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Army Educational Outreach Program

Gains in the Education of Mathematics and Science (GEMS)

2017 Annual Program Evaluation Report

PART 2: Evaluation Findings

February 2018

ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

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). GEMS is administered on behalf of the Army by the National Science Teachers Association (NSTA). 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 NSTA on behalf of the 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 sites 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, inquiry-based model) and procedures that make sense considering the specialties of each 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 younger GEMS participants. 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 15 Army research centers and laboratories operating in 8 states (see Table 1). In 2017, GEMS provided outreach to 2,845 students at 12 sites. This number represents a 15% increase in enrollment from 2016 when 2,427 students participated, a 20% increase from 2015 when 2,270 students participated, and a 26% 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

4,653 applications were submitted in 2017, an increase of 5% from 2016 when there were 4,414 applicants, an increase of 10% over 2015 when there were 4,161 applicants, and an increase of 28% over 2014 when 3,343 students submitted GEMS applications. Table 2 provides the application and participation data by GEMS site for 2017. In addition to student participants, there were 510 adults working in the program across the various sites, a 32% increase over adult participation in 2016.

Table 1. 2017 GEMS Sites		
Laboratory	**Command***	**Location**
U.S. Army Armament Research, Development and Engineering Center (ARDEC)	RDECOM	Picatinny Arsenal, NJ
U.S. Army Aviation and Missile Research Development and Engineering Center (AMRDEC)	RDECOM	Huntsville, AL
U.S. Army Research Laboratory –Aberdeen Proving Ground (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 (ATEC - 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 (MRMC-Ft. Detrick)	USAMRMC	Fort Detrick, MD
U.S. Army Research Institute for Surgical Research (USAISR)	USAMRMC	San Antonio, TX
U.S. Army Research Institute for Environmental Medicine (USARIEM)	USAMRMC	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

Table 2. 2017 GEMS Site Applicant and Enrollment Numbers			
Command	**2017 GEMS Site**	**Number of Applicants**	**Number of Enrolled Participants**
RDECOM	Armament Research, Development and Engineering Center (ARDEC)	158	133
	Aviation and Missile Research Development and Engineering Center (AMRDEC)	188	140
	Army Research Laboratory - Aberdeen Proving Ground (ARL-APG) †	613	249
	Army Research Laboratory-Adelphi (ARL-Adelphi)	294	164
	White Sands Missile Range (ARL-WSMR)	191	72
MRMC	Army Aeromedical Research Laboratory (USAARL)	504	404
	Army Medical Research and Material Command at Fort Detrick (USAMRMC-Ft. Detrick)	817	611
	Army Research Institute for Surgical Research (USAISR)	151	58
	Army Research Institute for Environmental Medicine (USARIEM)	346	191
	Walter Reed Army Institute of Research (WRAIR)	1166	672
USACE	Engineer Research & Development Center- Construction Engineering Research Laboratory (ERDC-CERL)	59	40
	Engineer Research & Development Center-Mississippi (ERDC-MS)	166	111
TOTAL		**4,653**	**2,845**

Table 3 displays demographic information for enrolled GEMS student participants in 2017. Enrollment in GEMS grew 15% from 2016 to 2017 (2,427 students in 2016; 2,845 students in 2017), exceeding the 2017 program goal of 2,550 participants. Overall student demographics for 2017 are similar to those of 2016. The percentage of females in 2017 was 47%, compared with 46% in 2016. The proportion of students identifying as White decreased somewhat from 42% in 2016 to 38% in 2017. There was a slight increase in participation of Black or African American students in 2017 (26% compared to 23% in 2016). Asian students comprised 18% of enrolled participants (compared to 17% in 2016) and 7% of students identified themselves as Hispanic or Latino (compared to 8% in 2016). The proportion of students receiving free or reduced-price lunch, a commonly used indicator of low-income status, in 2017 (12%) was also similar to 2016 (10%).

Table 3. 2017 GEMS Enrolled Student Profile		
Demographic Category	GEMS Participants	
Respondent Gender (n=2845)		
Female	1,323	47%
Male	1,513	53%
Choose not to report	9	<1%
Respondent Race/Ethnicity (n=2845)		
Asian	507	18%
Black or African American	737	26%
Hispanic or Latino	207	7%
Native American or Alaska Native	15	1%
Native Hawaiian or Other Pacific Islander	16	1%
White	1,088	38%
Other race or ethnicity	135	5%
Choose not to report	146	5%
Underserved[1] (n=2845)		
Yes	455	16%
No	2,390	84%
Receives Free or Reduced-Price Lunch (n=2845)		
Yes	344	12%
No	2501	88%
Choose not to report	0	0%

The total cost of the 2017 GEMS program was $1,306,404, 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 $459. 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 2017 GEMS program costs.

[1] AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other federal targeted outreach schools; females in certain STEM fields.

Table 4. 2017 GEMS Program Costs	
2017 GEMS Students – Cost Per Participant	
Number of Students	2,845
Total Cost	$1,306,404
Cost Per Participant (Student)	**$459**
2017 GEMS Students, Near-Peer Mentors, and Resource Teachers – Cost Per Participant	
Number of Students	2,845
Number of Adults (including S&Es and Teachers)	510
Grand Total Participants	3,355
Cost Per Participant	**$389**
2017 GEMS Cost Breakdown	
Participant Stipends (Students, NPMs and RTs)	$883,639
Administratative Costs	$214,212
Equipment and Supplies	$175,128
Other Operational Costs	$33,425

4 | 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. 2017 activities to support priority:
      i. Provided outreach materials to Local Program Coordinators (LPCs) for distribution at schools and community events.
      ii. Supported Widmeyer and Metriks Amerique in their marketing and outreach by providing access to stories from alumni and FY17 participants.
      iii. Conducted outreach on behalf of the GEMS sites in Adelphi and Silver Spring, Maryland.
      iv. Wrote alumni blogs for Widmeyer for recruitment support.

   b. Outcomes:
      i. FY 17 target participation of 2,550; actual participation of 2,845.
      ii. FY17 target applications of 4,600; actual applications of 4,653.
      iii. FY17 target of underserved and under-represented students of 16%; actual underserved and under-represented students served of 16%.

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

   a. 2017 activities to support priority:
      i. Set up communications with newly selected Local Program Coordinator (LPC) in Picatinny Arsenal, New Jersey, and Vicksburg, Mississippi.
   b. Outcome: FY17 target of 15 GEMS sites; 12 actual GEMS sites

III. **Increase Camp Invention (CI) Alumni participation in GEMS. (Supports Priority 1, Objectives A, B, C, & D)**
   a. 2017 activities to support priority:
      i. Invited each LPC to conduct site visits at their nearby sponsored location.
      ii. Conducted email marketing campaign to AEOP-CI participants to raise awareness of local GEMS program.
      iii. Provided AEOP collateral at each AEOP-CI location.
      iv. Hosted National Inventors Hall of Fame POC at GEMS Review to raise LPC's awareness of CI curriculum and success to promote CI alumni selection.

   b. Outcome: FY17 target participation of 7%; actual 6%.

