMS (n = 28)		
Instructor (typically a University or Army Scientist or Engineer)	0	0%
Classroom Assistant	0	0%
Resource teacher (RT)	3	11%
Near peer mentor (NPM)	21	75%
Assistant Near peer mentor	1	4%
Other	3	10%

Actionable Program Evaluation

The 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 and AEOP Goal 1 & 2 Program Efforts sections of Tables 5-9.

A focus of the Actionable Program Evaluation is 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 underrepresented and 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. The following sections report perceptions of students, mentors, and site program coordinators (from the APR) that pertain to current programmatic efforts, as well as recommendations for evidence-based improvements to help GEMS achieve its desired outcomes.

Marketing and Recruiting

The FY16 Annual Program Report details several strategies that were used to disseminate information about the GEMS program. Outreach efforts included the following:

- The Facebook advertising campaign was an effort to increase participation in FY16. Marketing collateral was also provided to LPCs to assist with outreach. This collateral included individual site flyers and business cards. Additional marketing included AEOP collateral such as brochures and rack cards.
- LPC and IPA sent emails to past participants.
- NSTA assisted in the San Antonio and Champaign areas by identifying and making connections with local school leaders. The IPA also established a toll-free number (1-800-807-9852) and email helpdesk (aeopgems@nsta.org) to encourage the completion of registrations.
- Sites conduct opportunistic outreach in their communities. For example:
  - ✓ The Fort Rucker location found a partnering school to promote the program during morning announcements time.
  - ✓ The Silver Spring staff attended multiple science fairs as judges to promote the program.

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In order to understand which outreach and recruitment methods are most effective, the questionnaire asked students to indicate how they learned about AEOP. Table 15 summarizes students' responses. Other than past participation (35% of respondents), the most frequently reported source of information about the local GEMS program were personal connections, including a friend (38%), past participant of the program (35%), and family member (34%). Other frequently reported sources included the AEOP website (19%) and a school or university newsletter, email, or website (17%).

Table 15. How Students Learned about AEOP (n=408)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	18.63 %	76
AEOP on Facebook, Twitter, Instagram, or other social media	2.94 %	12
School or university newsletter, email, or website	17.16 %	70
Past participant of program	34.56 %	141
Friend	37.50 %	153
Family Member	34.07 %	139
Someone who works at the school or university I attend	8.33 %	34
Someone who works with the program	6.86 %	28
Someone who works with the DoD (Army, Navy, Air Force, etc.)	11.03 %	45
Community group or program	5.88 %	24
Choose Not to Report	0.74 %	3

The responses of student focus group participants who were asked how they learned about GEMS focused on personal relationships and teacher recommendations. For example,

> *[I learned about GEMS from] one of my friends; she's a grade above me. She did it the summer before [and] she recommended it.* (GEMS Student)
>
> *I did [GEMS] because my science teacher recommended me for it.* (GEMS Student)
>
> *My mom recommended [GEMS]. She probably heard it from work because she works here.* (GEMS Student)
> *I heard [about GEMS] from my friend because she did it once before, somewhere else. Her mom recommended it to my mom, and she looked into it.* (GEMS Student)

Mentors were also asked how they learned about AEOP (see Table 16). Mentors reported learning about AEOP in various ways including through a school or university newsletter, email, or website (40%); through someone who works with the program (40%); from a past participant of the program (35%); and from someone who works in the DoD (30%).

Table 16. How Mentors Learned About AEOP (n=20)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	15.00 %	3

AEOP on Facebook, Twitter, Instagram, or other social media	0.00 %	0
School or university newsletter, email, or website	40.00 %	8
Past participant of program	35.00 %	7
Friend	6.82 %	3
Family Member	15.00 %	5
Someone who works at the school or university I attend	10.00 %	2
Someone who works with the program	40.00 %	8
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	30.00 %	6
Community group or program	5.00 %	1
Choose Not to Report	5.00 %	1

Motivating Factors for Participation

Students were asked both in questionnaires and in focus groups what motivated them to participate in GEMS. Specifically, the questionnaire asked how motivating a number of factors were in their decision to participate. Table 17 indicates the factors that students rated the most motivating for their GEMS participation. A large majority of students indicated that an interest in STEM (92%) and the desire to learn something new or interesting (90%) were motivators. About three-quarters of responding students (74%) indicated that learning in ways not possible in school motivated them to participate in GEMS. The opportunity to use advanced laboratory technology (67%) and the desire to expand laboratory or research skills (64%) were also relatively frequently mentioned motivators. Students also cited career interest and information as motivators, with over half citing exploring a unique work environment (53%), figuring out education or career goals (59%), and over a third (34%) citing interest in STEM careers with the Army as a motivator for GEMS participation.

Table 17. Factors Motivating Student Participation in GEMS (n=408)

	Response Percent	Response Total
Teacher or professor encouragement	17.65 %	72
An academic requirement or school grade	2.21 %	9
Desire to learn something new or interesting	90.20 %	368
The mentor(s)	11.27 %	46
Building college application or résumé	38.97 %	159
Networking opportunities	25.00 %	102
Interest in science, technology, engineering, or mathematics (STEM)	91.67 %	374
Interest in STEM careers with the Army	34.07 %	139
Having fun	68.63 %	280
Earning stipends or awards for doing STEM	29.17 %	119
Opportunity to do something with friends	25.74 %	105
Opportunity to use advanced laboratory technology	67.40 %	275
Desire to expand laboratory or research skills	63.97 %	261
Learning in ways that are not possible in school	73.77 %	301
Serving the community or country	33.82 %	138
Exploring a unique work environment	53.43 %	218
Figuring out education or career goals	59.31 %	242
Seeing how school learning applies to real life	53.43 %	218
Recommendations of past participants	19.85 %	81
Choose Not to Report	0.25 %	1

Student focus group participants expanded on some of these reasons for participating in GEMS, focusing on opportunities for learning about STEM and about STEM careers. For example:

> *I chose to participate because I'm interested in STEM. I like playing with stuff like the electric car and the fuel cell. I found that kind of stuff really interesting.* (GEMS Student)

> *[I chose to participate in GEMS] this year because I was interested in going into the biomedical field…I wanted to understand what it was, and see if I'm actually interested in it or not.* (GEMS Student)

> *I participated because I want to be a mechanical engineer when I grow up. I think this camp will help me get a better understanding of what, exactly, that is.* (GEMS Student)

The GEMS Experience

The student questionnaire included several items asking students about the nature of the activities they participated in during their GEMS experience and how those experiences compared to their STEM learning opportunities in school.

Table 18 summarizes student responses to a questionnaire item asking them about the nature of their activities in GEMS. Learning about STEM topics new to them was the most cited (87% of respondents) activity that students participated in "every day" or "most days." A similar majority of students indicated that they participated with this frequency in activities such as communicating with other students about STEM (81%), learning about careers that use STEM (76%), and interacting with scientists and engineers (73%). Mentors were asked a parallel item on the questionnaire and reported overall higher frequencies of student opportunities to engage in these activities than students reported.[2]

> *"GEMS lets me see what it feels like to do research and be a part of the scientific community."* – GEMS Student

[2] Because of the relatively low response rates on the mentor questionnaire, it is impossible to determine whether any differences between the two datasets are real or an artifact of which mentors provided data. In addition, since mentors typically worked with multiple students, it is not clear which students' mentors were considering when responding to these items.

Table 18. Nature of Student Activities in GEMS (n=1,747-1,774)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	1.3%	3.4%	8.1%	20%	67.2%	
	23	60	144	354	1193	**1774**
Apply STEM learning to real-life situations	2.5%	5.8%	13.9%	26.2%	51.6%	
	45	103	247	464	912	**1771**
Learn about new discoveries in STEM	3.1%	6.3%	14.6%	26.1%	49.9%	
	54	112	257	461	880	**1764**
Learn about different careers that use STEM	2.7%	6.7%	14.5%	22.3%	53.8%	
	47	117	254	390	941	**1749**
Interact with scientists or engineers	5.2%	7.9%	14.5%	20.8%	51.6%	
	90	138	253	363	903	**1747**
Communicate with other students about STEM	3.5%	4.2%	10.7%	14.3%	67.3%	
	61	75	189	253	1190	**1768**

Since exposing students to STEM careers in the Army and DoD is one objective of the GEMS program, student participants in focus groups were asked about how they learned about STEM research and careers in GEMS. Student responses to this question focused on having the opportunity to hear a variety of speakers and to visit labs. The student questionnaire asked how many jobs/careers in STEM in general, and how many STEM jobs/careers in the DoD more specifically, students learned about during their experience. Table 19 provides summaries of these data from 2014 through 2016. Nearly all students (97%) reported learning about at least one STEM job/career in 2016, and most (59%) reported learning about five or more. A smaller number (84%) reported learning about at least one DoD STEM job/career and 25% reported learning about 5 or more DoD STEM careers. These data are similar to student responses for 2014 and 2015 although somewhat fewer students reported learning about 5 or more STEM careers or DoD STEM careers in 2016 than in previous years.

Table 19. Number of STEM Jobs/Careers Students Learned about During GEMS						
	STEM Jobs/Careers			DoD STEM Jobs/Careers		
	2014 (n =1,745)	2015 (n=2,081)	2016 (n=1,102)	2014 (n = 1,653)	2015 (n=1,902)	2016 (n=1,102)
None	2%	2%	3%	16%	13%	16%
1	3%	2%	5%	9%	9%	14%
2	6%	6%	11%	13%	16%	19%
3	12%	13%	12%	20%	18%	18%
4	11%	13%	10%	9%	12%	8%
5 or more	66%	64%	59%	33%	32%	25%

For the evaluation further analysis of these items was conducted to determine the difference in experiences for GEMS participants by GEMS site. Table 20 illustrates the number of STEM Jobs/Careers that participants learned about by site and Table 21 displays the number of DoD STEM Jobs/Careers participants learned about by site. Most sites did expose students to STEM careers. However, students reported learning about fewer DoD STEM Jobs/Careers specifically.

Table 20. Number of STEM Jobs/Careers Students Learned about During GEMS by Site							
	STEM Jobs/Careers						
Site (participants)	NR	0	1	2	3	4	5+
ALABAMA - U.S. Army Aeromedical Research Laboratory (USAARL) - Fort Rucker, AL (n=367)	0%	2%	4%	9%	21%	18%	46%
ALABAMA - U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) - Redstone, AL (n=2)	0%	0%	0%	0%	0%	0%	100%
NEW MEXICO – White Sands Missile Range (ARL-WSMR) and (ATEC-WSMR) (n=62)	0%	0%	2%	5%	2%	12%	79%
VICKSBURG, MS - Engineer Research & Development Center - Vicksburg, MS (ERDC-MS) (n=29)	0%	4%	0%	19%	16%	19%	42%
ILLINOIS - U.S. Army Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL) - Champaign, IL (n=25)	52%	0%	0%	8%	12%	0%	28%
MARYLAND - Aberdeen Proving Ground (APG) – (ARL) and (CERDEC) and (USAMRICD) Aberdeen, MD (n=230)	2%	5%	4%	7%	9%	9%	64%
MARYLAND - U.S. Army Medical Research and Materiel Command - Walter Reed Army Institute of Research (WRAIR) - Silver Spring, MD (n=363)	17%	7%	10%	10%	9%	8%	39%
MARYLAND - U.S. Army Medical Research and Materiel Command (USAMRMC) - Fort Detrick, MD (n=583)	6%	1%	2%	12%	11%	8%	60%

MASSACHUSETTS - U.S. Army Institute of Environmental Medicine (USARIEM) - Natick, MA (n=2)	0%	0%	0%	50%	0%	0%	50%
TEXAS - U.S. Army Institute of Surgical Research (USAISR) – Ft. Sam Houston, TX (n=91)	0%	0%	2%	2%	13%	39%	44%

Table 21. Number of DoD STEM Jobs/Careers Students Learned about During GEMS by Site

	DoD STEM Jobs/Careers						
Site (participants)	**NR**	**None**	**1**	**2**	**3**	**4**	**5+**
ALABAMA - U.S. Army Aeromedical Research Laboratory (USAARL) - Fort Rucker, AL (n=367)	0%	11%	11%	18%	20%	15%	25%
ALABAMA - U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) - Redstone, AL (n=1)	0%	0%	0%	0%	0%	100%	0%
NEW MEXICO – White Sands Missile Range (ARL-WSMR) and (ATEC-WSMR) (n=62)	0%	2%	3%	5%	18%	18%	54%
VICKSBURG, MS - Engineer Research & Development Center - Vicksburg, MS (ERDC-MS) (n=29)	0%	24%	10%	14%	7%	14%	31%
ILLINOIS - U.S. Army Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL) - Champaign, IL (n=25)	52%	0%	8%	8%	12%	4%	16%
MARYLAND - Aberdeen Proving Ground (APG) – (ARL) and (CERDEC) and (USAMRICD) Aberdeen, MD (n=230)	3%	15%	6%	14%	15%	11%	36%
MARYLAND - U.S. Army Medical Research and Materiel Command - Walter Reed Army Institute of Research (WRAIR) - Silver Spring, MD (n=363)	17%	28%	12%	13%	11%	4%	15%
MARYLAND - U.S. Army Medical Research and Materiel Command (USAMRMC) - Fort Detrick, MD (n=583)	7%	7%	14%	21%	19%	8%	24%
MASSACHUSETTS - U.S. Army Institute of Environmental Medicine (USARIEM) and NSRDEC - Natick, MA (n=2)	0%	50%	0%	50%	0%	0%	0%
TEXAS - U.S. Army Institute of Surgical Research (USAISR) – Ft. Sam Houston, TX (n=91)	0%	3%	9%	13%	30%	28%	17%

Students were asked to indicate which resources impacted their awareness of DoD STEM careers (see Table 22). The most impactful resource was perceived by students to be participation in GEMS, with 76% of students reporting this to being somewhat or very much important to their awareness of DoD STEM careers. Over half of respondents indicated that their mentors (64%) and invited speakers or career events (62%) were somewhat or very much impactful. Only about a quarter of students (26%) indicated that the AEOP website was at least somewhat helpful in their awareness of DoD STEM careers, and only small percentages of students found other AEOP resources such as the AEOP brochure

(14%), AEOP on social media (8%), or the It Starts Here! magazine (7%) at least somewhat impactful. Data from the mentor questionnaire showed similar results, with program participation, invited speakers or career events, and GEMS program administrator or site coordinator chosen most frequently as impactful resources.

The questionnaire also asked students how often they engaged in various STEM practices during GEMS (see Table 23). Students reported high levels of engagement in most of these practices, with a majority of students indicating that they had engaged in the activities each on most days or every day with the exception of building or making a computer model (29%). For example, 95% of responding students reported working as part of a team, 92% reported participating in hands-on STEM activities, and 85% reported using laboratory tools and procedures most days or every day of their GEMS experience.