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

a. 2017 activities to support priority:

i. Coordinated with website admins for an individual GEMS landing page on www.usaeop.com for each GEMS location. This created an opportunity for applicants to navigate to other programs during time of high traffic, e.g., registration.

ii. Recruited participants into the alumni network, whose newsletters promote AEOP programming.

iii. Promoted AEOP knowledge to mentors and staff during IPA site visits to program through asking and answering questions.

iv. Provided AEOP marketing materials to LPCs to distribute.

v. Partnered with eCM staff to facilitate GEMS-site-led eCM teams. This is currently being discussed.

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

a. 2017 activities to support priority:

i. Promote and encourage inclusion of local scientists and engineers (S&E) to LPCs whenever and wherever possible.

5 | Evaluation At-A-Glance

Purdue University, in collaboration with NSTA, conducted a comprehensive evaluation of GEMS. The GEMS logic model below presents a summary of the expected outputs and outcomes for GEMS 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 15 Army research laboratories operating at 12 sites in 8 states • 2,845 Students participating in GEMS programs • 510 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 motivate participation?
- What aspects of GEMS structure and processes are working well?
- What aspects of GEMS could be improved?
- Did participation in GEMS:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

The assessment strategy for GEMS included student and mentor questionnaires, 4 focus groups with students, 2 focus groups with NPMs, 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. 2017 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. 2017 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. 2017 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. 2017 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. 2017 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 the appendices, found in Part 3 of the evaluation report. Appendix A contains the GEMS 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 Appendices 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; caution is therefore warranted when interpreting these data. It should be noted that the mentor response rate has continued an upward trend: 6% in 2015, 8% in 2016, and 11% in 2017. The student response rate for 2017 was slightly higher than in 2016 when 74% of students responded, but lower than the 2015 response rate of 93%.

Table 10. 2017 GEMS Questionnaire Participation				
Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[2]
Students	2,169	2,845	76%	±1.03%
Mentors	54	510	11%	±12.62%

[2] "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

Four student focus groups and 2 mentor focus groups were conducted at GEMS sites. Student focus groups were conducted at 3 sites and included 31 students (14 females, 17 males). Twelve student participants were White, 11 were Hispanic or Latino, 3 were Asian, 2 were Black or African American, and 3 were of other races/ethnicities. Five participants were elementary age students (grades 3-5); 15 were middle school age students (grades 6-8); and 11 were high school age students (grades 9-12). Two mentor focus groups were also conducted at 2 sites and included 10 NPMs (7 females and 3 males). Nine of the NPMs were White and 1 was Black or African American. 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

Demographic information for students who responded to the questionnaire are displayed in Table 11. Overall, students responding to the questionnaire were demographically similar to the population of enrolled GEMS students. For example, 48% of questionnaire respondents were female as compared to 47% of enrolled GEMS participants. Likewise, 25% of questionnaire respondents identified themselves as Black or African American and 6% as Hispanic or Latino compared with 26% (Black or African American) and 7% (Hispanic or Latino) of enrolled participants. A somewhat larger proportion of questionnaire respondents reported receiving free or reduced-price lunch (19%) than in the overall population (12%).

At enrollment, students were asked how many times they had participated in each of the AEOPs in the past. Table 12 displays the results for participants who provided this information and shows that nearly half (48%) of responding students had participated in GEMS at least once previously. Camp Invention was the only other program students had participated in (8%); 41% of students indicated never having participated in any AEOP in the past.

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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.

Table 11. 2017 GEMS Student Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 2,169)		
Female	1,043	48.1%
Male	1,121	51.7%
Choose not to report	5	0.2%
Respondent Race/Ethnicity (n = 2,128)		
Asian	403	18.9%
Black or African American	526	24.7%
Hispanic or Latino	137	6.4%
Native American or Alaska Native	17	0.8%
Native Hawaiian or Other Pacific Islander	14	0.7%
White	850	39.9%
Other race or ethnicity	94	4.4%
Choose not to report	87	4.1%
Respondent Grade Level (n = 1,400)		
4th	38	2.7%
5th	94	6.7%
6th	205	14.6%
7th	318	22.7%
8th	396	28.3%
9th	326	23.3%
10th	21	1.5%
11th	2	0.1%
12th	38	2.7%
First-Year College Student	0	0%
Choose not to report	0	0%
Respondent Eligible for Free/Reduced-Price Lunch (n = 2,158)		
Yes	407	18.9%
No	1705	79.0%
Choose not to report	46	2.1%

Table 12. Student Past Participation in AEOP Programs (n=152)

	Response Percent	Response Total
Camp Invention	7.89%	12
eCYBERMISSION	0.66%	1
Junior Solar Sprint (JSS)	0.00%	0
Gains in the Education of Mathematics and Science	48.68%	74
UNITE	0.00%	0
Junior Science & Humanities Symposium (JSHS)	0.00%	0
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	0.00%	0
I've never participated in any AEOP programs	41.45%	63

Mentor Demographics

Table 13 summarizes demographics, occupations, and roles in GEMS for responding mentors. Most mentors who responded to the questionnaire were female (61%) and nearly half (48%) identified themselves as White, while 26% identified themselves as Black or African American and 9% as Asian. Over a third (37%) of respondents were teachers and about a quarter of mentor respondents (24%) were scientists, engineers, or mathematicians in training. Over half (56%) of mentor respondents served as NPMs in the program and 30% served as RTs.

Table 13. 2017 GEMS Mentor Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 54)		
Female	33	61%
Male	21	39%
Respondent Race/Ethnicity (n = 54)		
Asian	5	9%
Black or African American	14	26%
Native American or Alaskan Native	0	0%
Native Hawaiian or other Pacific Islander	0	0%
White or Caucasian	26	48%

Other	3	6%
Respondent Occupation (n = 54)		
Teacher	20	37%
Other school staff	1	2%
University educator	0	0%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	13	24%
Scientist, Engineer, or Mathematics professional	5	9%
Other	15	28%
Respondent Role in GEMS (n = 54)		
Instructor (typically a University or Army Scientist or Engineer)	6	11%
Classroom Assistant	1	2%
Resource teacher (RT)	16	30%
Near peer mentor (NPM)	30	56%
Assistant Near peer mentor	0	0%
Other	1	2%

6 | 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. 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 Underrepresented and Underserved Populations

The FY17 Annual Program Report details several strategies that were used to disseminate information about the GEMS program. Program outreach efforts included the following:

- Provided outreach materials to Local Program Coordinators (LPCs) for distribution at schools and community events.
- Supported Widmeyer and Metriks Amerique in their marketing and outreach by providing access to stories from alumni and FY17 participants.
- Conducted outreach on behalf of the GEMS sites in Adelphi and Silver Spring, Maryland.
- Wrote alumni blogs for Widmeyer for recruitment support.
- Conducted email marketing campaign to AEOP-CI participants to raise awareness of local GEMS program.
- Cooperated with outreach partners, like DC STEM network and Prince Georges County Public Schools, to attend events in the Greater Washington, D.C. area (e.g., DC STEM network's 2017 STEM Fair).
- Provided Widmeyer Communications, AEOP's Marketing Partner, with stories and photos of those who participated in GEMS and came from U/U backgrounds.