Table 22. Impact of Resources on Student Awareness of DoD STEM Careers (n=1,714-1,727)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	49.9%	9.4%	15.2%	13.6%	11.9%	
	859	162	261	234	205	**1721**
AEOP on Facebook, Twitter, Pinterest or other social media	77.8%	9.4%	5%	4.8%	3%	
	1339	162	86	83	51	**1721**
AEOP brochure	67.5%	8.6%	9.8%	7.9%	6.2%	
	1160	148	168	136	107	**1719**
It Starts Here! Magazine	79.5%	8.6%	5%	3.6%	3.3%	
	1362	148	85	62	57	**1714**
My GEMS mentor(s)	14.4%	5.2%	16.4%	21.7%	42.3%	
	247	90	281	373	725	**1716**
Invited speakers or "career" events during GEMS	22.9%	4.6%	11.2%	18.8%	42.5%	
	395	79	193	324	736	**1727**
Participation in GEMS	9.5%	3.8%	10.6%	18.7%	57.4%	
	164	65	182	323	989	**1723**

Table 23. Student Engagement in STEM Practices in GEMS (n=1,750-1,770)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Use laboratory procedures and tools	3.8%	4.5%	7%	18.9%	65.8%	
	68	80	124	334	1164	**1770**
Participate in hands-on STEM activities	1.1%	2.2%	5.3%	14.6%	76.8%	
	19	39	93	259	1358	**1768**
Work as part of a team	0.3%	1.6%	4.9%	13.7%	79.5%	
	6	29	86	241	1403	**1765**
Identify questions or problems to investigate	2.4%	4.4%	12.1%	22.2%	58.9%	
	43	78	214	390	1039	**1764**
Design an investigation	10.7%	10.6%	14.8%	22.4%	41.5%	
	188	186	260	395	733	**1762**
Carry out an investigation	7.1%	7.3%	13%	20.9%	51.7%	
	125	129	228	368	910	**1760**
Analyze data or information	3.2%	5.2%	11.3%	21.8%	58.5%	
	56	91	199	383	1030	**1759**
Draw conclusions from an investigation	5.4%	6.9%	12.1%	22.8%	52.8%	
	94	121	211	399	925	**1750**
Come up with creative explanations or solutions	3.4%	4.9%	12.8%	22%	56.9%	
	59	87	226	387	1001	**1760**
Build or make a computer model	51.1%	10.2%	10.3%	10.5%	17.9%	
	898	180	182	185	314	**1759**

A composite score[3] was calculated for each set of items, the first titled "Learning about STEM in GEMS,"[4] and the second "Engaging in STEM Practices in GEMS."[5] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and calculating the average across all items in the scale. The composite scores were used to test whether there were differences in student experiences by gender and race/ethnic group (minority vs. non-minority students). Significant differences were found by gender in terms of GEMS Engagement with females reporting significantly higher views than males (small effect size; d = 0.201 standard deviations[6]).[7] There were no significant differences found by race/ethnicity in terms of Learning about STEM in GEMS.

To examine how the GEMS experience compares to their typical school experience, students were asked how often they engaged in the same activities in school. These responses were also combined into two composite variables: "Learning about STEM in School,"[8] and "Engaging in STEM Practices in School"[9] that are parallel to those about GEMS. As can be seen in Chart 1, scores were significantly higher on the "in GEMS" versions of both composites than on the "in school" versions with large effects of d = 2.24 standard deviations for Learning about STEM and d = 1.96 standard deviations for Engaging in STEM Practices.[10] These findings indicate that GEMS provides students with more intensive STEM learning experiences than they would typically receive in school.

[3] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.

[4] The Cronbach's alpha reliability for these 6 items was 0.849.

[5] The Cronbach's alpha reliability for these 10 items was 0.884.

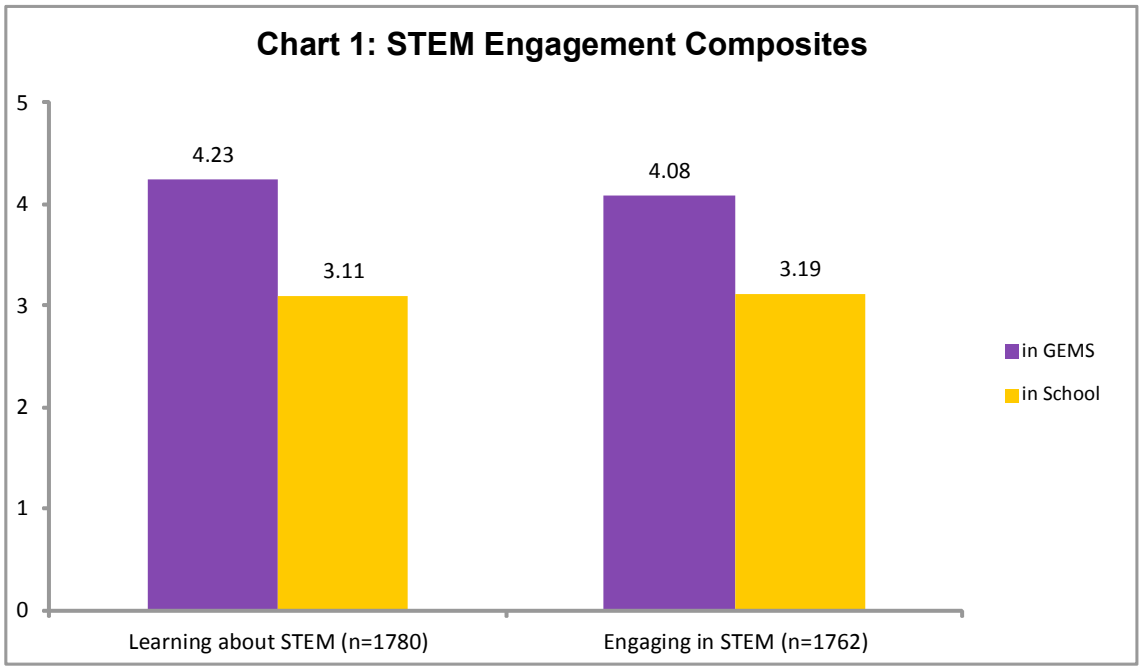
[6] Effect size calculated as Cohen's d: the difference in means of the two groups divided by the pooled standard deviation. Effect sizes of about 0.20 are typically considered small, 0.50 medium, and 0.80 large. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

[7] Independent samples t-test for STEM Knowledge: Gender $t(1679)=4.11$, $p<.001$.

[8] Cronbach's alpha reliability of 0.863.

[9] Cronbach's alpha reliability of 0.913.

[10] STEM Learning dependent samples t-test: $t(1779)=47.29$, $p<.001$. STEM Engagement dependent samples t-test: $t(1761)=41.09$, $p<.001$.



The Role of Mentors

Mentors, including NPMs, RTs, and site directors, play a critical role in the GEMS program in terms of students' engagement in STEM, their sustained interest in STEM, and their inspiration to pursue STEM careers in the future. The nature and quality of the various supports provided by these individuals is a key component in students' GEMS experiences. Mentors were therefore asked whether they used a number of strategies when working with students. These strategies comprised five main areas of effective mentoring:[11]

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

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

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

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

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

A large majority of responding mentors reported using strategies to help make the learning activities in GEMS relevant to students (see Table 25). All mentors reported becoming familiar students backgrounds and interests at the beginning of the program, while a large majority reported using strategies such as giving students real-life problems to investigate or solve (96%), helping students become aware of the role(s) that STEM plays in their everyday lives (96%), asking students to relate real-life events or activities to topics covered in GEMS (96%), and helping students understand how STEM can help them improve their own community (92%). Fewer mentors reported selecting reading or activities that relate to students' backgrounds (54%). The low response to this item may be due to the structure of the GEMS program in which diverse groups of students work on activities together.

Table 25. Mentors Using Strategies to Establish Relevance of Learning Activities (n=28)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the GEMS experience	100.0%	0.0%	
	28	0	**28**
Giving students real-life problems to investigate or solve	96.4%	3.6%	
	27	1	**28**
Selecting readings or activities that relate to students' backgrounds	53.6%	46.4%	
	15	13	**28**
Encouraging students to suggest new readings, activities, or projects	78.6%	21.4%	
	22	6	**28**
Helping students become aware of the role(s) that STEM plays in their everyday lives	96.4%	3.6%	
	27	1	**28**
Helping students understand how STEM can help them improve their own community	92.9%	7.1%	
	26	2	**28**
Asking students to relate real-life events or activities to topics covered in GEMS	96.4%	3.6%	
	27	1	**28**

Similarly, mentors reported using a variety of strategies to support the diverse needs of students as learners. Table 26 shows mentor responses to this questionnaire item. All mentors reported using a variety of teaching and/or mentoring strategies to meet the needs of all students. Similarly, 96% reported interacting with students and other personnel the same way regardless of their background. Most mentors (86%) also identified the different learning styles of students at the beginning of the GEMS experience. Likewise, a majority of mentors reported using strategies such as providing extra readings, activities, or learning support for students who lack essential background knowledge or skills (78%), integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (71%), and directing students to other individuals or programs for additional support as needed (71%). Just over half of mentors (54%) reported highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM.

Table 26. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=27-28)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the GEMS experience	85.7%	14.3%	
	24	4	**28**
Interact with students and other personnel the same way regardless of their background	96.4%	3.6%	
	27	1	**28**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	27	0	**27**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	71.4%	28.6%	
	20	8	**28**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	77.8%	22.2%	
	21	6	**27**
Directing students to other individuals or programs for additional support as needed	71.4%	28.6%	
	20	8	**28**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	53.6%	46.4%	
	15	13	**28**

Mentors also reported using strategies to support students' development of collaboration and interpersonal skills (see Table 27). All mentors reported having students listen to the ideas of others with an open mind, while a large majority reported using strategies such as having students work on collaborative activities or projects as members of a team (96%), having students work on collaborative activities or projects as a member of a team (96%), and allowing students to resolve conflicts and reach agreement within their team (96%).

Table 27. Mentors Using Strategies to Support Development of Collaboration and Interpersonal Skills (n=28)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	96.4%	3.6%	
	27	1	**28**
Having my student(s) explain difficult ideas to others	92.9%	7.1%	
	26	2	**28**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	28	0	**28**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	96.4%	3.6%	
	27	1	**28**
Having my student(s) give and receive constructive feedback with others	82.1%	17.9%	
	23	5	**28**
Having students work on collaborative activities or projects as a member of a team	96.4%	3.6%	
	27	1	**28**
Allowing my student(s) to resolve conflicts and reach agreement within their team	96.4%	3.6%	
	27	1	**28**

Mentors were also asked about the strategies they used to support student engagement in authentic STEM activities (see Table 28). All responding mentors reported providing students with constructive feedback to improve their STEM competencies and demonstrating laboratory/field techniques, procedures, and tools for students. Nearly all (96%) reported supervising students while they practiced STEM research skills, allowing students to work independently, encouraging students to learn collaboratively, and encouraging students to seek support from other team members. Similar to mentor responses in 2014 and 2015, only 32% reported having students search for and review technical

research to support their work, a phenomenon that may be attributable to resource and time limitations and the nature of the GEMS program activities.

Table 28. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=28)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	78.6%	21.4%	
	22	6	**28**
Having my student(s) search for and review technical research to support their work	32.1%	67.9%	
	9	19	**28**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	28	0	**28**
Supervising my student(s) while they practice STEM research skills	96.4%	3.6%	
	27	1	**28**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	28	0	**28**
Allowing students to work independently to improve their self-management abilities	96.4%	3.6%	
	27	1	**28**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	96.4%	3.6%	
	27	1	**28**
Encouraging students to seek support from other team members	96.4%	3.6%	
	27	1	**28**

The final set of items mentors were asked about their mentoring strategies focused on supporting students' STEM educational and career pathways (see Table 29). All mentors reported asking students about their educational and/or career goals and a large majority reported using strategies such providing guidance about educational pathways that will prepare students for a STEM career (96%), recommending extracurricular programs that align with students' goals (86%), and recommending army educational outreach programs that align with students' goals (86%). Fewer mentors

reported using strategies such as helping students build a professional network in a STEM field (57%) and helping students with resumes, applications, personal statements, and/or interview preparations (43%).

Table 29. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=28)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	100.0%	0.0%	
	28	0	**28**
Recommending extracurricular programs that align with students' goals	85.7%	14.3%	
	24	4	**28**
Recommending Army Educational Outreach Programs that align with students' goals	85.7%	14.3%	
	24	4	**28**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	96.4%	3.6%	
	27	1	**28**
Discussing STEM career opportunities within the DoD or other government agencies	82.1%	17.9%	
	23	5	**28**
Discussing STEM career opportunities in private industry or academia	75.0%	25.0%	
	21	7	**28**
Discussing the economic, political, ethical, and/or social context of a STEM career	71.4%	28.6%	
	20	8	**28**
Recommending student and professional organizations in STEM to my student(s)	75.0%	25.0%	
	21	7	**28**
Helping students build a professional network in a STEM field	57.1%	42.9%	
	16	12	**28**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	42.9%	57.1%	
	12	16	**28**

Mentors were asked which of the AEOP programs they explicitly discussed with their students during GEMS. Predictably, the most frequently discussed programs were GEMS (100%) and GEMS NPMs (93%) as can be seen in Table 30. The other most commonly discussed AEOPs were JSHS (39%) and SEAP (30%). Interestingly, less than a quarter of

mentors discussed other programs for which students are eligible in high school including HSAP (19%), REAP (18%), and UNITE (15%).

Table 30. Mentors Explicitly Discussing AEOPs with Students (n=28)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	100.0%	0.0%	
	28	0	**28**
UNITE	14.8%	85.2%	
	4	23	**27**
Junior Science & Humanities Symposium (JSHS)	39.3%	60.7%	
	11	17	**28**
Science & Engineering Apprenticeship Program (SEAP)	29.6%	70.4%	
	8	19	**27**
Research & Engineering Apprenticeship Program (REAP)	17.9%	82.1%	
	5	23	**28**
High School Apprenticeship Program (HSAP)	18.5%	81.5%	
	5	22	**27**
College Qualified Leaders (CQL)	22.2%	77.8%	
	6	21	**27**
GEMS Near Peer Mentor Program	92.6%	7.4%	
	25	2	**27**
Undergraduate Research Apprenticeship Program (URAP)	23.1%	76.9%	
	6	20	**26**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	14.8%	85.2%	
	4	23	**27**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	15.4%	84.6%	
	4	22	**26**
I discussed AEOP with my student(s) but did not discuss any specific program	59.3%	40.7%	
	16	11	**27**

In support of the AEOP goal of students progressing from GEMS into other AEOPs, mentors were asked how useful various resources were in their efforts to expose students to AEOPs (see Table 31). Participation in GEMS was most

frequently rated as "very useful" (82%), followed by GEMS program administrators or site coordinators (61%) and invited speakers or career events (57%). Fewer mentors (21%) rated the AEOP brochure and AEOP website (18%) as very useful while 64% of mentors had not experienced AEOP on social media and 71% had no experience with the It Starts Here! Magazine.

Table 31. Usefulness of Resources for Exposing Students to AEOPs (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	21.4%	3.6%	21.4%	35.7%	17.9%	
	6	1	6	10	5	**28**
AEOP on Facebook, Twitter, Pinterest or other social media	64.3%	14.3%	7.1%	10.7%	3.6%	
	18	4	2	3	1	**28**
AEOP brochure	17.9%	0.0%	32.1%	28.6%	21.4%	
	5	0	9	8	6	**28**
It Starts Here! Magazine	71.4%	10.7%	7.1%	3.6%	7.1%	
	20	3	2	1	2	**28**
GEMS Program administrator or site coordinator	0.0%	0.0%	10.7%	28.6%	60.7%	
	0	0	3	8	17	**28**
Invited speakers or "career" events	0.0%	0.0%	10.7%	32.1%	57.1%	
	0	0	3	9	16	**28**
Participation in GEMS	3.6%	0.0%	7.1%	7.1%	82.1%	
	1	0	2	2	23	**28**

In accordance with the AEOP and GEMS goal of exposing students to DoD STEM careers, mentors were also asked how useful these resources were for exposing students to DoD STEM careers (see Table 32). As with the previous item, mentors were most likely to rate participation in GEMS as "very much" useful (86%). Invited speakers or "career" events were rated "very much" useful by 75% of respondents while 71% of respondents indicated that the GEMS program administrator or site coordinator was a very valuable resource. Fewer mentors found AEOP materials very useful for this purpose (a range of 4-21%), with a substantial proportion of mentors (32-79%) indicating they did not experience resources such as the AEOP website, the AEOP brochure, AEOP on social media, and the It Starts Here! magazine.

Table 32. Usefulness of Resources for Exposing Student to DoD STEM Careers (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	32.1%	10.7%	25.0%	10.7%	21.4%	
	9	3	7	3	6	**28**
AEOP on Facebook, Twitter, Pinterest or other social media	67.9%	10.7%	10.7%	7.1%	3.6%	
	19	3	3	2	1	**28**
AEOP brochure	33.3%	0.0%	37.0%	11.1%	18.5%	
	9	0	10	3	5	**27**
It Starts Here! Magazine	78.6%	3.6%	7.1%	7.1%	3.6%	
	22	1	2	2	1	**28**
GEMS Program administrator or site coordinator	0.0%	0.0%	14.3%	14.3%	71.4%	
	0	0	4	4	20	**28**
Invited speakers or "career" events	0.0%	0.0%	7.1%	17.9%	75.0%	
	0	0	2	5	21	**28**
Participation in GEMS	0.0%	0.0%	3.6%	10.7%	85.7%	
	0	0	1	3	24	**28**

Mentor focus group participants discussed strategies used in their program to expose students to various DoD careers. These mentors emphasized the value of students having the experience of being in an Army lab and interacting with Army S&E's. For example,

> *I think one of the biggest things [in providing information about DoD STEM careers] is knowing that we exist, and that they can come to an Army facility and see that 99 percent of us are not in uniforms.* (GEMS Mentor)

> *[In previous years] we brought in some of the employees here to give talks. Someone came in and gave a talk on anthropology and digging up these mass graves over in Afghanistan and Iraq. We had someone come in and talk about their internship with the FBI ballistics. We try to bring them in when we can, but this year, with funding, it's hard because we need to pay them for their time, but then AEOP doesn't have it. Some of the people kindly donate it, which is good.* (GEMS Mentor)

I let GEMS students know about how the Army began…I go into the rank structure. I go into basic training and AIT.I show them a video that tells them that the Army has 150 jobs fields. (GEMS Mentor)

Satisfaction with GEMS

Students and mentors were asked how satisfied they were with a number of features of the GEMS program (see Table 33). The majority of responding students were somewhat or very much satisfied with all of the listed program features. For example, 94% of students were at least somewhat satisfied with the teaching or mentoring during program activities, 93% with the stipend, and 90% with the variety of STEM topics available to them in GEMS. In light of the findings indicating that connecting with DoD STEM professionals is important in exposing students to Army and DoD STEM careers, it is noteworthy that 15% of students reported not experiencing invited speakers or career events and 34% had not experienced field trips or lab tours.

"I thoroughly enjoyed the experience! I learned things that I did not know before and I completed activities that broadened my horizon. For a week I felt like I was a real scientist working in the STEM field." – GEMS Student

Table 33. Student Satisfaction with GEMS Program Features (n=1,690-1,727)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	4.9%	2.1%	11.1%	31.9%	50%	
	84	37	192	550	864	**1727**
Communicating with your GEMS host site organizers	18.1%	3.5%	10.9%	23.9%	43.6%	
	308	59	186	406	741	**1700**
The physical location(s) of GEMS activities	1.5%	4%	10.9%	22.1%	61.5%	
	26	68	186	378	1054	**1712**
The variety of STEM topics available to you in GEMS	1.5%	1.9%	7.1%	18.9%	70.6%	
	26	33	122	324	1206	**1711**
Teaching or mentoring provided during GEMS activities	0.9%	1.3%	3.8%	15.3%	78.7%	
	15	23	66	262	1351	**1717**
Stipends (payment)	2.7%	1.3%	3.5%	11.4%	81.1%	
	46	22	60	195	1389	**1712**
Educational materials (e.g., workbooks, online resources, etc.) used during program activities	5.7%	1.9%	9.6%	21.5%	61.3%	
	97	32	165	368	1048	**1710**
Invited speakers or "career" events	15%	2.1%	7.4%	19.1%	56.4%	
	254	36	125	323	952	**1690**
Field trips or laboratory tours	34.2%	1.1%	6.7%	13.2%	44.8%	
	584	19	114	225	767	**1709**

Students also responded to an open-ended item on the questionnaire asking them about their overall satisfaction with their GEMS experience. Of the 322 students in the sample who provided coherent responses,[12] 290, or 90%, commented only on positive aspects of the program, describing high levels of satisfaction with the content of the program, their interactions with mentors and peers, and their learning experiences. For example:

[12] Responses from a random sample of 327 students were coded, which represents 33% of the available responses.

Participating in this program has allowed me to learn more about STEM, learn about lab procedures, learn about different careers and STEM, collaborate with other students, and interact with near peer mentors who are currently studying STEM fields. (GEMS Student)

What I enjoyed the most [about GEMS] was interacting with the near peers and other students. I enjoyed talking about the paths they have taken to pursue STEM and learning more about opportunities in STEM. I would definitely recommend this program to prospective applicants in the future. (GEMS Student)

My one week at GEMS was very exciting. I learned a whole lot of new thing and they bring out the fun in it. When I first started I thought it would be like school but it turned out that it's about ten times better. They made it seem like we are real scientists. (GEMS Student)

I was very satisfied with my GEMS experience. I learned about STEM in the real world and about all the jobs that STEM can lead to. I learned the most about how STEM fits into the work of the army. (GEMS Student)

Twenty-six responses (9%) included positive comments, but had some caveats. The most common caveat was a desire for more hands-on activities or more challenging activities. Another four respondents expressed dissatisfaction with various aspects of the program including complaints about the amount of notes and lectures in the program and a lack of structure.

Another open-ended questionnaire item asked students to list three ways that the GEMS program helped them. In the 346 responses analyzed (33% of the 1047 available responses), the most frequently mentioned response (mentioned 278 times) was GEMS' impact on students' learning or knowledge in STEM areas. Students also valued the career information provided to them in GEMS (mentioned 174 times), the opportunity for teamwork (mentioned 83 times), the increase in their interest and motivation in STEM (mentioned 74 times), and the new skills they developed (mentioned 65 times). Other areas in which students felt that GEMS was helpful included making friends (mentioned 39 times), providing hands-on and/or lab experience (mentioned 39 times), developing problem-solving skills (mentioned 33 times), developing students' confidence (mentioned 27 times), and having fun (mentioned 25 times). For example,

GEMS lets me see what it feels like to do research and be a part of the scientific community. (GEMS Student)

GEMS was an excellent program which helped me discover more occupations I might be interested in. I experienced genuine hands-on experiments using professional equipment and procedures. GEMS helped me appreciate science more by exposing me to areas of open research and study. (GEMS Student)

GEM has ignited my love and passion for science. (GEMS Student)

Students were also asked to provide three ways in which the program could be improved. Of the 308 student responses analyzed (33% of the 932 responses available), the most commonly mentioned improvement (mentioned 105 times) focused on providing more or different activities. Other frequently mentioned improvements included lengthening the program (52 responses), providing more hands-on activities (45 responses), providing a broader range of topics and/or more camps (28 responses), providing more speakers (27 responses), and providing more or longer breaks and/or free time (27 responses). Other suggestions included providing more career information, improving organization and/or time management within the program, improving the application process and/or communication with program administrators, and altering the way groups are formed or used (i.e., allowing students to choose their own groups, having more group work, or having less group work).

Students participating in focus groups also commented upon ways that GEMS could be improved. Students suggested a variety of improvements including focusing on fewer topics, publicizing the program more broadly, altering the hours of the program, more hands-on content, and a less strict dress code.

Mentors were also asked about their satisfaction with a number of program features and a majority reported being somewhat or very much satisfied with most program components they experienced (see Table 34). For example, 90% were at least somewhat satisfied with the support they received for instructing or mentoring during program activities, 89% with communication with GEMS organizers/site coordinators, and 86% with invited speakers or career events.

"As a college student who participated in the GEMS program in high school, I found that the program was extremely beneficial in gaining experience in the lab setting as well as getting exposed to scientific terminology and concepts before learning about them in school. As a near peer this year, I thought that the program was well run and organized and an overall beneficial experience to the participants. I found this job to be extremely rewarding and enjoyable, but also a fantastic learning experience as an educator." – GEMS NPM

Table 34. Mentor Satisfaction with GEMS Program Features (n=28)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	7.1%	0.0%	3.6%	39.3%	50.0%	
	2	0	1	11	14	**28**
Communicating with the National Science Teachers Association (NSTA)	42.9%	3.6%	10.7%	28.6%	14.3%	
	12	1	3	8	4	**28**
Communicating with GEMS organizers / site coordinators	0.0%	3.6%	7.1%	14.3%	75.0%	
	0	1	2	4	21	**28**
The physical location(s) of GEMS's activities	0.0%	7.1%	10.7%	14.3%	67.9%	
	0	2	3	4	19	**28**
Support for instruction or mentorship during program activities	0.0%	0.0%	10.7%	28.6%	60.7%	
	0	0	3	8	17	**28**
Stipends (payment)	0.0%	3.6%	17.9%	10.7%	67.9%	
	0	1	5	3	19	**28**
Invited speakers or "career" events	0.0%	0.0%	14.3%	28.6%	57.1%	
	0	0	4	8	16	**28**
Field trips or laboratory tours	25.0%	3.6%	7.1%	14.3%	50.0%	
	7	1	2	4	14	**28**

Mentors were also asked to respond to open-ended questionnaire items asking for their opinions about the program. One item asked them to identify the three most important strengths of GEMS. Among the 27 mentors who responded to this item, the most frequently mentioned responses were the real-world applications of knowledge and hands-on experiences GEMS offers (12 responses) and the mentor-student relationships (12 responses). Other strengths relatively frequently mentioned included the use of NPMs (8 responses), career information (8 responses), and the opportunity for students to interact with Army S&Es. For example:

[GEMS] students gain a better understanding of STEM topics through hands-on learning. (GEMS Mentor)

[A strength of GEMS is] the interactions with Near-Peers who are studying STEM topics (GEMS Mentor)

Mentors participating in focus groups also discussed benefits to themselves from participating in GEMS. Mentors discussed having a high level of satisfaction in working with students, enjoying teaching, and thinking about their own work from a different perspective. For instance:

> *I get to interact with the young minds of the future. They're going to be our future scientists, our future engineers, doctors, lawyers…I get to interact with them and give them a military perspective of how we've gotten better as a whole because of technology.* (GEMS Mentor)

> *It's a true sign you know what you're doing if you can explain it to someone of a certain education level. It gets you thinking about, talking about what you can do and explaining it to the community.* (GEMS Mentor)

> *We all fell in love with science along the road somewhere…It's kind of fun to look back to that point and realize, "oh yeah, this is something I actually truly love." We all get to go back and play with the fun parts then pass it along to the students. It's really fun.* (GEMS Mentor)

Near Peer Mentor focus group participants pointed out the learning associated with the NPM role and the career insight they gain from the experience. For example:

> *Personally, I'm learning a whole lot about everything because we need new lessons on new things.* (GEMS NPM)

> *I've been thinking lately about going into teaching. I'm a chemistry major…Last week we had the beginner students, and I really thoroughly enjoyed working with them, so I've been considering maybe going into a teaching position.* (GEMS mentor)

Another open-ended questionnaire item asked mentors to note three ways in which GEMS should be improved for future participants. A variety of improvements were suggested among the 24 mentors who responded. The most frequently mentioned areas for improvement were the increasing the diversity of activities or topics available (6 responses), having fewer lectures (5 responses), more assistants or NPMs (5 responses), and shortening the questionnaire (5 responses).

Mentors participating in focus groups also suggested improvements to GEMS. Several mentors suggested publicizing GEMS more widely. As one mentor said,

> *I think we need a larger effort or help getting the word out to our community…We don't get any sort of help for us to be able to set time aside to promote the week. We rely on someone else to do that [but] I think those resources are also overwhelmed and don't have the time…Our participation is almost falling. I find myself spending lunch hours going to schools at the last minute, trying to rally students into the program.* (GEMS Mentor)

Other mentor suggestions included more time for activities, garnering more internal support for GEMS mentors in terms of overhead funding and support from superiors, more supplies for the program (several mentors mentioned purchasing supplies with their own funds), and support for NPMs in lesson planning and teaching. The NPMs at one site were particularly adamant about ensuring that stipends were paid on time. As one NPM said,

> *It was really inexcusable that we were all paid two weeks late, especially with people having rent. There's some question if we're going to get paychecks tomorrow…we can understand once, and we can understand a few days. We can't understand two weeks and repeatedly.* (GEMS NPM Mentor)

Mentors were asked in another open-ended questionnaire item to share their overall satisfaction with their GEMS experience. Nineteen of the 24 respondents commented positively on the program. The most common themes in these responses were GEMS were enjoyment in working with students and the opportunity to hone teaching skills. For example:

> *This was my second year at GEMS, and it was amazing. I always love connecting with the students and watching them learn. They all had so much fun with the different experiments that we had prepared for them. I also felt like I learned so much, from the other mentors, the students, and also the professionals we visited, both civilian and DoD.* (GEMS Mentor)

> *This was the best job I have ever had. I loved working with every one of my students. I absolutely gained a new set of skills from teaching by learning patience and how to adapt to different situations. Before becoming a mentor at GEMS, I was unsure of my career choices. Now I am strongly leaning towards a career in the field of higher-level sciences and education.* (GEMS Mentor)

Mentors who expressed dissatisfaction with aspects of the program focused on logistical issues such as the timeliness of stipend payments for NPMs, and communication.

In summary, findings from the Actionable Program Evaluation indicate that the program is actively engaging students in authentic STEM experiences and providing mentorship that meets diverse student needs. Once in the GEMS program, students are learning about DoD or STEM job/careers, with most mentors crediting student participation in the program, invited speakers, and GEMS site coordinators as useful in this process. The GEMS program actively engages students in learning about STEM and in STEM practices in ways that they are not engaged in typical school activities. Mentors employed strategies to help make learning activities relevant to students, support the diverse needs of students as learners, support students' development of collaboration and interpersonal skills, support student engagement in authentic STEM activities, and support students' educational and career pathways. Overall, students and mentors were satisfied with their experience in the GEMS program.

Outcomes Evaluation

The evaluation of GEMS included measurement of several outcomes relating to AEOP and program objectives, including impacts on students' STEM competencies (e.g., knowledge and skills), STEM identity and confidence, interest in and intent for future STEM engagement (e.g., further education, careers), attitudes toward STEM, knowledge of and interest in participating in additional AEOP opportunities, and knowledge of DoD STEM careers.[13]

STEM competencies include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are not only important for those pursuing STEM careers, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The GEMS evaluation therefore measured students' self-reported gains in STEM competencies and engagement in opportunities intended to develop what is considered to be a critical STEM skill in the 21st century—collaboration and teamwork.

STEM Knowledge and Skills

Students were asked to report their gains in STEM knowledge as a result of participating in GEMS. As can be seen in Table 35, nearly all responding students reported some level of gains in their STEM knowledge as a result of the GEMS program. A majority of students reported some gains or large gains in all areas, including in-depth knowledge of a STEM topic (92%), their knowledge of how scientists and engineers work on real problems in STEM (91%), knowledge of what everyday research work is like in STEM (89%), knowledge of research conducted in a STEM topic or field (88%), and knowledge of research professes, ethics, and rules for conduct in STEM (84%). Mentors were asked to respond to a parallel item and responded similarly.

[13] The outcomes measured in the evaluation study were informed by the following documents:

Committee on STEM Education. (2013*). Federal Science, Technology, Engineering, and Mathematics (STEM) education 5-year strategic plan: A report from the Committee on STEM Education, National Science and Technology Council.* Washington, DC: The White House, Office of Science and Technology Policy.

National Research Council. (2009). Learning Science in Informal Environments: People, Places, and Pursuits. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* Executive Office of the President.

Report of the Academic Competitiveness Council (ACC). (2007). U.S. Department of Education. Available on the Department's Web site at: http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html.

Table 35. Student Report of Impacts on STEM Knowledge (n=1,706-1,724)

	No gain	A little gain	Some gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	1.5%	6.8%	37.3%	54.4%	
	25	118	643	938	**1724**
Knowledge of research conducted in a STEM topic or field	2%	9.4%	32.4%	56.2%	
	35	162	556	963	**1716**
Knowledge of research processes, ethics, and rules for conduct in STEM	3.1%	12.8%	32.7%	51.4%	
	53	218	558	877	**1706**
Knowledge of how scientists and engineers work on real problems in STEM	1.7%	7.2%	26.4%	64.7%	
	29	124	452	1108	**1713**
Knowledge of what everyday research work is like in STEM	2.1%	8.8%	29.4%	59.7%	
	36	151	503	1019	**1709**

These items were combined into a composite variable[14] to test for differential impacts across subgroups of students. Significant differences were found by gender, with females reporting higher impacts (small effect size, d-0.201). No significant differences were found by race/ethnicity.[15]

Students were also asked about how GEMS impacted their STEM competencies, defined as their abilities in a number of STEM practices. Table 36 reports data for students who indicated that science was the focus of their GEMS experience while Table 37 reports data for students who indicated that engineering or technology was the focus of their experience. For science-focused students, the greatest gains were in supporting an explanation for an observation with data from experiments (80% reported at least some gain), followed by communicating about experiments and explanations in different ways (79% reported at least some gain). A majority of students reported at least some gain in all other areas including supporting an explanation for an observation with data from experiments (80%), making a model of an object or system showing its parts and how they work (80%) asking a question that can be answered with one or more scientific experiments (79%), considering different interpretations of data when deciding how the data answer a question (77%), and using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation (75%). For engineering-focused students, the greatest areas of perceived gains (students reporting at least some gain) were in

[14] The Cronbach's alpha reliability for these 5 items was 0.855.