In order to understand which outreach and recruitment methods are most effective, students were asked when they enrolled for GEMS to indicate how they learned about AEOP. Table 14 summarizes students' responses. Other than past participation in the program (37%), the most frequently reported sources of information about GEMS were personal connections, including friends (43%), family members (41%), past participants of the program (37%), and family members (34%). Other sources of information included the AEOP website (12%) and a school or university newsletter, email, or website (13%).

Table 14. How Students Learned about AEOP (n=152)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	11.84%	18
AEOP on Facebook, Twitter, Instagram, or other social media	3.29%	5
School or university newsletter, email, or website	12.50%	19
Past participant of program	37.50%	57
Friend	43.42%	66
Family Member	40.79%	62
Someone who works at the school or university I attend	7.89%	12
Someone who works with the program	2.63%	4
Someone who works with the DoD (Army, Navy, Air Force, etc.)	6.58%	10
Community group or program	3.95%	6
Choose Not to Report	0.66%	1

Student focus group participants were also asked how they had learned about GEMS. Students' responses focused on personal relationships and teacher recommendations. Several participants indicated that they learned about GEMS through parents or relatives who work for an Army lab or through siblings who had participated in the past. Several students also indicated that their teachers had informed them about GEMS.

Mentors were also asked how they learned about AEOP (see Table 15). The most commonly reported sources of information were personal connections, including someone who works with the program (42%), someone who works with the DoD (39%), a family member (32%), and a friend (27%).

Table 15. How Mentors Learned About AEOP (n=41)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	14.63 %	6
AEOP on Facebook, Twitter, Instagram, or other social media	4.87%	2
School or university newsletter, email, or website	19.51 %	8
Past participant of program	19.51 %	8
Friend	26.83 %	11
Family Member	31.70 %	13
Someone who works at the school or university I attend	17.07 %	7
Someone who works with the program	41.46 %	17

Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	39.02 %	16
Community group or program	4.87 %	2
Choose Not to Report	0.00 %	0

Factors Motivating Apprentice Participation

Students were asked both at enrollment and in focus groups what motivated them to participate in GEMS. Table 16 displays student responses to a questionnaire item asking them to indicate what factors motivated them to participate. A large majority of students indicated that learning opportunities motivated their participation, and the most frequently cited motivators were the desire to learn something new or interesting (92%), an interest in STEM (90%), and the opportunity to learn in ways not possible in school (82%). Three-quarters of responding students (75%) indicated that having fun motivated them to participate in GEMS. The opportunity to use advanced laboratory technology (65%) and the desire to expand laboratory or research skills (64%) were also relatively frequently mentioned motivators. Over half of students also cited career interest and information as motivators, including figuring out education or career goals (57%) and exploring a unique work environment (54%) as motivators for GEMS participation.

Table 16. Factors Motivating Student Participation in GEMS (n=152)

	Response Percent	Response Total
Teacher or professor encouragement	15.13%	23
An academic requirement or school grade	1.32%	2
Desire to learn something new or interesting	92.11%	140
The mentor(s)	10.53%	16
Building college application or résumé	30.26%	46
Networking opportunities	13.82%	21
Interest in science, technology, engineering, or mathematics (STEM)	90.13%	137
Interest in STEM careers with the Army	26.97%	41
Having fun	75.00%	114
Earning stipends or awards for doing STEM	26.32%	40
Opportunity to do something with friends	34.21%	52
Opportunity to use advanced laboratory technology	64.47%	98
Desire to expand laboratory or research skills	63.82%	97
Learning in ways that are not possible in school	82.24%	125

Serving the community or country	30.92%	47
Exploring a unique work environment	50.66%	77
Figuring out education or career goals	57.24%	87
Seeing how school learning applies to real life	53.29%	81
Recommendations of past participants	28.95%	44
Choose Not to Report	0.00%	0

Student focus group participants also offered a variety of motivations for participating. These students cited interest in STEM, learning opportunities, career information, networking, family encouragement, and the stipend. For example:

> *I really love math, science, technology, engineering. One day I would really like to work for the Army…I just thought that this would be a good program…to work with people and meet new people as well.* (GEMS Student)

> *My brother went last year and he had good things to say about it…My mom said it would look good on my transcript.* (GEMS Student)

> *I just wanted to learn more about STEM because that's what I would like to do when I grow up.* (GEMS Student)

The GEMS Experience

A goal of GEMS is to provide students with STEM experiences they would not normally experience in traditional school environments. In order to understand these experiences, students were asked to respond to several questions about their GEMS experiences.

Since exposing students to STEM careers in the Army and DoD is an objective of GEMS program, 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 17 provides summaries of these data from 2015 through 2017. As in 2016, nearly all students (97%) reported learning about at least one STEM job/career, and most (58%) reported learning about five or more. A smaller number (81%) reported learning about at least one DoD STEM job/career and 28% reported learning about 5 or more DoD STEM careers. These data are similar to student responses for 2015 and 2016.

Table 17. Number of STEM Jobs/Careers Students Learned About During GEMS

	STEM Jobs/Careers	DoD STEM Jobs/Careers

	2015 (n=2,081)	2016 (n=1,102)	2017 (n=2,037)	2015 (n=1,902)	2016 (n=1,102)	2017 (n=2,029)
None	2%	3%	3%	13%	16%	19%
1	2%	5%	4%	9%	14%	10%
2	6%	11%	8%	16%	19%	16%
3	13%	12%	15%	18%	18%	17%
4	13%	10%	12%	12%	8%	10%
5 or more	64%	59%	58%	32%	25%	28%

In order to understand the effectiveness of various resources for informing students about DoD STEM careers, students were asked to rate the impact of these resources on their awareness of Army or DoD STEM careers (see Table 18). The most impactful resource reported was participation in GEMS, with 72% of students reporting this as being somewhat or very much impactful on their awareness of DoD STEM careers. Over half of respondents indicated that their mentors (64%) were somewhat or very much impactful and 40% reported that invited speakers or career events were at least somewhat impactful. Over a third of students reported that they had not experienced the other resources. For example, 38% had not experienced invited speakers or career events, 40% had not experienced the AEOP website, and 64% had not experienced the AEOP brochure. Data from the mentor questionnaire showed similar results, with program participation, invited speakers or career events, and GEMS program administrators or site coordinators chosen most frequently as resources useful for informing students about DoD STEM careers

Table 18. Impact of Resources on Student Awareness of DoD STEM Careers (n=493)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	39.6%	8.5%	19.9%	18.7%	13.4%	
	195	42	98	92	66	**493**
AEOP on Facebook, Twitter, Pinterest or other social media	78.7%	9.5%	6.7%	2.4%	2.6%	
	388	47	33	12	13	**493**
AEOP brochure	63.7%	9.3%	14.2%	7.7%	5.1%	
	314	46	70	38	25	**493**
It Starts Here! Magazine	12.6%	7.3%	16.0%	24.9%	39.1%	
	62	36	79	123	193	**493**
My GEMS mentor(s)	37.5%	9.7%	13.2%	15.8%	23.7%	
	185	48	65	78	117	**493**
Invited speakers or "career" events during GEMS	8.3%	5.1%	14.4%	21.5%	50.7%	
	41	25	71	106	250	**493**

	Not at all	At least once	A few times	Most days	Every day	Response Total
Participation in GEMS	39.6%	8.5%	19.9%	18.7%	13.4%	
	195	42	98	92	66	**493**

In order to understand the nature of their STEM engagement during GEMS, the questionnaire also asked students how often they engaged in various STEM practices (see Table 19). A large majority of students (76% - 93%) reported engaging in all STEM practices at least once during GEMS, with the exception of building or making a computer model (58% had not done this) and presenting research to a panel of judges from industry or the military (57% had not done this). Three-quarters or more of students had engaged at least a few times during GEMS in practices such as using laboratory procedures and tools (88%), analyzing data or information and drawing conclusions (84%), and communicating with other students about STEM (78%).

Table 19. Student Engagement in STEM Practices in GEMS (n=2,139-2,158)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	24%	16%	16%	14%	29%	
	516	343	354	311	634	**2158**
Work with a STEM researcher on a research project assigned by my teacher	21%	14%	17%	16%	32%	
	456	305	361	339	695	**2156**
Design my own research or investigation based on my own questions	22%	21%	25%	17%	15%	
	482	458	527	361	323	**2151**
Present my STEM research to a panel of judges from industry or the military	57%	21%	10%	5%	6%	
	1230	454	220	112	135	**2151**
Interact with STEM researchers	12%	15%	17%	15%	40%	
	266	333	373	329	855	**2156**
Use laboratory procedures and tools	6%	7%	15%	19%	54%	
	124	146	312	412	1156	**2150**
Design and carry out an investigation or experiment	11%	15%	20%	20%	34%	
	226	326	437	421	735	**2145**
Analyze data or information and draw conclusions	7%	10%	19%	23%	42%	
	140	206	402	489	907	**2144**
Work collaboratively as part of a team	1%	3%	8%	18%	70%	
	30	57	173	394	1492	**2146**
Build or make a computer model	58%	18%	11%	7%	7%	
	1243	378	226	141	159	**2147**

Solve real-world problems	13%	17%	23%	21%	26%	
	288	362	486	453	559	**2148**
Communicate with other students about STEM	8%	14%	22%	24%	32%	
	167	305	471	515	691	**2149**
Learn about different careers that use STEM	5%	12%	22%	23%	38%	
	114	259	464	499	816	**2152**
Learn about new discoveries in STEM	7%	9%	15%	18%	52%	
	141	186	316	392	1104	**2139**

A composite score[3] was calculated for this set of items entitled "Engaging in STEM Practices in GEMS"[4]. Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. A composite score was 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; females reported significantly higher views than males (small effect size; d = 0.122 standard deviations).[5] Additionally, significant differences were found by race/ethnicity in terms of Engagement with STEM Practices while in GEMS with minority students reporting significantly greater impact (small effect size; d = 0.187 standard deviations).[6]

To examine how the GEMS experience compares to students' typical school experience, they were asked how often they engaged in the same STEM Practices in school. These responses were also combined into a composite variable "Engaging in STEM Practices in School"[7]. As can be seen in Chart 1, scores were significantly higher on the "in GEMS" version of compared to the "in school" version with a large effect size (d = 1.79 standard deviations).[8]

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[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.

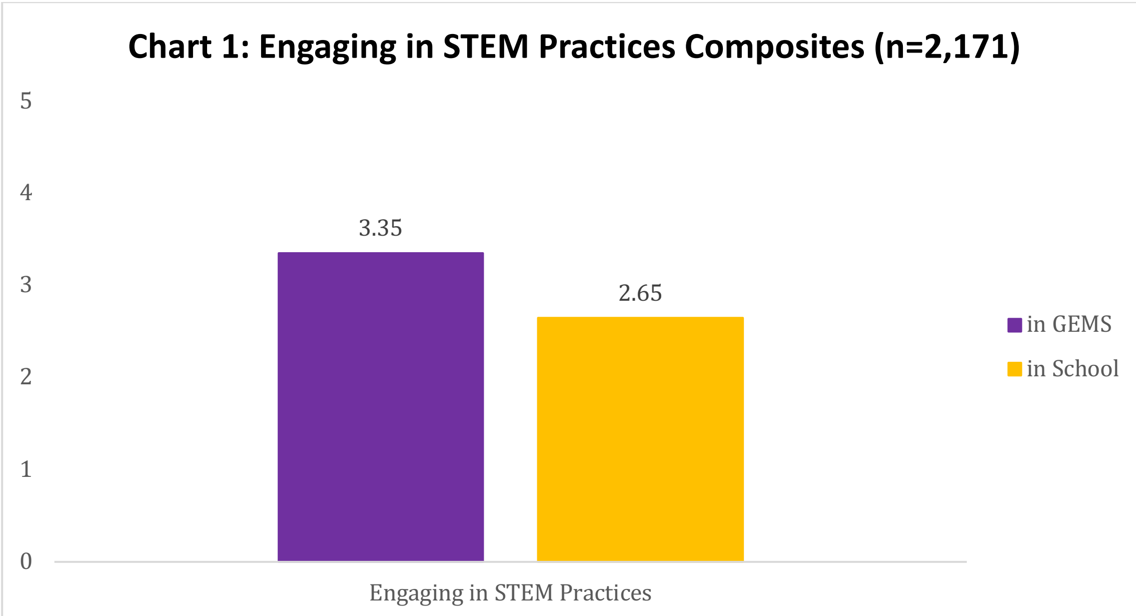
[4] The Cronbach's alpha reliability for the 14 Engaging in STEM Practices in GEMS items was 0.885.

[5] Independent samples t-test for STEM Engagement in GEMS: Gender; $t(2153)=2.83$, $p=.005$.

[6] Independent samples t-test for STEM Engagement in GEMS: Race/Ethnicity; $t(2033)=4.21$, $p<.001$.

[7] Cronbach's alpha reliability for the 14 Engage in STEM Practices in School items was 0.885.

[8] STEM Engagement dependent samples t-test: $t(2170)=41.65$, $p<.001$.



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:[9]

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.

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[9] 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.

Tables 20-24 summarize mentors' reported use of strategies associated with each of the five areas of effective mentoring. A majority of mentors reported using most strategies in each area.

A large majority of responding mentors (67% - 94%) reported using each strategy to help make the learning activities in GEMS relevant to students, with the exception of selecting readings or activities that relate to students' backgrounds (48% used this strategy) (Table 20). For example, 94% of mentors reported becoming familiar with students' backgrounds and interests at the beginning of the program, and 89% giving students real-life problems to investigate or solve.

Table 20. Mentors Using Strategies to Establish Relevance of Learning Activities (n=54)

	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	94.4%	5.6%	
	51	3	**54**
Giving students real-life problems to investigate or solve	88.9%	11.1%	
	48	6	**54**
Selecting readings or activities that relate to students' backgrounds	48.1%	51.9%	
	26	28	**54**
Encouraging students to suggest new readings, activities, or projects	66.7%	33.3%	
	36	18	**54**
Helping students become aware of the role(s) that STEM plays in their everyday lives	96.3%	3.7%	
	52	2	**54**
Helping students understand how STEM can help them improve their own community	79.6%	20.4%	
	43	11	**54**
Asking students to relate real-life events or activities to topics covered in GEMS	90.7%	9.3%	
	49	5	**54**

Most mentors also reported using all strategies to support the diverse needs of students as learners (52% - 98%). Table 21 shows mentor responses to this questionnaire item. Nearly all mentors (98%) reported using a variety of teaching and/or mentoring strategies to meet the needs of all students, and 93% reported interacting with students and other personnel the same way regardless of their background. Most mentors also used strategies such as directing students to other individuals or programs for additional support as needed (74%), identifying the different learning styles students may have (69%), and integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM.