[15] Independent samples t-test for STEM Knowledge: Gender t(1679)=4.11, p<.001.

using knowledge and creativity to propose a testable solution for a problem (82%); defining a problem that can be solved by developing a new or improved object, process, or system (79%); carrying out procedures for an experiment; communicating information about design experiments and solutions in different ways (77%); and making a model of an object or system to show its parts and how they work (77%). Mentors were asked to respond to a parallel set of items on the questionnaire and reported similar impacts in these areas.

Table 36. Students Reporting Gains in their STEM Competencies – Science Practices (n=1,686-1,706)

	No gain	A little gain	Some gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	5.6%	15.9%	41.1%	37.4%	
	95	271	701	639	**1706**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	7.1%	17.8%	37%	38.1%	
	121	304	629	648	**1702**
Considering different interpretations of data when deciding how the data answer a question	6.7%	16%	37.1%	40.2%	
	114	271	628	679	**1692**
Supporting an explanation for an observation with data from experiments	5.9%	14.1%	34.2%	45.8%	
	100	239	579	773	**1691**
Defending an argument that conveys how an explanation best describes an observation	12.5%	21.6%	31.8%	34.1%	
	210	364	536	576	**1686**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	13%	19.3%	33.5%	34.2%	
	219	326	566	580	**1691**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	5.7%	15%	29.9%	49.4%	
	96	254	507	837	**1694**

Table 37. Students Reporting Gains in their STEM Competencies – Engineering Practices (n=1,650-1,690)

	No gain	A little gain	Some gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved object, process, or system	5.6%	15.2%	32.5%	46.7%	
	94	257	550	789	**1690**
Using knowledge and creativity to propose a testable solution for a problem	4.3%	13.6%	32.9%	49.2%	
	72	229	556	832	**1689**
Making a model of an object or system to show its parts and how they work	7.4%	15.8%	28.4%	48.4%	
	125	266	477	814	**1682**
Carrying out procedures for an experiment and recording data accurately	5.2%	15.5%	31.5%	47.8%	
	88	261	532	808	**1689**
Using computer models of an object or system to investigate cause and effect relationships	29.1%	19.5%	23.7%	27.7%	
	487	326	397	462	**1672**
Considering different interpretations of the data when deciding if a solution works as intended	9.2%	19.3%	34.6%	36.9%	
	153	322	578	617	**1670**
Organizing data in charts or graphs to find patterns and relationships	19.2%	20.7%	26.8%	33.3%	
	322	347	450	557	**1676**
Supporting a solution for a problem with data from experiments	9.5%	20.2%	30.1%	40.2%	
	158	338	503	671	**1670**
Defend an argument that conveys how a solution best meets design criteria	13.8%	20.2%	32%	34%	
	230	338	534	568	**1670**
Integrating information from technical or scientific texts and other media to support your solution to a problem	14.7%	19.8%	31.3%	34.2%	
	244	328	519	569	**1660**
Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)	6.4%	16.7%	28.5%	48.4%	
	105	276	470	799	**1650**

Composite scores were calculated from each set of items related to STEM competencies[16] to examine whether the GEMS program had differential impacts on subgroups of students. Females had significantly higher perceptions of their Science Competencies after GEMS as compared to males (effect size is small, d=0.145). Minority students reported significantly higher perceptions of their Science Competencies after GEMS compared to non-minority students (effect size is small, d=0.199).[17] Likewise, females had significantly higher perceptions of their Engineering Competencies after GEMS compared to males (effect size is small, d=0.115), and minority students reported significantly higher perceptions of their Engineering Competencies after GEMS compared to non-minority students (effect size is small, d=0.175).[18]

Students were also asked to indicate the impact of GEMS on their "21st Century Skills," defined as skills that are necessary across a wide variety of fields. As can be seen in Table 38, over three-quarters of responding students reported at least some gain in all of these skills, including working well with students of all backgrounds (90%), communicating effectively with others (87%), making changes when things do not go as planned (86%), and sticking with a task until it is finished (85%). Mentors were asked to respond to a similar item and, like students, the vast majority reported at least some gains in all areas.

Table 38. Student Report of Impacts on 21st Century Skills (n=1,681-1,695)

	No gain	A little gain	Some gain	Large gain	Response Total
Sticking with a task until it is finished	4.4%	10%	31.2%	54.4%	
	75	170	528	922	**1695**
Making changes when things do not go as planned	3.5%	10.6%	28.7%	57.2%	
	59	180	486	967	**1692**
Working well with students from all backgrounds	4%	8.8%	25.1%	62.1%	
	68	148	423	1048	**1687**
Including others' perspectives when making decisions	3.3%	10.7%	27.7%	58.3%	
	56	180	467	984	**1687**
Communicating effectively with others	2.9%	9.9%	27.1%	60.1%	
	48	167	455	1011	**1681**
Viewing failure as an opportunity to learn	5.9%	12.9%	25.9%	55.3%	
	100	217	436	930	**1683**

[16] The science practices composite has a Cronbach's alpha reliability of 0.907; The engineering practices composite has a Cronbach's alpha reliability of 0.902.

[17] Independent samples t-test for Science Competencies: Gender t(1679)=4.11, p<.001; Race/Ethnicity t(629)=2.50, p=.013.

[18] Independent samples t-test for Engineering Competencies: Gender t(1655)=2.32, p=.020; Race/Ethnicity t(627)=2.18, p=.030.

These items were also combined into a composite variable[19] to test for differential impacts across subgroups of students. Females had significantly higher perceptions of their 21st Century Skills after GEMS compared to males (effect size is small, d=0.140).[20] There were no significant differences by race/ethnicity.

STEM Identity and Confidence

While deepening students' STEM knowledge and skills are important for increasing the likelihood that they will pursue STEM further in their education and/or careers, they are unlikely to do so if they do not see themselves as capable of succeeding in STEM.[21] The student questionnaire therefore included a series of items intended to measure the impact of GEMS participation on students' STEM identity, defined as their feelings of confidence and self-efficacy in terms of STEM achievement. Table 39 displays student responses to the items associated with students' STEM identity. A large majority of students reported at least some gain in all areas, suggesting that the program had a positive impact on students' confidence in their STEM abilities. For example, 89% of responding students reported at least some gains in feeling more prepared for more challenging STEM activities, 86% in their sense of accomplishing something in STEM, and 76% in their ability to think creatively about a STEM project or activity. Comparing results on the composite created from these items,[22] there were no differences in STEM identity and confidence impact based on race/ethnicity, but females had significantly higher views than males (small effect size d = 0.149 standard deviations)[23].

"My one week at GEMS was very exciting. I learned a whole lot of new thing and they bring out the fun in it. When I first started I thought it would be like school but it turned out that it's about ten times better. They made it seem like we are real scientists." – GEMS Student

[19] The 21st Century Skills composite has a Cronbach's alpha reliability of 0.89.

[20] Two-tailed Independent Samples t-test: 21st Century differences by Gender $t(1652) = 2.85$, $p = .004$.

[21] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.

[22] The Cronbach's alpha reliability for these 7 items was 0.897.

[23] Independent samples t-test for STEM Knowledge: Gender t(1643)=3.01, p=.003.

Table 39. Student Report of Impacts on STEM Identity (n=1,664-1,686)

	No gain	A little gain	Some gain	Large gain	Response Total
Interest in a new STEM topic	6.4%	12.4%	27.2%	54%	
	108	209	458	911	**1686**
Deciding on a path to pursue a STEM career	9.7%	16.2%	30.5%	43.6%	
	163	272	511	730	**1676**
Sense of accomplishing something in STEM	4%	10.4%	25.7%	59.9%	
	67	175	431	1006	**1679**
Feeling prepared for more challenging STEM activities	2.8%	9.1%	26.5%	61.6%	
	47	152	442	1029	**1670**
Thinking creatively about a STEM project or activity	3.6%	10.2%	26.3%	59.9%	
	60	171	442	1004	**1677**
Desire to build relationships with mentors who work in STEM	4.6%	13.1%	27.4%	54.9%	
	77	219	456	917	**1669**
Connecting a STEM topic or field to my personal values	6.9%	14.4%	28.3%	50.4%	
	114	240	471	839	**1664**

Interest and Future Engagement in STEM

A key goal of the AEOP program is to develop a STEM-literate citizenry. To achieve this goal, it is important that students be engaged in high-quality STEM activities both in and out of school. Because of this, students were asked to reflect on whether the likelihood of their engaging in STEM outside of required school activities and their interest in participating in future AEOPs changed as a result of their GEMS experience. As can be seen in Table 40, students indicated they were more likely to engage in many of these activities as a result of GEMS. For example, 76% indicated being more likely to be involved in a STEM camp, club, or competition; 74% reported being more likely to work on a STEM project or experiment in a university or professional setting; and 72% reported being more likely to take a STEM elective class.

Table 40. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=1,657-1,670)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	3.8%	4.1%	47.7%	27.4%	17%	
	64	68	796	458	284	**1670**
Tinker (play) with a mechanical or electrical device	1.9%	2.3%	24.8%	39%	32%	
	32	39	412	652	535	**1670**
Work on solving mathematical or scientific puzzles	1.4%	3.1%	36%	34.3%	25.2%	
	24	52	598	570	418	**1662**
Use a computer to design or program something	3.1%	4.6%	37.2%	26.2%	28.9%	
	51	77	622	437	483	**1670**
Talk with friends or family about STEM	1.9%	2.4%	28.6%	32.1%	35%	
	31	40	477	534	583	**1665**
Mentor or teach other students about STEM	2.8%	3.9%	29.8%	32.3%	31.2%	
	46	65	495	536	519	**1661**
Help with a community service project related to STEM	1.9%	3.1%	31.3%	35%	28.7%	
	32	52	522	583	479	**1668**
Participate in a STEM camp, club, or competition	2.2%	2.2%	19.3%	33.2%	43.1%	
	37	37	321	552	718	**1665**
Take an elective (not required) STEM class	2.8%	3%	22%	33.1%	39.1%	
	46	50	365	548	648	**1657**
Work on a STEM project or experiment in a university or professional setting	2.2%	2.7%	22%	33.5%	39.6%	
	36	45	367	559	661	**1668**

In an analysis of a composite created from these items[24] by subgroup, females had significantly higher perceptions of their likeliness to engage in STEM Activities after GEMS compared to males (effect size is small, d=0.105), and White students reported being more likely to engage in comparison to minority students (a small effect of d = 0.295 standard deviations).[25]

Table 41 displays responses to an item asking students how interested they are in participating in other AEOP programs. A large majority (88%) of respondents indicated being at least a little interested in participating in GEMS again and 70% indicated being at least somewhat interested in participating as NPMs. Students also reported interest in participating in several AEOPs available to them in high school. For instance, 49% indicated future interest in SEAP, 44% in REAP, and 42% in HSAP. Over a third of students were interested in participating in programs such as e-Cybermission (39%) and JSHS (36%). In spite of this interest, large numbers of students had not heard of the other AEOPs for which they are, or soon will be, eligible, including JSHS (56% had not heard of the program) and SEAP (47% had not heard of the program).

"I really love being a part of this program. Not only do I get to participate in activities from a career that I would like to do, but I also get to improve my basic skills like working as a team, trying and something and see if it doesn't work out and getting along with people I may not know. I had the two nicest counselors that made my experience even more enjoyable." – GEMS Student

[24] The Cronbach's alpha reliability for these 10 items was 0.912.

[25] Independent samples t-test for Engagement in STEM activities: Gender t(1633)=2.13, p=.034; Race/Ethnicity t(617)=3.66, p<.001.

Table 41. Student Interest in Future AEOP Programs (n=1,628-1,646)

	I've never heard of this program	Not at all	A little	Very much	Response Total
Camp Invention	46.7%	16%	23.7%	13.6%	
	767	262	389	224	1642
eCYBERMISSION	50.3%	10.8%	22.9%	16%	
	827	177	376	264	1644
Junior Solar Sprint (JSS)	52.5%	11.8%	20.1%	15.6%	
	856	193	328	254	1631
Gains in the Education of Mathematics and Science (GEMS)	8.9%	3.2%	15.3%	72.6%	
	147	53	252	1191	1643
UNITE	63%	7.8%	16.9%	12.3%	
	1031	128	276	201	1636
Junior Science & Humanities Symposium (JSHS)	56.2%	7.9%	20.3%	15.6%	
	920	129	332	255	1636
Science & Engineering Apprenticeship Program (SEAP)	46.8%	5.2%	20.5%	27.5%	
	770	86	338	451	1645
Research & Engineering Apprenticeship Program (REAP)	50.1%	5.7%	19.8%	24.4%	
	821	94	324	399	1638
High School Apprenticeship Program (HSAP)	52.2%	5.7%	17.8%	24.3%	
	860	94	293	399	1646
College Qualified Leaders (CQL)	57.3%	7.8%	17.1%	17.8%	
	935	127	280	291	1633
GEMS Near Peer Mentor Program	24.3%	5.6%	26.9%	43.2%	
	397	92	440	708	1637
Undergraduate Research Apprenticeship Program (URAP)	56.6%	6.6%	18.1%	18.7%	
	922	108	294	304	1628
Science Mathematics, and Research for Transformation (SMART) College Scholarship	50%	4.7%	17.4%	27.9%	
	821	77	286	459	1643
National Defense Science & Engineering Graduate	58.4%	5.9%	18.2%	17.5%	

(NDSEG) Fellowship	960	97	299	289	**1645**

Students were also asked to indicate which resources impacted their awareness of the various AEOPs (see Table 42). Students rated participating in GEMS as most likely to impact their awareness "somewhat" or "very much" (84%). Their mentor (68%) and invited speakers or career events (58%) were other frequently cited resources. Large proportions of students reported never having heard of AEOP resources such as the It Starts Here! Magazine (80%), AEOP on social media (77%), and the AEOP brochure (65%).

Table 42. Impact of Resources on Student Awareness of AEOPs (n=1,722-1,740)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	42.6%	4.6%	15.5%	17.4%	19.9%	
	742	80	270	303	345	**1740**
AEOP on Facebook, Twitter, Pinterest or other social media	76.5%	8.9%	6.7%	4.7%	3.2%	
	1327	155	117	81	54	**1734**
AEOP brochure	64.9%	7.6%	9.3%	10.1%	8.1%	
	1121	132	160	175	140	**1728**
It Starts Here! Magazine	79.4%	9.4%	4.2%	3.5%	3.5%	
	1368	162	72	61	59	**1722**
My GEMS mentor(s)	12.7%	5%	14%	20.9%	47.4%	
	219	87	242	361	815	**1724**
Invited speakers or "career" events during GEMS	23.1%	5.8%	12.7%	19.3%	39.1%	
	400	100	220	334	676	**1730**
Participation in GEMS	6%	2.2%	7.9%	12.7%	71.2%	
	104	39	137	221	1236	**1737**

Attitudes toward Research

Because students' attitudes about the importance of DoD research is a prerequisite to their continued interest in the field and potential involvement in the future, students were asked their opinions of DoD researchers and the value of DoD research. As the responses in Table 43 indicate, students had overwhelmingly positive perceptions of both DoD researchers and the value of DoD research. For example, 86% agreed or strongly agreed that DoD research is valuable to society and 84% that DoD researchers advance science and engineering fields.