Table 21. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=54)

	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	68.5%	31.5%	
	37	17	**54**
Interact with students and other personnel the same way regardless of their background	92.6%	7.4%	
	50	4	**54**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	98.1%	1.9%	
	53	1	**54**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	68.5%	31.5%	
	37	17	**54**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	61.1%	38.9%	
	33	21	**54**
Directing students to other individuals or programs for additional support as needed	74.1%	25.9%	
	40	14	**54**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	51.9%	48.1%	
	28	26	**54**

Large majorities of mentors (83% - 98%) reported using each strategy associated with supporting students' development of collaboration and interpersonal skills (see Table 22). For example, nearly all mentors (98%) reported having students work on collaborative activities or projects as members of a team, while 94% had students resolve conflicts and reach agreements within their teams, and 93% had students listen to the ideas of others with an open mind.

Table 22. 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	88.9%	11.1%	
	48	6	**54**
Having my student(s) explain difficult ideas to others	83.3%	16.7%	

	45	9	**54**
Having my student(s) listen to the ideas of others with an open mind	92.6%	7.4%	
	50	4	**54**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	87.0%	13.0%	
	47	7	**54**
Having my student(s) give and receive constructive feedback with others	87.0%	13.0%	
	47	7	**54**
Having students work on collaborative activities or projects as a member of a team	98.1%	1.9%	
	53	1	**54**
Allowing my student(s) to resolve conflicts and reach agreement within their team	94.4%	5.6%	
	51	3	**54**

Mentors were also asked about the strategies they used to support student engagement in authentic STEM activities (see Table 23). A large majority of mentors (76% - 98%) reported using each strategy associated with this area of mentoring with the exception of having students search for and review technical literature to support their work (35% used this strategy). For example, nearly all responding mentors (98%) reported encouraging students to learn collaboratively, and encouraging students to seek support from other team members, while 94% encouraged students to seek support from other team members, and 91% demonstrated laboratory/field techniques, procedures, and tools for students.

Table 23. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=54)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	75.9%	24.1%	
	41	13	**54**
Having my student(s) search for and review technical research to support their work	35.2%	64.8%	
	19	35	**54**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	90.7%	9.3%	
	49	5	**54**
Supervising my student(s) while they practice STEM research skills	88.9%	11.1%	
	48	6	**54**

Providing my student(s) with constructive feedback to improve their STEM competencies	85.2%	14.8%	
	46	8	**54**
Allowing students to work independently to improve their self-management abilities	88.9%	11.1%	
	48	6	**54**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	98.1%	1.9%	
	53	1	**54**
Encouraging students to seek support from other team members	94.4%	5.6%	
	51	3	**54**

The final set of items asking about mentoring strategies asked mentors to report on their use of mentoring strategies to support students' STEM educational and career pathways (see Table 24). Responses were varied for this area of mentoring, with between 44% and 89% of mentors using each strategy. For example, 89% of mentors reported asking students about their educational and/or career goals and providing guidance about educational pathways that will prepare students for STEM careers. Fewer mentors reported recommending AEOPs that align with student goals (59%), helping students build a professional network in a STEM field (54%), and helping students with their resume, application, personal statement, and/or interview preparations (41%). It is possible that mentors who did not use these strategies worked with younger (elementary and middle school aged) students for whom some strategies are not as relevant as they are for older students.

Table 24. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=54)

	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	88.9%	11.1%	
	48	6	**54**
Recommending extracurricular programs that align with students' goals	79.6%	20.4%	
	43	11	**54**
Recommending Army Educational Outreach Programs that align with students' goals	59.3%	40.7%	
	32	22	**54**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	88.9%	11.1%	
	48	6	**54**
Discussing STEM career opportunities within the DoD or other government agencies	79.6%	20.4%	
	43	11	**54**
	77.8%	22.2%	

Discussing STEM career opportunities in private	42	12	54
Discussing the economic, political, ethical, and/or social context of a STEM career	61.1%	38.9%	
	33	21	54
Recommending student and professional organizations in STEM to my student(s)	64.8%	35.2%	
	35	19	54
Helping students build a professional network in a STEM field	53.7%	46.3%	
	29	25	54
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	44.4%	55.6%	
	24	30	54

Mentors were asked which of the AEOP programs they explicitly discussed with their students during GEMS. Not surprisingly, the most frequently discussed programs were GEMS (96%) and GEMS NPMs (80%) (Table 25). More than half of mentors (52%) reported discussing AEOPs generally with students but without reference to any specific program. Relatively few mentors discussed other AEOPs specifically. For example, 15% discussed JSHS, 15% discussed SEAP, and 7% discussed Unite.

Table 25. Mentors Explicitly Discussing AEOPs with Students (n=54)

	Yes - I discussed this program with	No - I did not discuss this program with my	Response Total
Gains in the Education of Mathematics and Science (GEMS)	96.3%	3.7%	
	52	2	54
UNITE	7.4%	92.6%	
	4	50	54
Junior Science & Humanities Symposium (JSHS)	14.8%	85.2%	
	8	46	54
Science & Engineering Apprenticeship Program (SEAP)	14.8%	85.2%	
	8	46	54
Research & Engineering Apprenticeship Program (REAP)	5.6%	94.4%	
	3	51	54
High School Apprenticeship Program (HSAP)	11.1%	88.9%	
	6	48	54
College Qualified Leaders (CQL)	9.3%	90.7%	
	5	49	54
GEMS Near Peer Mentor Program	79.6%	20.4%	
	43	11	54

Undergraduate Research Apprenticeship Program (URAP)	11.1%	88.9%	
	6	48	**54**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	16.7%	83.3%	
	9	45	**54**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	5.6%	94.4%	
	3	51	**54**
I discussed AEOP with my student(s) but did not discuss any specific program	51.9%	48.1%	
	28	26	**54**

Since it is a goal of the AEOP for students to progress from GEMS into other AEOPs, mentors were asked how useful various resources were in efforts to expose students to AEOPs (see Table 26). Participation in GEMS was most frequently rated as "somewhat" or "very much" useful (93%), followed by GEMS program administrators or site coordinators (88%) and invited speakers or career events (76%). While nearly half of mentors (48%) indicated that the AEOP website was at least somewhat useful for this purpose, over a third (35%) had not experienced the website, and 28% had not experienced the AEOP brochure. Likewise, over half of mentors (61%) had not experienced AEOP on social media and 67% had no experience with the It Starts Here! Magazine.