Table 43. Student Opinions about DoD Researchers and Research (n=1,646-1,656)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.1%	0.8%	13.9%	42.6%	41.6%	
	18	14	230	706	688	**1,656**
DoD researchers develop new, cutting edge technologies	0.9%	1.3%	14.6%	40.5%	42.7%	
	15	22	241	670	707	**1,655**
DoD researchers solve real-world problems	0.9%	1.4%	11.1%	34.1%	52.5%	
	14	23	182	561	866	**1,646**
DoD research is valuable to society	1%	1.5%	12.2%	34.5%	50.8%	
	16	24	201	573	839	**1,653**

Education and Career Aspirations

Students were also asked to consider the program's impact on their education and career aspirations. In terms of education, the questionnaire asked students how far they wanted to go in school before and after participating in GEMS (see Table 44). When students were asked to think back on how far they wanted to go in school before participating in GEMS, 40% indicated that they had wanted to finish college, and 55% that they had wanted to get more education after college. After GEMS, there was an upward shift in students' education aspirations, with 29% wishing to finish college and 67% wanting to get more education after college.

Table 44. Student Education Aspirations Before and After GEMS

	Before GEMS (n=1107)		After GEMS (n=1065)	
	Response Percent	Response Total	Response Percent	Response Total
Graduate from high school	2.44 %	27	1.45 %	16
Go to a trade or vocational school	0.36 %	4	0.27 %	3
Go to college for a little while	1.99 %	22	1.54 %	17
Finish college (get a Bachelor's degree)	39.93 %	442	29.28 %	323
Get more education after college	55.28 %	612	67.45 %	744

Students were asked to reflect on their career aspirations as well, reflecting upon what kind of work they expected to be doing at age 30 before participating in GEMS and after then after participating in GEMS (see Table 45). Most responding students expressed interest in STEM-related careers both before and after participating in GEMS, however there was a shift in student interest in careers in engineering and architectures (17% of students aspiring to these careers before GEMS and 22% after participating in GEMS) and in careers as scientists or researchers (8% of students aspiring to these careers before GEMS and 12% after participating in GEMS).

"I was very satisfied with my gems experience. I learned about STEM in the real world and about all the jobs that STEM can lead to. I learned the most about how STEM fits into the work of the Army." – GEMS Student

Table 45. Student Career Aspirations Before and After GEMS (n= 1,672)

	Before GEMS (n=1065)		After GEMS (n=1043)	
	Response Percent	Response Total	Response Percent	Response Total
Undecided	16.81 %	179	16.40 %	171
Scientist or researcher	7.89 %	84	11.98 %	125
Work in computers or technology	11.17 %	119	12.75 %	133
Engineer or architect	16.53 %	176	21.67 %	226
Work in the medical field (doctor, nurse, lab technician)	15.87 %	169	14.77 %	154
Teacher	1.50 %	16	1.34 %	14
Business person or manager	3.29 %	35	2.21 %	23
Lawyer	3.85 %	41	2.21 %	23
Military, police, or security	3.00 %	32	1.82 %	19
Artist (writer, dancer, painter)	3.10 %	33	1.82 %	19
Skilled craftsperson (carpenter, electrician, machinist)	0.09 %	1	0.19 %	2
Athlete or other work in sports	7.04 %	75	4.41 %	46
Other	9.86 %	105	8.44 %	88

Students were also asked to respond to a questionnaire item regarding the extent to which they expect to use their STEM knowledge, skills, and/or abilities in their work when they are age 30. Table 46 displays student responses to this item. Over three-quarters of students (76%) expected to use STEM in their work more than 50% of the time. Only 9% of students expect to use STEM less than 25% of the time or not at all in their future work.

Table 46. Students Expecting to Use STEM in Their Work at Age 30 (n=1,672)

	Response Percent	Response Total
not at all	1.9 %	31
up to 25% of the time	6.8 %	114
up to 50% of the time	16.1 %	269
up to 75% of the time	37.7 %	621
up to 100% of the time	38.1 %	637

Overall Impact

Finally, students were asked to respond to an item gauging the impacts of participating in GEMS more broadly. These data are displayed in Table 47 and indicate that GEMS contributed substantially to students' interest in, awareness of, and confidence in a number of STEM-related areas. For example, 93% of students reported that GEMS contributed to their confidence in their STEM knowledge, skills, and abilities. Likewise, a large majority of students reported that GEMS contributed to their interest in participating in STEM activities outside of school requirements (86%), to their appreciation of Army or DoD STEM research (85%), to their awareness of Army or DoD STEM careers (84%), and to their interest in taking STEM classes in school (80%). Mentors responded to a parallel item and responded similarly to students. These items were combined into a composite variable[26] to test for differences among subgroups of students; no significant differences were found by gender or by race/ethnicity.

"Participating in this program has allowed me to learn more about STEM, learn about lab procedures, learn about different careers and STEM, collaborate with other students, and interact with near peer mentors who are currently studying STEM fields." – GEMS Student

[26] The Cronbach's alpha reliability for these 10 items was 0.905.

Table 47. Student Opinions of GEMS Impacts (n=1,647-1,668)

	Disagree - This did not happen	Disagree - This happened but not because of GEMS	Agree - GEMS contributed	Agree - GEMS was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	1.9%	5.5%	57.3%	35.3%	
	32	92	956	587	1667
I am more interested in participating in STEM activities outside of school requirements	4.1%	10.6%	49.8%	35.5%	
	69	176	830	593	1668
I am more aware of other AEOPs	15.6%	8.1%	36.6%	39.7%	
	257	134	605	655	1651
I am more interested in participating in other AEOPs	13.3%	8.4%	39.1%	39.2%	
	220	138	644	646	1648
I am more interested in taking STEM classes in school	5.8%	14.6%	47.1%	32.5%	
	96	241	778	537	1652
I am more interested in earning a STEM degree	8.1%	14.1%	47.2%	30.6%	
	134	232	777	502	1645
I am more interested in pursuing a career in STEM	7.6%	15%	47%	30.4%	
	126	248	774	500	1648
I am more aware of Army or DoD STEM research and careers	9.8%	7%	40.7%	42.5%	
	162	116	670	699	1647
I have a greater appreciation of Army or DoD STEM research	7.6%	7.9%	41.6%	42.9%	
	126	131	685	709	1651
I am more interested in pursuing a STEM career with the Army or DoD	20%	12.7%	38.3%	29%	
	330	209	633	478	1650

Summary of Findings

The FY16 evaluation of GEMS collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in Table 48.

Table 48. 2016 GEMS Evaluation Findings	
Participant Profiles	
GEMS served students from populations historically underrepresented in STEM at rates similar to previous years.	In FY16, 46% of enrolled participants were female, indicating that GEMS successfully attracted participation from female students, a population historically underrepresented in engineering fields; this participation rate is comparable to the FY15 female participation rate of 45% and the FY14 rate of 44%.
	Students from historically underrepresented and underserved minority race/ethnicity and low-income groups participated in GEMS comparably to previous years. In FY16, 23% of participating students identified themselves as Black or African American, a rate comparable to this group's participation in FY15 (22%). Participation for students identifying themselves as Hispanic or Latino was 8%, comparable to the 9%, of students identifying with this group in FY15. A small proportion (10% in FY16 versus 11% in FY15 and 12% in FY14) of students continued to report qualifying for free or reduced-price lunch (FRL) – a common indicator of low-income status.
	GEMS served students across a range of school contexts, although more than half (60%) of participants identified their school setting as suburban.
GEMS attracted more applicants and served more students in FY16 as compared to previous years.	GEMS met and exceeded its FY16 target of receiving 3,750 applications (4,414 applications were received in FY16, an increase of 6% over the 4,161 applications in FY15). Although the program failed to meet its FY16 goal for student participation of 2,600, there was a 6% increase in student enrollment from FY15 to FY16, continuing an upward trend in enrollment over the past three program years.
Actionable Program Evaluation	
GEMS marketed the program in a number of ways, however reaching schools and organizations serving groups historically under-represented in STEM is an area for growth.	While NSTA and GEMS sites employed multiple strategies to disseminate information about the GEMS program, few of these efforts were targeted specifically to reaching underserved and underrepresented populations.
	Students most frequently learned about the GEMS through personal connections including past participants, friends, and DoD employees.

GEMS students reported being motivated to participate in the program by an interest in STEM and the learning opportunities GEMS presents.	Students were most frequently motivated to participate in GEMS by their interest in STEM and a desire to learn something new and interesting. Other motivators cited by most students included learning in ways not possible in school and the opportunity to used advanced laboratory technology.
GEMS students reported engaging in meaningful STEM learning through team-based and hands-on activities.	Students reported engaging in a number of STEM activities on most days or every day of their GEMS experience. Over three-quarters of students reported learning about STEM topics new to them, communicating with other students about STEM, and learning about careers on most days or every day of their GEMS experience.
	Students reported engaging in a variety of STEM practices during their GEMS experience, with nearly all students reporting working as part of a team most days or every day. Large majorities of students (76%) also reported engaging in practices such as participating in hands-on STEM activities and using laboratory procedures or tools on most days or every day of their GEMS experience.
	Students reported that they had more opportunities to learn about STEM and engage in STEM practices in their GEMS experience than they typically have in school.
	Mentors reported using strategies to help make learning activities relevant to students, support the needs of diverse learners, develop students' collaboration and interpersonal skills, engage students in "authentic" STEM activities, and support students' STEM educational and career pathways.
GEMS informed students about STEM careers in general and, to a lesser extent, about DoD STEM careers specifically.	Nearly all students (97%) reported learning about 1 or more STEM careers during GEMS and over three-quarters learned about 3 or more STEM careers. Slightly fewer students (84%) reported learning about 1 or more DoD STEM career and slightly more than half reported learning about 3 or more.
	All responding mentors reported asking students about their educational and career interests and nearly all reported providing guidance about educational pathways that will prepare students for STEM careers. Most mentors also discussed STEM career opportunities within the DoD or other government agencies.
	Other than simply participating in GEMS, students reported that participating in GEMS, their GEMS mentors and invited speakers or career events during GEMS were resources that impacted their awareness of DoD STEM careers. Most students had not experienced AEOP resources such as the website, brochure, social media, and It Starts Here! magazine.

GEMS has an opportunity to improve student and mentor awareness of other AEOPs.	The programs mentors most frequently reported discussing with students were GEMS and GEMS Near Peer Mentors. Less than half (15-40%) reported discussing any other AEOPs specifically, although over half reported discussing AEOPs generally but without referencing any specific program.
	Mentors reported that the most useful resources for exposing students to AEOP were participation in GEMS, program administrators or site coordinators, and invited speakers or career events. Over half of mentors had no experience with AEOP on social media or It Starts Here! Magazine as resources to expose students to AEOPs.
Students and mentors value the GEMS experience.	Nearly all students (90-94%) indicated being somewhat or very much satisfied with GEMS program features such as teaching or mentoring, the stipend, and availability of program topics. Students also offered positive comments about their overall satisfaction with the program, focusing on their learning experiences in GEMS and the personal connections they made with mentors and peers.
	Mentors also reported being satisfied with most program features, including the support they received for instruction or mentoring, communication with program organizers, and invited speakers and career events.
Outcomes Evaluation	
GEMS students reported positive impacts on their STEM knowledge and competencies.	Students reported gains in their STEM knowledge as a result of participating in GEMS. These gains were reported in areas such as in depth knowledge of a STEM topic, knowledge of how scientists and engineers work on real problems in STEM, and knowledge of what everyday research work is like in STEM. Females reported significantly higher impacts in these areas than males, however there were no differences across races/ethnicities.
	Students also reported impacts on their abilities in various STEM competencies, including science and engineering practices. Participants reported some to large gain in their science practices (65%) and engineering practices (50%) after participating in GEMS. These gains were reported in abilities such as supporting an explanation for an observation with data from experiments, communicating about experiments and explanations in different ways, and using knowledge and creativity to propose a testable solution for a problem. Female students and students identifying with racial/ethnic minority groups reported significantly higher gains than males and non-minority students.
GEMS participants reported gains in students' 21st Century Skills.	A large majority of students (81%) reported gains in their 21st Century Skills as a result of participating in GEMS. These gains were reported in areas such as their ability to work well with students of all backgrounds, communicating effectively with others, making changes when things do not go as planned, and sticking with a task until it is finished. Female

	students reported significantly more gains than male students although there were no significant differences across races/ethnicities.
GEMS participants reported gains in their confidence and identity in STEM, and in their interest in engaging in STEM in the future.	A large majority of students (79%) reported gains in areas related to their STEM identity, defined as confidence in one's ability to succeed in STEM. These gains were reported in areas such as students' sense of accomplishing something in STEM, feeling prepared for more challenging STEM activities, and thinking creatively about a STEM project or activity. Females reported significantly higher gains in STEM identity and confidence than males although there were no significant differences across races/ethnicities.
	Students also reported gains in the likelihood that they would engage in STEM activities in the future after participating in GEMS. For example, most students indicated that, as a result of GEMS, they were more likely to participate in a STEM camp, club, or competition; work on a STEM project or experiment in a university or professional setting; and take an elective STEM class. Females reported significantly higher perceptions of their likeliness to engage in STEM Activities compared to males, and White students reported being more likely to engage in STEM activities in comparison to minority students.
Students reported higher education aspirations after participating in GEMS, although their career aspirations showed little change.	After participating in GEMS, students reported an upward shift in their educational aspirations evidenced by an increase in the number of students who aspired to continue their education after college (from 55% before GEMS to 67% after).
	Most responding students expressed interest in STEM-related careers both before and after participating in GEMS. There was, however, a shift in student interest in careers in engineering and architectures (17% of students aspiring to these careers before GEMS and 22% after participating in GEMS) and in careers as scientists or researchers (8% of students aspiring to these careers before GEMS and how 12% after participating in GEMS).
Although GEMS students have limited awareness of other AEOP initiatives, students showed interest in future AEOP opportunities.	Around half or more of responding students had not heard of AEOP initiatives other than GEMS and GEMS Near Peer Mentors. In spite of this, between a third and a half of students indicated interest in participating in future AEOPs other than GEMS. For example, approximately half (49%) of students indicated interest in participating in SEAP in the future and over a third (36%) expressed interest in participating in JSHS. Students credited participating in GEMS, their mentors, and invited speakers or career events with increasing their interest in participating in other AEOPs. Over half of students had not experienced AEOP on social media as a resource for learning about AEOPs and 21% and 18% respectively reported not having experienced the AEOP website and AEOP brochure as a resource for learning about AEOPs.

GEMS participants reported positive opinions of DoD research and DoD researchers and reported increases in their awareness of their interest in pursuing a STEM career with the DoD.	Students had overwhelmingly positive opinions of DoD research and researchers and the value of DoD research. For example, large majorities of students agreed that DoD research is valuable to society and that DoD researchers advance science and engineering fields.
	Large majorities of students reported that GEMS contributed to their awareness of DoD STEM research and careers and to a greater appreciation of Army and DoD STEM research. Over half of students also indicated that they are more interested in pursuing a STEM career with the Army or DoD after participating in GEMS.

Responsiveness to FY14 and FY15 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY16 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

In this report, we will highlight recommendations made in FY15 to programs and summarize efforts and outcomes reflected in the FY16 APR toward these areas.

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

Finding: The large number of applications the program receives provides some evidence that the GEMS program could successfully be expanded to accommodate the considerable amount of unmet need and interest that persist with qualified students. It is recommended that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interests in more communities.

> **GEMS FY16 Efforts and Outcomes:** The student placement rate for FY16 remained at FY15 levels (55%), however, 8 out of 11 GEMS sites grew in enrollment. For example the program at Adelphi added 71 student participants, Fort Rucker added 31, and San Antonio added 27. Program staff reported that 9 of the 11 sites were at or near capacity in FY16, indicating that space and staffing will need to be expanded for significant program growth. There was no RFP process to expand sites in FY16, however the program did maintain the 11 sites that transitioned into the consortium in FY16. The next RFP to add a location is scheduled for FY17.

Finding: It is likely that GEMS will need to expand targeted marketing while implementing more aggressive marketing and recruitment practices. The program may wish to particularly consider targeting outreach to low-income and minority-serving schools, educational networks, community organizations, and professional associations that serve these populations.

GEMS FY16 Efforts and Outcomes: Participation by females and participants identifying as Black or African American and Hispanic or Latino and those remained essentially constant (changes of < 2%) since FY15. Due to a change in the definition of underserved/underprivileged students in FY16, the rate of participation of these students was reported in the annual program report at 10% although it should be noted that 23% of enrolled students were Black or African American, 8% were Hispanic or Latino, and 10% reported receiving free or reduced price lunch. Facebook advertising was used more aggressively in FY16 and low-income schools were targeted by local program coordinators (LPCs) in areas around their sites. Furthermore, the addition of strategic partners such as the Society for Women Engineers and the Tiger Woods Foundation will provide further opportunities to reach underserved and/or underrepresented populations of students.

Finding: The program and individual GEMS sites may need to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes.

GEMS FY16 Efforts and Outcomes: Transportation to and from sites was an issue again in FY16. While White Sands Missile Range was provided transportation with GEMS funding, other locations did not receive this support. The major limiting factor was the increased liability to damages during student transport. White Sands Missile Range avoided this issue by hiring a vendor, but that option seemed cost prohibitive at other locations. Student stipends are designed to compensate for increased cost of transportation, however stipends are often seen as a reward for participation. This unintentional mixed message diverted focus away from stipends as a potential solution for participants.

Finding: Given the large proportion of students who reported learning about GEMS through personal connections, it is recommended that the program consider strategies to ensure that students without a personal connection to sites have access to the GEMS program.

GEMS FY16 Efforts and Outcomes: In FY16, personal relationships continued to be a factor in choosing a student for participation. Program administrators reported that LPCs choose participants with a variety of methods. "Connected" selections are still a potential issue, but it is unclear which selection methods increase risk. The program focused on including U/U participants in FY 16 as a way to offset the number of connected participants. The program used target marketing, such as Facebook advertising, to expand the possible pool of applicants beyond personal connections.

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

Finding: The programs' ability to serve increasing numbers of students is limited by the number of mentors available, and therefore strategies to recruit additional RTs and NPMs should be considered.

GEMS FY16 Efforts and Outcomes: There was no FY16 goal for Near-Peer Mentor (NPM) and Resource Teacher (RT) involvement; however, NSTA observed a best practice for staff ratios during site visits. Sites that were closer to this ratio had observably higher student engagement. This ratio was one RT for every four NPMs, and one NPM for every six to eight students.

Finding: Mentors should be provided with more comprehensive information about AEOP initiatives. The program may therefore wish to incorporate information about other AEOPs into the mentor orientation materials.

GEMS FY16 Efforts and Outcomes: GEMS participant awareness of other AEOP opportunities was above the target of 60% for FY16. GEMS locations were given AEOP collateral to support staff training. Also, Widmeyer created a presentation of program overviews that were provided to LPC for staff orientations. ERDC-CERL and WRAIR reported using SEAP and/or CQL students as Near Peer Mentors in program to increase awareness.

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

Finding: The program may want to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs.

GEMS FY16 Efforts and Outcomes: GEMS awareness of other AEOP opportunities was above the target of 60% in FY16. LPC and regional Camp Invention (CI) leaders met and conducted cross-program site visits in FY16 to increase recruitment of CI into GEMS. Some locations also used SEAP and CQL students in curriculum to increase awareness.

Finding: Familiarize mentors with resources available to expose students to DoD STEM careers.

GEMS FY16 Efforts and Outcomes: The program relied heavily on scientists and engineers (S&E) for the majority of the Department of Defense (DoD) and STEM career influence. A large majority of participants reported learning about at least one DoD STEM career.

Finding: It may also be useful to familiarize mentors with strategies to increase the likelihood that the program will have a long-term impact on students' decisions to pursue STEM.

GEMS FY16 Efforts and Outcomes: Specific mentor skill training was not provided to LPCs by the IPA. Some sites may have training that wasn't reported to the IPA.

Finding: The program may want to consider emphasizing the importance of these evaluations with individual program sites and communicating expectations for evaluation activities.

GEMS FY16 Efforts and Outcomes: Time was set-aside during the program for students to complete evaluations. A lack of reliable Internet access challenged the viability of internet-based evaluation instruments. Paper was provided at many locations to offset this challenge, but logistics problems created some delays in paper implementation.

Recommendations

Evaluation findings indicate that FY16 was a successful year overall for the GEMS program. Notable successes for the year include continued increases in participant applications and enrollment, continued participation by groups traditionally under-represented in STEM fields, and high levels of mentor and student satisfaction with the programs. Both students and mentors reported gains in students' STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the GEMS experience, and students emerged from the program more aware of other AEOPs and of Army and DoD STEM careers.

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

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

1. GEMS served 2,427 students in FY16, a 6% increase over FY15. The continued upward trends in applications and enrollment provides some indication that the program attended to previous evaluator recommendations that existing sites expand their capacity to accommodate more students in order to meet existing needs and interest in communities that are already served by GEMS programs. The placement rate of 55% remained constant from FY15 to FY16 however; indicating significant continued unmet need in the program. Therefore, the FY14 and FY15 recommendation that more GEMS sites be identified, recruited, and started in a variety of geographic locations to meet the needs and interest in more communities is repeated. Program administrators noted that there was no RFP for a new site in FY16, precluding an expansion in the number of sites, although the program did maintain the 11 sites that transitioned into the consortium in FY16. The next RFP to add a location is scheduled for FY17, and it is recommended that the program evaluate existing sites' ability to expand their capacity as well as consider adding new locations in the coming years. In order to expand the capacity of existing sites, the program should consider ways of increasing administrative support, teaching staff, physical infrastructure, and mentor participation to meet the needs and interest of potential GEMS participants.

2. There was little change in participation of groups underserved and underrepresented in STEM from FY14 to FY16. In FY15 and FY16 there was little evidence of targeted outreach to organizations that serve groups historically underserved and underrepresented in STEM. It is likely that in order to engage increasing numbers of students underserved and underrepresented in STEM, GEMS will need to expand targeted marketing while implementing more aggressive marketing and recruitment practices. The inclusion of organizations such as the Society for Women Engineers (SWE) and the Tiger Woods Foundation as strategic partners of the AEOP presents opportunities for marketing targeted toward theses underserved and underrepresented groups. In addition, the more aggressive use of Facebook marketing implemented in FY16 should be continued, although program administrators should be mindful that only a very small percentage (3%) of students reported learning about AEOP via social media. Due to the perception of mentors that travel barriers preclude participation of some groups of students, the program and

individual GEMS sites may wish to consider practical solutions to help more GEMS students travel to sites that are not close in proximity to their homes.

3. Students continue to report that their primary source of information about GEMS was personal connections, which emphasizes the quality of experience that students have in the program that motivates them to tell others about the program. However, this does exclude students who may not have connections to current or past participants. Given the large proportions of students who learned about GEMS through family, friends, and past participants of the program, the recommendation is repeated for FY16 to take measures to diversify the applicant and participant pool and to ensure that students without personal connections to sites have access to the GEMS program.

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

1. Since the program's ability to serve increasing numbers of students is limited by the number of mentors available, strategies to recruit additional RTs and NPMs and should be considered. Mentors noted in focus groups that they felt that additional support for mentors in terms of overhead funding, support for mentoring from superiors, and assistance in recruiting students for the program would be beneficial in retaining existing mentors and would increase the likelihood that Army S&Es would volunteer to act as GEMS mentors.

2. Since a majority of students identified their mentors as a key resource for information about AEOP opportunities, mentors should be provided with more comprehensive information about AEOP initiatives. Many mentors reported having no experience with AEOP resources. The program noted that in FY16 a presentation highlighting the AEOP portfolio was created for LPCs for use during staff orientation. Program administrators should take measures to ensure that this, and other AEOP resources, is utilized at sites during mentor orientation or informational sessions.

3. Late stipend payments were a concern for NPMs. In order to retain highly skilled NPMs and recruit new NPMs, it is recommended that the program take measures to ensure that stipend payments are made on a regular, timely basis.

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

1. Due to continued low rates of student awareness of AEOPs other than GEMS, the FY15 recommendation is repeated for the program to consider innovative ways to work with other AEOPs to create a more seamless continuum of programs. Since students reported that their mentors were key resources for learning about AEOPs, the program should ensure that AEOP informational materials, including the presentation created in FY16 highlighting the AEOP portfolio, reach mentors.

2. The FY16 GEMS participation in the evaluation questionnaire is an area for concern. While the response rates for students were at an acceptable level, it was lower than in FY15. The ongoing low response rates for mentors raise questions about the representativeness of the results. Continued efforts should be undertaken to increase completion of the questionnaire, particularly for mentors. The program should emphasize the importance of evaluations with individual program sites and communicate expectations for evaluation activities. Because of issues with Internet access at GEMS sites, alternative means of questionnaire access for students should be considered. In addition, the evaluation instruments may need to be streamlined as perceived response burden could affect participation.

Appendices

Appendix A

FY16 GEMS Evaluation Plan

Questionnaires

Purpose:

As per the approved FY16 AEOP APP, the external evaluation of GEMS includes two post-program questionnaires:

1. AEOP Youth Questionnaire to be completed by student participants; and
2. AEOP Mentor Questionnaire to be completed by Army S&Es, near-peer mentors, and/or resource teachers that facilitate, assist, or support students during GEMS educational activities.

Questionnaires are the primary method of data collection for AEOP evaluation and collect information about participants' experiences with and perceptions of program resources, structures, and activities; potential benefits to participants; and strengths and areas of improvement for programs.

The questionnaires were revised in FY 13 and FY14 to align with:

- Army's strategic plan and AEOP Priorities 1 (STEM Literate Citizenry), 2 (STEM Savvy Educators) *and* 3 (Sustainable Infrastructure);
- Federal guidance for evaluation of Federal STEM investments (e.g., inclusive of implementation and outcomes evaluation, and outcomes of STEM-specific competencies, transferrable competencies, attitudes about/identifying with STEM, future engagement in STEM-related activities, and educational/career pathways);
- Best practices and published assessment tools in STEM education, STEM informal/outreach, and the evaluation/ research communities; and
- AEOP's vision to improve the quality of the data collected, focusing on changes in intended student outcomes and contributions of AEOPs like CQL effecting those changes.

The use of common questionnaires and sets of items that are appropriate across programs will allow for comparisons across AEOP programs and, if administered in successive years, longitudinal studies of students as they advance through pipelines within the AEOP. Because the questionnaires incorporate batteries of items from existing tools that have been validated in published research, external comparisons may also be possible.

All AEOPs are expected to administer the Youth and Mentor questionnaires provided for their program. Both the Youth and Mentor questionnaires have two versions, an "advanced" version (JSHS and apprenticeship programs) or a "basic" version (all other programs). The same basic set of items is used in both, with slightly modified items and/or additional items used in the advanced version. Additionally, the surveys are customized to gather information specific structures, resources, and activities of programs.

Site Visits/Onsite Focus Groups

Purpose:
As per the approved FY16 AEOP APP, the external evaluation of GEMS includes site visits for 3 laboratories with a local GEMS-SEAP-CQL pipeline.

Site visits provide the evaluation team with first-hand opportunities to speak with apprentices and their mentors. We are able to observe the AEOPs in action. The information gleaned from these visits assists in illustrating and more deeply understanding the findings of other data collected (from questionnaires). In total, the evaluation findings are used to highlight program successes and inform program changes so that the AEOPs can be even better in the future.

Evaluation Activities during GEMS Site Visits:

- One 45 minute focus group with 6-8 youth participants (apprentices);
- One 45-minute focus group with 6-8 mentors;
- 30-60 minutes to observe the program (specifically, to see students engaged in program activities, preferably with their mentors); and
- 10-15 minute transitions between each evaluation activity for moving groups in and out and providing evaluators with time to organize paperwork and take nature breaks.

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. Emergent coding was used for the qualitative data to identify the most common themes in responses.

Evaluators conducted inferential statistics to study any differences among participant groups (e.g., by gender or race/ethnicity) that could indicate inequities in the GEMS program. Statistical significance indicates whether a result is unlikely to be due to chance alone. Statistical significance was determined with t-tests, chi-square tests, and various non-parametric tests as appropriate, with significance defined at $p < 0.05$. Because statistical significance is sensitive to the number of respondents, it is more difficult to detect significant changes with small numbers of respondents. Practical significance, also known as effect size, indicates the magnitude of an effect, and is typically reported when differences are statistically significant. The formula for effect sizes depends on the type of statistical test used, and is specified, along with generally accepted rules of thumb for interpretation, in the body of the report.

Appendix B

FY16 GEMS Student Focus Group Protocol

2016 Gains in the Education of Mathematics and Science (GEMS) Evaluation Study Student Focus Group Protocol

Facilitator: My name is [evaluator] and I'd like to thank you for meeting with us today! We are really excited to learn more about your experiences in GEMS. In case you have not been in a focus group before, I'd like to give the group some ground rules that I like to use in focus groups. They seem to help the group move forward and make everyone a little more comfortable:

- What is shared in the room stays in the room.
- Only one person speaks at a time.
- If you disagree please do so respectfully.
- It is important for us to hear the positive and negative sides of an issue.
- This is voluntary - you may choose not to answer any question, or stop participating at any time.
- We will be audio recording the session for note-taking purposes only. Audio will be destroyed.
- Do you have any questions before we begin?

Key Questions

1. **Why did you choose to participate in GEMS this year?**
   - How did you hear about GEMS?
   - Who did you hear about it from?

   The Army Educational Outreach Program (AEOP) is a primary sponsor of GEMS. We do these focus groups to help the AEOP create reports and defend funding for the program. They need specific information to defend the money for the program.

2. **We need to understand more about how GEMS is teaching students about STEM career opportunities in the Army and Department of Defense.**
   - During GEMS, did you learn anything about STEM careers in the Army or Department of Defense?
   - How did you learn about them (e.g., field trips, invited speakers, other activities, etc.)?
   - Are you interested in pursuing a career in STEM with the Army or Department of Defense?

3. **The AEOP sponsors a wide range of national STEM outreach programs other than GEMS. You are definitely eligible to participate in some of these programs and we need to know if you learned about them during GEMS.**
   - During GEMS, did you learn about any of the outreach programs that the AEOP sponsors? (REAP, SEAP, CQL, SMART, etc.)
   - How did you learn about them?
   - Do you think that you will try to participate in any of those programs?

4. **Were you happy that you chose to participate in GEMS this year?**
   - What, specifically do you think you got out of participating in GEMS?
   - Were there any other benefits of participating in GEMS?

5. **Do you have any suggestions for improving GEMS for other students in the future?**

6. **Last Chance - Have we missed anything? Tell us anything you want us to know that we didn't ask about.**

Appendix C

FY16 GEMS Mentor Focus Group Protocol

2016 Gains in the Education of Mathematics and Science (GEMS) Evaluation Study Mentor Focus Group Protocol

Facilitator: My name is [evaluator] and I'd like to thank you for meeting with us today! We are really excited to learn more about your experiences in GEMS. In case you haven't been in a focus group before, I'd like to give you some ground rules that I like to use in focus groups. They seem to help the group move forward and make everyone a little more comfortable:

- What is shared in the room stays in the room.
- Only one person speaks at a time.
- If you disagree please do so respectfully.
- It is important for us to hear the positive and negative sides of all issues.
- We will be audio recording the session for note-taking purposes only. Audio will be destroyed.
- Do you have any questions about participating in the focus group?

Key Questions:

1. **When you think about GEMS, what kind of value does this program add**?
   - How do you think students benefit from participating in GEMS?
   - Can you think of a particular student or group of students that benefit the most from GEMS?
   - How have you benefited from participating in GEMS?

   One of the primary sponsors of the GEMS program is the Army Educational Outreach Program (AEOP). The AEOP needs specific information to create reports and defend funding for its outreach programs, GEMS included.

2. **We need to understand more about how GEMS is helping students know more about STEM career opportunities in the Department of Defense, especially civilian positions.**
   - Have you seen any efforts by GEMS to educate participants about the Army, DoD, or careers in the DoD?
   - What strategies seem to be the most effective for GEMS students?
   - Do you have any suggestions for helping GEMS teach students about careers in the DoD?