Table 26. Usefulness of Resources for Exposing Students to AEOPs (n=54)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	35.2%	1.9%	14.8%	35.2%	13.0%	
	19	1	8	19	7	**54**
AEOP on Facebook, Twitter, Pinterest or other social media	61.1%	3.7%	18.5%	14.8%	1.9%	
	33	2	10	8	1	**54**
AEOP brochure	27.8%	1.9%	16.7%	27.8%	25.9%	
	15	1	9	15	14	**54**
It Starts Here! Magazine	66.7%	9.3%	18.5%	5.6%	0.0%	
	36	5	10	3	0	**54**
GEMS Program administrator or site coordinator	5.6%	0.0%	5.6%	18.5%	70.4%	
	3	0	3	10	38	**54**
Invited speakers or "career" events	18.5%	0.0%	5.6%	14.8%	61.1%	
	10	0	3	8	33	**54**
Participation in GEMS	5.6%	0.0%	1.9%	11.1%	81.5%	

	3	0	1	6	44	**54**

Another goal of the AEOP and GEMS is to expose students to DoD STEM careers. Mentors were therefore asked to rate the usefulness of resources for exposing students to DoD STEM careers (see Table 27). Again, mentors were most likely to rate participation in GEMS as at least somewhat useful (93%). A large majority of mentors (89%) indicated that the GEMS program administrator or site coordinator was somewhat or very much useful, and 84% indicated that invited speakers or "career" events were somewhat or very much useful for this purpose. Fewer mentors found AEOP materials somewhat or very much useful for exposing students to DoD STEM careers. For example, 47% indicated that the AEOP brochure was at least somewhat useful (37% had not experienced it), and 37% indicated that the AEOP website was at least somewhat useful (43% had not experienced it).

Table 27. Usefulness of Resources for Exposing Student to DoD STEM Careers (n=54)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	42.6%	3.7%	16.7%	24.1%	13.0%	
	23	2	9	13	7	**54**
AEOP on Facebook, Twitter, Pinterest or other social media	63.0%	5.6%	20.4%	11.1%	0.0%	
	34	3	11	6	0	**54**
AEOP brochure	37.0%	1.9%	14.8%	24.1%	22.2%	
	20	1	8	13	12	**54**
It Starts Here! Magazine	70.4%	7.4%	13.0%	9.3%	0.0%	
	38	4	7	5	0	**54**
GEMS Program administrator or site coordinator	9.3%	0.0%	1.9%	24.1%	64.8%	
	5	0	1	13	35	**54**
Invited speakers or "career" events	14.8%	1.9%	0.0%	18.5%	64.8%	
	8	1	0	10	35	**54**
Participation in GEMS	7.4%	0.0%	0.0%	11.1%	81.5%	
	4	0	0	6	44	**54**

Mentor focus group participants discussed strategies used in their programs to expose students to various DoD careers. Although strategies for exposing student to careers varied by site, most mentors emphasized the value of students being on-site in an Army lab and linking student learning with careers. For example, *The colonel of the base comes down and talks to them about different opportunities that are out here as far as future employment opportunities.* (GEMS Mentor)

We make it a point to include in all of our PowerPoints what careers this could lead to if the kids are interested in a particular area. (GEMS Mentor)

One NPM pointed out a potential barrier to exposing students to DoD STEM careers at her site, saying,

If [the NPMs] teach every single lesson, that's not really giving them a good exposure to what's out there and the different types of people that et jobs…The PIs are donating their time right now. They lose a day at work, plus any prep time to come up with lesson plans. (GEMS Mentor)

Satisfaction with GEMS

Students and mentors were asked how satisfied they were with a number of features of the GEMS program. Most students (56% - 91%) indicated that they were somewhat or very much satisfied with all program features (Table 28). For example, 89% were at least somewhat satisfied with the variety of STEM topics available to them in GEMS, 91% with the teaching or mentoring during program activities, and 91% with the stipend. Only 3% of students had not experienced invited speakers or career events and 2% had not experienced field trips or laboratory tours, a marked change from 2016 when 15% of students reported not experiencing invited speakers or career events and 34% had not experienced field trips or lab tours.

Table 28. Student Satisfaction with GEMS Program Features (n=2,111-2,125)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	3%	6%	10%	31%	50%	
	54	132	219	655	1065	**2125**
Communicating with your GEMS host site organizers	3%	15%	12%	27%	44%	
	57	310	249	575	923	**2114**
The physical location(s) of GEMS activities	5%	1%	11%	25%	59%	
	98	19	224	540	1244	**2125**
The variety of STEM topics available to you in GEMS	1%	1%	8%	22%	67%	
	31	25	171	464	1425	**2116**
Teaching or mentoring provided during GEMS activities	2%	1%	6%	18%	73%	
	34	20	135	391	1541	**2121**
Stipends (payment)	1%	3%	5%	14%	77%	
	30	60	103	296	1633	**2122**
Educational materials (e.g., workbooks, online resources, etc.) used during program activities	2%	5%	10%	25%	58%	
	46	106	218	521	1225	**2116**

Invited speakers or "career" events	3%	21%	9%	21%	46%	
	59	451	193	444	964	**2111**
Field trips or laboratory tours	2%	33%	8%	14%	42%	
	41	700	169	305	896	**2111**

Students also responded to an open-ended item on the questionnaire asking them about their overall satisfaction with their GEMS experiences. Of the 100 responses sampled, 86 commented only on positive aspects of the program, focusing on the learning they experienced during GEMS, their interactions with mentors and peers, the career information they gained, and their hands-on experiences. For example:

> *Not only did I learn a lot about STEM, I learned more about teamwork and persevering, especially when my design wasn't working. I like how GEMS didn't focus on one particular thing, even though I was in the CSI group we still did an array of learning. Overall, my GEMS experience was very important and so amazing because now I know I want a STEM position when I get older.* (GEMS Student)

> *GEMS has given me a chance to feel like a scientist. I have gotten the chance to use lab tools and a great working environment. The near pears are great! They really understand what is going on in a child's head and I think that other older teachers don't think the same way.* (GEMS Student)

> *I really enjoyed the near peers and how much they helped and worked with us all week. I also enjoyed the conversation about college on Wednesday, it really helped me better understand different aspects of the college experience. I really benefited from all the different kind of engineering and technology involved with this program.* (GEMS Student)

> *It has greatly bolstered my interest in STEM, and shown me multiple careers and major paths to choose from. It has also given me a chance to interact with college students and ask them various questions, something I am not usually able to do.* (GEMS Student)

Thirteen responses (13%) included positive comments, but included some caveats. These caveats were varied, with students commenting that they would like to eliminate recess, have more time for lunch, a longer program, better communication with organizers, better content explanations or teaching, an increased focus on independent work, and a different location. Only 1 student had no positive comments about the program, indicating that more speakers and less strict rules would have enhanced his GEMS experience.

Another open-ended questionnaire item asked students to list three ways that the GEMS program helped them. Of the 100 responses analyzed, the most frequently mentioned responses were GEMS' impact on students' learning or knowledge in STEM (mentioned in 59 responses), the career information provided during GEMS (mentioned in 58 responses), and the laboratory or hands-on experience students gained (mentioned 49 times). Students commented on an array of benefits associated with 21st Century skills, including teamwork (mentioned in 23 responses), problem-solving (mentioned in 23 responses), communication (mentioned in 4 responses), and critical thinking (mentioned in 3 responses). Other students' comments included the value of GEMS in motivating them for future STEM engagement both in and out of school (mentioned 19 times), gaining a new appreciation or enjoyment of STEM (mentioned 17 times), and simply having fun (mentioned 8 times).