   The AEOP sponsors a wide range of national STEM outreach programs that these students qualify for.

3. **The AEOP needs to know if GEMS is teaching students about the other STEM outreach programs that it sponsors.**
   - First, are you aware of the other programs offered by the AEOP? (e.g., JSHS, JSS, REAP, SEAP, HSAP, etc.)
   - Have you seen any efforts at GEMS to educate adults or students about the other AEOP programs?
   - What seems to work the best? The worst?
   - Any suggestions for helping the AEOP educate these students about the other programs?

4. **The AEOP is trying to make sure that its programs become more effective at reaching adult and youth participants from underserved and underrepresented groups (racial/ethnic groups, low SES, etc.).**
   - Have you seen any efforts by GEMS to help engage underserved or underrepresented groups of adults and youth?
   - What strategies seem to work the best? The worst?
   - Any suggestions for helping GEMS reach new populations of adult and youth participants?

5. **What suggestions do you have for improving GEMS?**

6. **Last Chance - Have we missed anything? Tell us anything you want us to know that we didn't ask about.**

Appendix D

FY16 GEMS Student Survey Instrument

Contact Information		
Please verify the following information:		
*First Name:		
*Last Name:		
*Email Address:		
All fields with an asterisk (*) are required.		

*1. Do you agree to participate in this survey? (required)(*Required)		
Select one.		
○	Yes, I agree to participate in this survey	
○	No, I do not wish to participate in this survey	Go to end of chapter

2. What grade will you start in the fall? (select one)	
Select one.	
○	4th
○	5th
○	6th
○	7th
○	8th
○	9th
○	10th
○	11th
○	12th
○	College freshman
○	Choose not to report
○	Other, (specify)::

3. What is your gender?	
Select one.	
○	Male
○	Female
○	Choose not to report

4. What is your race or ethnicity?	
Select one.	
○	Hispanic or Latino
○	Asian
○	Black or African American
○	Native American or Alaska Native
○	Native Hawaiian or Other Pacific Islander
○	White
○	Choose not to report
○	Other race or ethnicity, (specify)::

5. Do you get free or reduced price lunches at school?	
Select one.	
○	Yes
○	No
○	Choose not to report

6. Which GEMS site did you participate in? (select one)

Select one.

○	ALABAMA – U.S. Army Aeromedical Research Laboratory (USAARL) – Fort Rucker, AL
○	ALABAMA – U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) – Redstone, AL
○	ILLINOIS – U.S. Army Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL) – Champaign, IL
○	MARYLAND – Aberdeen Proving Ground (APG) – Aberdeen, MD
○	MARYLAND – U.S. Army Medical Research and Materiel Command (USAMRMC) – Fort Detrick, MD
○	MARYLAND – U.S. Army Medical Research and Materiel Command - Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD
○	MASSACHUSETTS – U.S. Army Institute of Environmental Medicine (USARIEM) – Natick, MA
○	MISSISSIPPI – U.S. Army Engineer Research & Development Center - Vicksburg (ERDC-MS) – Vicksburg, MS
○	NEW MEXICO – White Sands Missile Range (WSMR) – White Sands, NM
○	TEXAS – U.S. Army Institute of Surgical Research (USAISR) – San Antonio, TX
○	DELAWARE - Armed Forces Medical Examiner System (AFMES) Dover Air Force Base

7. How often did you do each of the following in STEM classes at school?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	○	○	○	○	○
Apply STEM learning to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○

8. How often did you do each of the following in GEMS this year?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn about science, technology, engineering, or mathematics (STEM) topics that are new to you	○	○	○	○	○
Apply STEM learning to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○

9. How often did you do each of the following in STEM classes at school?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Use laboratory procedures and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

10. How often did you do each of the following in GEMS this year?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Use laboratory procedures and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

11. The list below includes effective teaching and mentoring strategies. From the list, please indicate which strategies that your mentor(s) used when working with you in GEMS:

Select one per row.

	Yes - my mentor used this strategy with me	*No - my mentor did not use this strategy with me*
Helped me become aware of STEM in my everyday life	○	○
Helped me understand how I can use STEM to improve my community	○	○
Used a variety of strategies to help me learn	○	○
Gave me extra support when I needed it	○	○
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	○	○
Allowed me to work on a team project or activity	○	○
Helped me learn or practice a variety of STEM skills	○	○
Gave me feedback to help me improve in STEM	○	○
Talked to me about the education I need for a STEM career	○	○
Recommended Army Educational Outreach Programs that match my interests	○	○
Discussed STEM careers with the DoD or government	○	○

12. How much did each of the following resources help you learn about Army Educational Outreach Programs (AEOPs)?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
My GEMS mentor(s)	○	○	○	○	○
Invited speakers or "career" events during GEMS	○	○	○	○	○
Participation in GEMS	○	○	○	○	○

13. How much did each of the following resources help you learn about STEM careers in the Army or Department of Defense (DoD)?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
My GEMS mentor(s)	○	○	○	○	○
Invited speakers or "career" events during GEMS	○	○	○	○	○
Participation in GEMS	○	○	○	○	○

14. How SATISFIED were you with the following GEMS features?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Applying or registering for the program	○	○	○	○	○
Communicating with your GEMS host site organizers	○	○	○	○	○
The physical location(s) of GEMS activities	○	○	○	○	○
The variety of STEM topics available to you in GEMS	○	○	○	○	○
Teaching or mentoring provided during GEMS activities	○	○	○	○	○
Stipends (payment)	○	○	○	○	○
Educational materials (e.g., workbooks, online resources, etc.) used during program activities	○	○	○	○	○
Invited speakers or "career" events	○	○	○	○	○
Field trips or laboratory tours	○	○	○	○	○

15. As a result of your GEMS experience, how much did you GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
In depth knowledge of a STEM topic(s)	○	○	○	○	○
Knowledge of research conducted in a STEM topic or field	○	○	○	○	○
Knowledge of research processes, ethics, and rules for conduct in STEM	○	○	○	○	○
Knowledge of how scientists and engineers work on real problems in STEM	○	○	○	○	○
Knowledge of what everyday research work is like in STEM	○	○	○	○	○

16. Which category best describes the focus of your student(s) GEMS activities?

Select one.

○	Science
○	Technology
○	Engineering
○	Mathematics

17. As a result of your GEMS experience, how much did you GAIN in the following areas?

Select one per row.

If answered, go to question number 19.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Asking a question that can be answered with one or more scientific experiments	○	○	○	○	○
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	○	○	○	○	○
Considering different interpretations of data when deciding how the data answer a question	○	○	○	○	○
Supporting an explanation for an observation with data from experiments	○	○	○	○	○
Defending an argument that conveys how an explanation best describes an observation	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your explanation of an observation	○	○	○	○	○
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	○	○	○	○	○

18. As a result of your GEMS experience, how much did you GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Defining a problem that can be solved by developing a new or improved object, process, or system	○	○	○	○	○
Using knowledge and creativity to propose a testable solution for a problem	○	○	○	○	○
Making a model of an object or system to show its parts and how they work	○	○	○	○	○
Carrying out procedures for an experiment and recording data accurately	○	○	○	○	○
Using computer models of an object or system to investigate cause and effect relationships	○	○	○	○	○
Considering different interpretations of the data when deciding if a solution works as intended	○	○	○	○	○
Organizing data in charts or graphs to find patterns and relationships	○	○	○	○	○
Supporting a solution for a problem with data from experiments	○	○	○	○	○
Defend an argument that conveys how a solution best meets design criteria	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your solution to a problem	○	○	○	○	○
Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)	○	○	○	○	○

19. As a result of your GEMS experience, how much did you GAIN in each of the skills/abilities listed below?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Sticking with a task until it is finished	○	○	○	○	○
Making changes when things do not go as planned	○	○	○	○	○
Working well with students from all backgrounds	○	○	○	○	○
Including others' perspectives when making decisions	○	○	○	○	○
Communicating effectively with others	○	○	○	○	○
Viewing failure as an opportunity to learn	○	○	○	○	○

20. As a result of your GEMS experience, how much did you GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Interest in a new STEM topic	○	○	○	○	○
Deciding on a path to pursue a STEM career	○	○	○	○	○
Sense of accomplishing something in STEM	○	○	○	○	○
Feeling prepared for more challenging STEM activities	○	○	○	○	○
Thinking creatively about a STEM project or activity	○	○	○	○	○
Desire to build relationships with mentors who work in STEM	○	○	○	○	○
Connecting a STEM topic or field to my personal values	○	○	○	○	○

21. As a result of your GEMS experience, are you MORE or LESS likely to engage in the following activities in science, technology, engineering, or mathematics (STEM) outside of school requirements or activities?

Select one per row.

	Much less likely	*Less likely*	*About the same before and after*	*More likely*	*Much more likely*
Watch or read non-fiction STEM	○	○	○	○	○
Tinker (play) with a mechanical or electrical device	○	○	○	○	○
Work on solving mathematical or scientific puzzles	○	○	○	○	○
Use a computer to design or program something	○	○	○	○	○
Talk with friends or family about STEM	○	○	○	○	○
Mentor or teach other students about STEM	○	○	○	○	○
Help with a community service project related to STEM	○	○	○	○	○
Participate in a STEM camp, club, or competition	○	○	○	○	○
Take an elective (not required) STEM class	○	○	○	○	○
Work on a STEM project or experiment in a university or professional setting	○	○	○	○	○

22. Before you participated in GEMS, how far did you want to go in school?	
Select one.	
○	Graduate from high school
○	Go to a trade or vocational school
○	Go to college for a little while
○	Finish college (get a Bachelor's degree)
○	Get more education after college

23. After you have participated in GEMS, how far do you want to go in school?	
Select one.	
○	Graduate from high school
○	Go to a trade or vocational school
○	Go to college for a little while
○	Finish college (get a Bachelor's degree)
○	Get more education after college

24. When you are 30, to what extent do you expect to use your STEM knowledge, skills, and/or abilities in your job?	
Select one.	
○	not at all
○	up to 25% of the time
○	up to 50% of the time
○	up to 75% of the time
○	up to 100% of the time

25. Before you participated in GEMS, what kind of work did want to do when you are 30 years old? (select one)

Select one.

○	Undecided
○	Scientist or researcher
○	Work in computers or technology
○	Engineer or architect
○	Work in the medical field (doctor, nurse, lab technician)
○	Teacher
○	Business person or manager
○	Lawyer
○	Military, police, or security
○	Artist (writer, dancer, painter)
○	Skilled craftsperson (carpenter, electrician, machinist)
○	Athlete or other work in sports
○	Other, (specify)::

26. After you have participated in GEMS, what kind of work do you want to do when you are 30 years old? (select one)

Select one.

○	Undecided
○	Scientist or researcher
○	Work in computers or technology
○	Engineer or architect
○	Work in the medical field (doctor, nurse, lab technician)
○	Teacher
○	Business person or manager
○	Lawyer
○	Military, police, or security
○	Artist (writer, dancer, painter)
○	Skilled craftsperson (carpenter, electrician, machinist)
○	Athlete or other work in sports
○	Other, specify::

27. How interested are you in participating in the following programs in the future?

Select one per row.

	I've never heard of this program	*Not at all*	*A little*	*Somewhat*	*Very much*
Camp Invention	○	○	○	○	○
eCYBERMISSION	○	○	○	○	○
Junior Solar Sprint (JSS)	○	○	○	○	○
Gains in the Education of Mathematics and Science (GEMS)	○	○	○	○	○
UNITE	○	○	○	○	○
Junior Science & Humanities Symposium (JSHS)	○	○	○	○	○
Science & Engineering Apprenticeship Program (SEAP)	○	○	○	○	○
Research & Engineering Apprenticeship Program (REAP)	○	○	○	○	○
High School Apprenticeship Program (HSAP)	○	○	○	○	○
College Qualified Leaders (CQL)	○	○	○	○	○
GEMS Near Peer Mentor Program	○	○	○	○	○
Undergraduate Research Apprenticeship Program (URAP)	○	○	○	○	○
Science Mathematics, and Research for Transformation (SMART) College Scholarship	○	○	○	○	○
National Defense Science & Engineering Graduate (NDSEG) Fellowship	○	○	○	○	○

28. How many jobs/careers in STEM did you learn about during GEMS?

Select one.

○	None
○	1
○	2
○	3
○	4
○	5 or more

29. How many Army or Department of Defense (DoD) STEM jobs/careers did you learn about during GEMS?

Select one.

○	None
○	1
○	2
○	3
○	4
○	5 or more

30. How much do you agree or disagree with the following statements about Department of Defense (DoD) researchers and research:

Select one per row.

	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
DoD researchers advance science and engineering fields	○	○	○	○	○
DoD researchers develop new, cutting edge technologies	○	○	○	○	○
DoD researchers solve real-world problems	○	○	○	○	○
DoD research is valuable to society	○	○	○	○	○

31. Which of the following statements describe you AFTER participating in the GEMS program?

Select one per row.

	Disagree - This did not happen	*Disagree - This happened but not because of GEMS*	*Agree - GEMS contributed*	*Agree - GEMS was primary reason*
I am more confident in my STEM knowledge, skills, and abilities	○	○	○	○
I am more interested in participating in STEM activities outside of school requirements	○	○	○	○
I am more aware of other AEOPs	○	○	○	○
I am more interested in participating in other AEOPs	○	○	○	○
I am more interested in taking STEM classes in school	○	○	○	○
I am more interested in earning a STEM degree	○	○	○	○
I am more interested in pursuing a career in STEM	○	○	○	○
I am more aware of Army or DoD STEM research and careers	○	○	○	○
I have a greater appreciation of Army or DoD STEM research	○	○	○	○
I am more interested in pursuing a STEM career with the Army or DoD	○	○	○	○

32. What are the three most important ways that GEMS has helped you?	
Benefit #1:	
Benefit #2:	
Benefit #3:	

33. What are the three ways that we could make GEMS better?	
Improvement #1:	
Improvement #2:	
Improvement #3:	

34. Please tell us about your overall satisfaction with your GEMS experience.

Appendix E

FY16 GEMS Mentor Survey Instrument

Contact Information		
Please verify the following information:		
*First Name:		
*Last Name:		
*Email Address:		
All fields with an asterisk (*) are required.		

*1. Do you agree to participate in this survey? (required)(*Required)		
Select one.		
○	Yes, I agree to participate in this survey	(Go to question number 2.)
○	No, I do not wish to participate in this survey	Go to end of chapter

4. What is your gender?	
Select one.	
○	Male
○	Female
○	Choose not to report

5. What is your race or ethnicity?	
Select one.	
○	Hispanic or Latino
○	Asian
○	Black or African American
○	Native American or Alaska Native
○	Native Hawaiian or Other Pacific Islander
○	White
○	Choose not to report
○	Other race or ethnicity, (specify)::

6. Which of the following BEST describes the organization you work for? (select ONE)	
Select one.	
○	No organization
○	School or district (K-12)
○	State educational agency
○	Institution of higher education (vocational school, junior college, college, or university)
○	Private Industry
○	Department of Defense or other government agency
○	Non-profit
○	Other, (specify):

7. Which of the following BEST describes your current occupation (select ONE)		
Select one.		
○	Teacher	(Go to question number 8.)
○	Other school staff	(Go to question number 8.)
○	University educator	(Go to question number 13.)
○	Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	(Go to question number 13.)
○	Scientist, Engineer, or Mathematics professional	(Go to question number 13.)
○	Other, (specify):	(Go to question number 13.)

8. What grade level(s) do you teach (select all that apply)?	
Select all that apply.	
☐	Upper elementary
☐	Middle school
☐	High school

9. Which best describes the location of your school?	
Select one.	
○	Frontier or tribal school
○	Rural (country)
○	Suburban
○	Urban (city)

10. At what kind of school did you teach while participating in GEMS?	
Select one.	
○	Public school
○	Private school
○	Home school
○	Online school
○	Department of Defense school (DoDDS, DoDEA)

11. Do you work at a "Title-I" school?	
Select one.	
○	Yes
○	No
○	I am not sure

12. Which of the following subjects do you teach? (select ALL that apply)

Select all that apply.

☐	Upper elementary
☐	Physical science (physics, chemistry, astronomy, materials science, etc.)
☐	Biological science
☐	Earth, atmospheric, or oceanic science
☐	Environmental science
☐	Computer science
☐	Technology
☐	Engineering
☐	Mathematics or statistics
☐	Medical, health, or behavioral science
☐	Social Science (psychology, sociology, anthropology)
☐	Other, (specify)::

13. Which of the following best describes your primary area of research?

Select one.

○	Physical science (physics, chemistry, astronomy, materials science, etc.)
○	Biological science
○	Earth, atmospheric, or oceanic science
○	Environmental science
○	Computer science
○	Technology
○	Engineering
○	Mathematics or statistics
○	Medical, health, or behavioral science
○	Social Science (psychology, sociology, anthropology)
○	Other, (specify)::

14. Which GEMS site did you participate in? (select one)	
Select one.	
○	ALABAMA – U.S. Army Aeromedical Research Laboratory (USAARL) – Fort Rucker, AL
○	ALABAMA – U.S. Army Aviation & Missile Research, Development & Engineering Center (AMRDEC) – Redstone, AL
○	ILLINOIS – U.S. Army Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL) – Champaign, IL
○	MARYLAND – Aberdeen Proving Ground (APG) – Aberdeen, MD
○	MARYLAND – U.S. Army Medical Research and Materiel Command (USAMRMC) – Fort Detrick, MD
○	MARYLAND – U.S. Army Medical Research and Materiel Command - Walter Reed Army Institute of Research (WRAIR) – Silver Spring, MD
○	MARYLAND – U.S. Army Research Laboratory - Adelphi (ARL-A) – Adelphi, MD
○	MASSACHUSETTS – U.S. Army Institute of Environmental Medicine (USARIEM) – Natick, MA
○	MISSISSIPPI – U.S. Army Engineer Research & Development Center - Vicksburg (ERDC-MS) – Vicksburg, MS
○	NEW MEXICO – White Sands Missile Range (WSMR) – White Sands, NM
○	TEXAS – U.S. Army Institute of Surgical Research (USAISR) – San Antonio, TX
○	DELAWARE - Armed Forces Medical Examiner System (AFMES) Dover Air Force Base

15. Which of the following BEST describes your role during GEMS?	
Select one.	
○	Instructor (typically a University or Army Scientist or Engineer)
○	Classroom Assistant
○	Resource Teacher
○	Near Peer mentor
○	Assistant Near Peer mentor
○	Other, (specify)::

16. How many GEMS students did you work with this year?
_____ students.

19. How SATISFIED were you with the following GEMS features?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Application or registration process	○	○	○	○	○
Communicating with the National Science Teachers Association (NSTA)	○	○	○	○	○
Communicating with GEMS organizers / site coordinators	○	○	○	○	○
The physical location(s) of GEMS's activities	○	○	○	○	○
Support for instruction or mentorship during program activities	○	○	○	○	○
Stipends (payment)	○	○	○	○	○
Invited speakers or "career" events	○	○	○	○	○
Field trips or laboratory tours	○	○	○	○	○

20. The list below describes mentoring strategies that are effective ways to establish the relevance of learning activities for students. From the list below, please indicate which strategies you used when working with your student(s) in GEMS.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Become familiar with my student(s) background and interests at the beginning of the GEMS experience	○	○
Giving students real-life problems to investigate or solve	○	○
Selecting readings or activities that relate to students' backgrounds	○	○
Encouraging students to suggest new readings, activities, or projects	○	○
Helping students become aware of the role(s) that STEM plays in their everyday lives	○	○
Helping students understand how STEM can help them improve their own community	○	○
Asking students to relate real-life events or activities to topics covered in GEMS	○	○

21. The list below describes mentoring strategies that are effective ways to support the diverse needs of students as learners. From the list below, please indicate which strategies you used when working with your student(s) in GEMS.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Identify the different learning styles that my student (s) may have at the beginning of the GEMS experience	○	○
Interact with students and other personnel the same way regardless of their background	○	○
Use a variety of teaching and/or mentoring activities to meet the needs of all students	○	○
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	○	○
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	○	○
Directing students to other individuals or programs for additional support as needed	○	○
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	○	○

22. The list below describes mentoring strategies that are effective ways to support students' development of collaboration and interpersonal skills. From the list below, please indicate which strategies you used when working with your student(s) in GEMS.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Having my student(s) tell other people about their backgrounds and interests	○	○
Having my student(s) explain difficult ideas to others	○	○
Having my student(s) listen to the ideas of others with an open mind	○	○
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	○	○
Having my student(s) give and receive constructive feedback with others	○	○
Having students work on collaborative activities or projects as a member of a team	○	○
Allowing my student(s) to resolve conflicts and reach agreement within their team	○	○

23. The list below describes mentoring strategies that are effective ways to support students' engagement in "authentic" STEM activities. From the list below, please indicate which strategies you used when working with your student(s) in GEMS.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Teaching (or assigning readings) about specific STEM subject matter	○	○
Having my student(s) search for and review technical research to support their work	○	○
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	○	○
Supervising my student(s) while they practice STEM research skills	○	○
Providing my student(s) with constructive feedback to improve their STEM competencies	○	○
Allowing students to work independently to improve their self-management abilities	○	○
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	○	○
Encouraging students to seek support from other team members	○	○

24. This list describes mentoring strategies that are effective ways to support students' STEM educational and career pathways. The list also includes items that reflect AEOP and Army priorities. From this list, please indicate which strategies you used when working with your student(s) in GEMS.

Select one per row.

	Yes - I used this strategy	*No - I did not use this strategy*
Asking my student(s) about their educational and/or career goals	○	○
Recommending extracurricular programs that align with students' goals	○	○
Recommending Army Educational Outreach Programs that align with students' goals	○	○
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	○	○
Discussing STEM career opportunities within the DoD or other government agencies	○	○
Discussing STEM career opportunities in private industry or academia	○	○
Discussing the economic, political, ethical, and/or social context of a STEM career	○	○
Recommending student and professional organizations in STEM to my student(s)	○	○
Helping students build a professional network in a STEM field	○	○
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	○	○

25. How useful were each of the following in your efforts to expose student(s) to Army Educational Outreach Programs (AEOPs) during GEMS?

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
GEMS Program administrator or site coordinator	○	○	○	○	○
Invited speakers or "career" events	○	○	○	○	○
Participation in GEMS	○	○	○	○	○

26. How USEFUL were each of the following in your efforts to expose your student(s) to Department of Defense (DoD) STEM careers during GEMS.

Select one per row.

	Did not experience	*Not at all*	*A little*	*Somewhat*	*Very much*
Army Educational Outreach Program (AEOP) website	○	○	○	○	○
AEOP on Facebook, Twitter, Pinterest or other social media	○	○	○	○	○
AEOP brochure	○	○	○	○	○
It Starts Here! Magazine	○	○	○	○	○
GEMS Program administrator or site coordinator	○	○	○	○	○
Invited speakers or "career" events	○	○	○	○	○
Participation in GEMS	○	○	○	○	○

27. Which of the following AEOPs did YOU EXPLICITLY DISCUSS with your student(s) during GEMS? (check ALL that apply)

Select one per row.

	Yes - I discussed this program with my student(s)	*No - I did not discuss this program with my student(s)*
Gains in the Education of Mathematics and Science (GEMS)	○	○
UNITE	○	○
Junior Science & Humanities Symposium (JSHS)	○	○
Science & Engineering Apprenticeship Program (SEAP)	○	○
Research & Engineering Apprenticeship Program (REAP)	○	○
High School Apprenticeship Program (HSAP)	○	○
College Qualified Leaders (CQL)	○	○
GEMS Near Peer Mentor Program	○	○
Undergraduate Research Apprenticeship Program (URAP)	○	○
Science Mathematics, and Research for Transformation (SMART) College Scholarship	○	○
National Defense Science & Engineering Graduate (NDSEG) Fellowship	○	○
I discussed AEOP with my student(s) but did not discuss any specific program	○	○

28. How much do you agree or disagree with the following statements about Department of Defense (DoD) researchers and research:

Select one per row.

	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*
DoD researchers advance science and engineering fields	○	○	○	○	○
DoD researchers develop new, cutting edge technologies	○	○	○	○	○
DoD researchers solve real-world problems	○	○	○	○	○
DoD research is valuable to society	○	○	○	○	○

29. How often did YOUR STUDENT(S) have opportunities to do each of the following in GEMS?

Select one per row.

	Not at all	*At least once*	*A few times*	*Most days*	*Every day*
Learn new science, technology, engineering, or mathematics (STEM) topics	○	○	○	○	○
Apply STEM knowledge to real-life situations	○	○	○	○	○
Learn about new discoveries in STEM	○	○	○	○	○
Learn about different careers that use STEM	○	○	○	○	○
Interact with scientists or engineers	○	○	○	○	○
Communicate with other students about STEM	○	○	○	○	○
Use laboratory or field techniques, procedures, and tools	○	○	○	○	○
Participate in hands-on STEM activities	○	○	○	○	○
Work as part of a team	○	○	○	○	○
Identify questions or problems to investigate	○	○	○	○	○
Design an investigation	○	○	○	○	○
Carry out an investigation	○	○	○	○	○
Analyze data or information	○	○	○	○	○
Draw conclusions from an investigation	○	○	○	○	○
Come up with creative explanations or solutions	○	○	○	○	○
Build or make a computer model	○	○	○	○	○

30. AS A RESULT OF THEIR GEMS EXPERIENCE, how much did your student(s) GAIN in the following areas?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
In depth knowledge of a STEM topic(s)	○	○	○	○	○
Knowledge of research conducted in a STEM topic or field	○	○	○	○	○
Knowledge of research processes, ethics, and rules for conduct in STEM	○	○	○	○	○
Knowledge of how professionals work on real problems in STEM	○	○	○	○	○
Knowledge of what everyday research work is like in STEM	○	○	○	○	○

31. Which category best describes the focus of your student(s) GEMS activities?

Select one.

○	Science
○	Technology
○	Engineering
○	Mathematics

32. AS A RESULT OF THEIR GEMS EXPERIENCE, how much did your student(s) GAIN in their abilities to do each of the following?

Select one per row.

If answered, go to question number 34.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Asking a question that can be answered with one or more scientific experiments	○	○	○	○	○
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	○	○	○	○	○
Considering different interpretations of data when deciding how the data answer a question	○	○	○	○	○
Supporting an explanation for an observation with data from experiments	○	○	○	○	○
Defending an argument that conveys how an explanation best describes an observation	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your explanation of an observation	○	○	○	○	○
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	○	○	○	○	○

33. AS A RESULT OF THEIR GEMS EXPERIENCE, how much did your student(s) GAIN in their ability to do each of the following?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Defining a problem that can be solved by developing a new or improved object, process, or system	○	○	○	○	○
Using knowledge and creativity to propose a testable solution for a problem	○	○	○	○	○
Making a model of an object or system to show its parts and how they work	○	○	○	○	○
Carrying out procedures for an experiment and recording data accurately	○	○	○	○	○
Using computer models of an object or system to investigate cause and effect relationships	○	○	○	○	○
Considering different interpretations of the data when deciding if a solution works as intended	○	○	○	○	○
Organizing data in charts or graphs to find patterns and relationships	○	○	○	○	○
Supporting a solution for a problem with data from experiments	○	○	○	○	○
Defend an argument that conveys how a solution best meets design criteria	○	○	○	○	○
Integrating information from technical or scientific texts and other media to support your solution to a problem	○	○	○	○	○
Communicating information about your design experiments and solutions in different ways (through talking, writing, graphics, or math equations)	○	○	○	○	○

34. AS A RESULT OF THE GEMS EXPERIENCE, how much did your student(s) GAIN (on average) in the skills/abilities listed below?

Select one per row.

	No gain	*A little gain*	*Some gain*	*Large gain*	*Extreme gain*
Sticking with a task until it is finished	○	○	○	○	○
Making changes when things do not go as planned	○	○	○	○	○
Including others' perspectives when making decisions	○	○	○	○	○
Communicating effectively with others	○	○	○	○	○
Desire to build relationships with professionals in a field	○	○	○	○	○
Connecting a topic or field with their personal values	○	○	○	○	○

35. Which of the following statements describe YOUR STUDENT(S) after participating in the GEMS program?

Select one per row.

	Disagree - This did not happen	*Disagree - This happened but not because of JSS*	*Agree - JSS contributed*	*Agree - JSS was primary reason*
More confident in STEM knowledge, skills, and abilities	○	○	○	○
More interested in participating in STEM activities outside of school requirements	○	○	○	○
More aware of other AEOPs	○	○	○	○
More interested in participating in other AEOPs	○	○	○	○
More interested in taking STEM classes in school	○	○	○	○
More interested in earning a STEM degree	○	○	○	○
More interested in pursuing a career in STEM	○	○	○	○
More aware of DoD STEM research and careers	○	○	○	○
Greater appreciation of DoD STEM research	○	○	○	○
More interested in pursuing a STEM career with the DoD	○	○	○	○

36. What are the three most important strengths of GEMS?	
Strength #1:	
Strength #2:	
Strength #3:	

37. What are the three ways GEMS should be improved for future participants?	
Improvement #1:	
Improvement #2:	
Improvement #3:	

38. Please tell us about your overall satisfaction with your GEMS experience.

Appendix F

NSTA FY16 Evaluation Report Response

On behalf of NSTA, we want to thank the evaluation team for the useful data that will guide our efforts to improve our efforts in promoting not only GEMS, but also all AEOP initiatives, along with the AEOP goals. NSTA will share and discuss these findings with our GEMS staff to accomplish the changes needed to provide a better program in FY17.

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

1) GEMS is always looking to expand and invite more students. The addition of new locations is welcome and much of FY17 tasking will be welcoming these new locations. Current locations are unlikely to expand without further support from the command elements that lead them. Physical space to meet and staff time to coordinate are arranged by the leaders of each facility. It will be up to these leaders to further their investment and up to AEOP elements to protect and support that investment. NSTA increased GEMS staffing from 1.3 FTE to 2.0 FTE to help build support.
2) Underserved and underrepresented population demographics vary from site to site but transportation seems to be a difficulty at every location. GEMS is hopeful that newly chosen AEOP Strategic Partners will be able to create important bridges to transportation partners. Local partners are also a potential solution, but the complexity of working with many small partners that only affect a single location may be challenging given the current scope of work.
3) Personal connections are an important part of how parents trust GEMS with their children for many hours a week; however, GEMS stands to gain from giving more students with diverse backgrounds a connection to the lab. The application and selection process should be weighted to help select the underserved/underrepresented populations that are goals for the GEMS program. This will increase the number of personal connections with members of underrepresented and underserved community. GEMS will also have to evaluate barriers in addition to selection for members of those communities. Widmeyer and MetriKs Amerique will be important partners in evaluating outreach methods.

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

1) Focus group responses from mentors echo some of the concerns of Local Program Coordinators, especially with respect of overhead funding and support of leaders. Overhead funding is difficult to affect for those outside of the lab's directorate. GEMS and AEOP may be able to encourage support from leaders and formalize some of that support in terms of certificates and letters of recognition. The request for assistance in recruiting students seems somewhat at odds with the increase in applications and the repeated recommendation to expand

services. GEMS may be able to further streamline operational tasks like recruitment to address perceptions of difficulty. Army S&Es are not used as mentors at all locations. Most students experience five days of mentorship with a specific NPM or RT; most students spend less than half a day with a specific S&E.

2) GEMS will look to start formalizing some of its staff onboarding processes to insure better dissemination of AEOP information. A standardized welcome letter or an appendix to the IPA's Terms and Conditions may support this process in FY17.
3) GEMS' IPA was in a transitional year during FY16 and processes are in place for FY17 to increase the communication and timeliness of staff payments.

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

1) GEMS will look to start formalizing some of its staff onboarding processes to insure better dissemination of AEOP information. A standardized welcome letter or an appendix to the IPA's Terms and Conditions may support this process in FY17.
2) GEMS will recommend setting aside program time for Mentor Questionnaires as a best practice to increase the number of completed questionnaires. Additional tablets with offline capabilities are planned for FY17; this should increase survey participation.