Students participating in focus groups echoed these themes. For example,

> *GEMS gives you an opportunity to learn what you really like…we learned how to do circuit stuff, like electric currents and stuff…I really liked that.* (GEMS Student)

> *[In GEMS], you get to meet people who do the jobs and hear their side of the story about what the [jobs are like] that you may be considering going in to.* (GEMS Student)

> *I'll be leaving [GEMS] with experience, knowing I've done stuff that probably other people haven't done…I'll be joining some clubs in school for STEM.* (GEMS Student)

Students were also asked in an open-ended questionnaire item to list three ways in which the program could be improved. Of the 100 responses sampled, the most commonly mentioned improvements were making the program longer and/or providing more time to complete projects (mentioned in 38 responses), providing more options for program topics (mentioned in 37 responses), and providing more hands-on activities (mentioned in 22 responses). Other, less frequently mentioned, improvements included providing more teaching and more feedback to students (mentioned in 14 responses), improving the quality and availability of supplies and resources (mentioned in 12 responses), providing more DoD career information (mentioned in 10 responses), providing more speakers and field trips (mentioned in 9 responses), and integrating STEM disciplines into activities more effectively (i.e., incorporating both science and engineering into curricula) (mentioned in 6 responses).

Students participating in focus groups were also asked for their opinions about ways that GEMS could be improved. Students' suggestions were similar to those in questionnaire responses, although focus group participants added that GEMS could be improved by providing more publicity and more opportunities to talk with mentors about college and career opportunities.

Mentors were also asked to rate their satisfaction with a number of GEMS program features (Table 29). Large majorities of mentors (79% - 98%) were at least somewhat satisfied with each feature with the exception of communicating with the NSTA (44% had not experienced this). For example, 98% were at least somewhat satisfied with the location of GEMS activities and with communicating with GEMS organizers, 91% with the support or mentorship they received during program activities, and 83% with invited speakers or career events. Very few mentors expressed dissatisfaction with any program feature (0% - 2%).

Table 29. Mentor Satisfaction with GEMS Program Features (n=54)

		Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	%	13.0%	0.0%	5.6%	16.7%	64.8%	
	n	7	0	3	9	35	**54**
Communicating with the National Science Teachers Association (NSTA)	%	44.4%	0.0%	9.3%	16.7%	29.6%	
	n	24	0	5	9	16	**54**
Communicating with GEMS organizers / site coordinators	%	0.0%	0.0%	1.9%	18.5%	79.6%	
	n	0	0	1	10	43	**54**
The physical location(s) of GEMS's activities	%	0.0%	1.9%	11.1%	20.4%	66.7%	
	n	0	1	6	11	36	**54**
Support for instruction or mentorship during program activities	%	3.7%	1.9%	3.7%	24.1%	66.7%	
	n	2	1	2	13	36	**54**
Stipends (payment)	%	9.3%	1.9%	7.4%	22.2%	59.3%	
	n	5	1	4	12	32	**54**
Invited speakers or "career" events	%	13.0%	1.9%	1.9%	20.4%	63.0%	
	n	7	1	1	11	34	**54**
Field trips or laboratory tours	%	18.5%	0.0%	1.9%	9.3%	70.4%	
	n	10	0	1	5	38	**54**

Like students, mentors were also asked to respond to open-ended questionnaire items asking for their opinions about the program. One item asked mentors to identify the three most important strengths of GEMS. Among the 49 mentors who responded to this item, the most frequently mentioned responses were the STEM learning GEMS students experience (mentioned in 18 responses), the lab experiences and hands-on, real-world applications of knowledge GEMS offers (mentioned in 17 responses), networking opportunities (mentioned in 15 responses), and speakers and field trips or lab tours (mentioned in 15 responses). Mentor comments also included the value of the career information students receive (mentioned in 14 responses), the value of the mentor-student relationships (mentioned in 8 responses), and the fun students have (mentioned in 7 responses).

Mentors participating in focus groups were also asked about the benefits of GEMS. These mentors' comments echoed the questionnaire responses and added that student friendships are an added benefit of GEMS. For example,

> *[GEMS] makes science seem cool.* (GEMS Mentor)

[GEMS] kids are able to learn principles and apply them immediately, as opposed to the typical classroom setting where they would learn something but not get the direct application. They're able to conceptualize how it would happen in the real world as well as what skill sets they could use in a career. (GEMS Mentor)

[GEMS] kids are excelling in science and it surrounds them with other kids who are excelling in science. You can tell that it creates these friendships. (GEMS Mentor)

Mentors participating in focus groups also discussed the benefits to them of serving as NPMs. These mentors cited expanded career interests, the value of the work experience, and the satisfaction of watching students learn as benefits. For instance:

I'm not a STEM major. I'm majoring in sociology and psychology. [Being a GEMS NPM] has actually broadened some career interests for me. (GEMS Mentor)

I simply entered the program wanting some experience in teaching. I can go in now to student teaching my senior year and say 'I've had teaching experience'. It's been great. (GEMS Mentor)

Another open-ended questionnaire item asked mentors to note three ways in which GEMS should be improved for future participants. The 46 mentors who responded suggested a variety of improvements. These included suggestions such as having more or more engaging speakers (mentioned in 11 responses), improving curriculum to enhance activities or make it more age-appropriate (mentioned in 10 responses), providing a larger space and/or more resources (mentioned in 10 responses), incorporating more field trips and/or lab tours (mentioned in 8 comments), and ensuring better technology access.

Mentors participating in focus groups made similar suggestions for improvements. Other themes that emerged during focus groups were having more assistant near peer mentors and extending the program to five days rather than four.

Mentors were asked in an open-ended questionnaire item about their overall satisfaction with GEMS. Of the 47 mentors who responded, 41 commented only on positive aspects of the program, including student learning, mentor learning, networking opportunities, career information, and lab tours. For example:

My experience with GEMS was an awesome experience. I think the kids had a wonderful time learning how to collaborate and adapt to change if something was unsuccessful. I also enjoyed working with the program coordinators, they were the best to work with even when things might have been confusing at times. I appreciate this opportunity working with you all. (GEMS Mentor)

I really enjoyed this experience of teaching students for an entire week. I usually volunteer once or twice a week with local schools but have never led a teaching team. The students' enthusiasm is *very catching and we had a LOT of fun. The professional teachers we had on our team also gave us great pointers and feedback about how to structure our lessons...The experience was eye-opening all around and I believe everyone had a great time.* (GEMS Mentor)

Being a GEMS Near Peer Mentor provided me with learning, not only about STEM and jobs within the DoD, but about how to interact with the engineers and mentees. I had the most pleasant experience of being able to speak to the engineers about their experiences throughout schooling, employment in [the DoD] and truly gain insight as to what is expected of a STEM professional and what can be expected of a profession in STEM. (GEMS Mentor)

My overall satisfaction with the GEMS experience was outstanding. It was such an honor and a wonderful opportunity to be a part GEMS for the year 2017. The students were wonderful and so were the other mentors. Not only is GEMS fun for the mentors and the students, but you learn so much from the different experiments, guest speakers, STEM researchers, and the students themselves. (GEMS Mentor)

Five mentors made positive comments but included some caveats. These caveats focused on more effectively incorporating technology into the program, improving curriculum, scheduling issues, and selecting qualified students. Only one mentor made no positive comments about the program, indicating that she disagreed with the policy of paying students stipends.

Findings from the Actionable Program Evaluation indicate that GEMS actively engaged students in authentic STEM experiences in ways not typically available to them in school. Findings also indicate that mentors use a variety of evidence-based mentoring techniques, employing numerous strategies to enhance students' GEMS experiences. Both apprentices and mentors reported high levels of satisfaction with the program, and appreciated the unique opportunities for STEM learning that GEMS provided.

7 | Outcomes Evaluation

The evaluation of GEMS included measurement of several outcomes relating to AEOP and program objectives, including impacts on students' STEM knowledge, STEM competencies or skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes towards Army or DoD research, and their knowledge of and interest in participating in additional AEOP opportunities.[10] Foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately, are necessary for a STEM-literate citizenry. STEM competencies are therefore important not only for those engaging in STEM enterprises 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 evaluation of GEMS measured students' self-reported gains in STEM competencies and engagement in opportunities intended to develop what are considered to be critical STEM skills in the 21st century—collaboration and teamwork.

STEM Knowledge and Skills

Students were asked to report on how GEMS impacted their STEM knowledge and STEM competencies. Nearly all responding students reported some level of STEM learning as a result of the GEMS program (Table 30). A majority of students (81% - 87%) reported that they learned "more than a little" or "learned a lot" in each area. For example, 87% learned more than a little or a lot about a STEM topic and 84% experienced this level of learning about how scientists and engineers work on real problems in STEM.

[10] 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 30. Student Report of Impacts on STEM Knowledge (n=2,099-2,114)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
Knowledge of a STEM topic(s)	3%	10%	28%	59%	
	53	214	598	1249	**2114**
Knowledge of research conducted in a STEM topic or field	3%	13%	29%	55%	
	73	281	601	1145	**2100**
Knowledge of how scientists and engineers work on real problems in STEM	3%	13%	26%	58%	
	71	270	552	1212	**2105**
Knowledge of what everyday research work is like in STEM	4%	14%	27%	54%	
	93	299	574	1133	**2099**

These items were combined into a composite variable[11] to test for differential impacts across subgroups of students. Significant differences were found by gender, with females reporting higher impacts (small effect size, d=0.214); and differences were found by race/ethnicity with minority students reporting higher impacts (small effect size, d=0.115).[12]

Students were also asked about how GEMS impacted their STEM competencies or skills in either science or engineering, depending on the focus of their GEMS experience. Table 31 reports data for students who indicated that science was the focus of their GEMS experience while Table 32 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 communicating about experiments and explanations in different ways (68% learned more than a little or learned a lot) and supporting an explanation for an observation with data from experiments (67% learned more than a little or learned a lot). For engineering-focused students, the greatest areas of learning (students reporting learning more than a little or learning a lot) were in carrying out procedures for an experiment (72%) and making a model of an object or system to show its parts and how they work (71%).

[11] The Cronbach's alpha reliability for these 5 STEM Knowledge items was 0.852.

[12] Independent samples t-test for STEM Knowledge: Gender t(2100)=4.90, p<.001; Race/Ethnicity t(1985)=2.57, p=.01.

Table 31. Students Reporting Gains in their STEM Competencies – Science Practices (n=2,071-2,088)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
Asking a question that can be answered with one or more scientific experiments	14%	22%	35%	29%	
	285	467	725	611	**2088**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	13%	20%	33%	33%	
	273	422	693	697	**2085**
Considering different interpretations of data when deciding how the data answer a question	11%	22%	30%	36%	
	238	462	632	746	**2078**
Supporting an explanation for an observation with data from experiments	12%	21%	29%	38%	
	251	437	600	791	**2079**
Defending an argument that conveys how an explanation best describes an observation	20%	23%	27%	30%	
	411	480	564	618	**2073**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	18%	25%	27%	30%	
	368	511	566	626	**2071**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	11%	22%	29%	39%	
	227	450	596	799	**2072**

Table 32. Students Reporting Gains in their STEM Competencies – Engineering Practices (n=2,058-2,067)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
Defining a problem that can be solved by developing a new or improved object, process, or system	9%	19%	33%	39%	
	186	401	675	802	**2064**
Making a model of an object or system to show its parts and how they work	11%	18%	28%	43%	
	230	370	576	891	**2067**
Carrying out procedures for an experiment and recording data accurately	9%	19%	28%	44%	
	188	400	572	898	**2058**
Using computer models of an object or system to investigate cause and effect relationships	31%	21%	22%	27%	
	630	427	450	558	**2065**
Organizing data in charts or graphs to find patterns and relationships	26%	26%	23%	26%	
	534	530	469	527	**2060**

Composite scores were calculated from each set of items related to Science and Engineering competencies[13] to examine whether the GEMS program had differential impacts on subgroups of students. There were no significant differences found in Science or Engineering Competences by gender. For both Science and Engineering Competencies, significant differences were found by race/ethnicity with minority students reporting greater higher perceptions (Science – effect size is small, d=0.137; Engineering – effect size is small, d=0.120).[14]

Students were also asked to rate the impact of GEMS on their "21st Century Skills," defined as skills such as collaboration, communication, perseverance, and problem-solving that are necessary across a wide variety of fields (Table 33). Nearly three-quarters or more of students (71% - 78%) reported that they learned more than a little or had learned a lot in all of these skills. Mentors were asked to respond to a similar item and a large majority of mentors reported that students had at least some gain in each of the skills.

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[13] The science practices composite (7 items) has a Cronbach's alpha reliability of 0.925; The engineering practices composite (5 items) had a Cronbach's alpha reliability of 0.829.

[14] Independent samples t-test for Race/Ethnicity differences – Science Competencies t(1970)=3.04, p=.002; Engineering Competencies t(1949)=4.41, p<.001.

Table 33. Student Report of Impacts on 21st Century Skills (n=2,051-2,069)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
Sticking with a task until it is finished	11%	16%	25%	49%	
	222	333	507	1007	**2069**
Making changes when things do not go as planned	8%	15%	26%	52%	
	162	302	533	1063	**2060**
Working well with students from all backgrounds	9%	13%	21%	57%	
	184	268	433	1180	**2065**
Including others' perspectives when making decisions	9%	15%	24%	51%	
	187	318	502	1055	**2062**
Communicating effectively with others	9%	15%	24%	53%	
	182	308	487	1085	**2062**
Viewing failure as an opportunity to learn	12%	16%	22%	49%	
	253	338	461	999	**2051**

The 21st Century Skills items were combined into a composite variable[15] 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=0.171).[16] There were no significant differences by race/ethnicity.

STEM Identity and Confidence

Since STEM identity, or seeing oneself as capable of succeeding in STEM, has been linked to future interest and participation in STEM as a field of study and career choice[17], GEMS and other programs in the AEOP portfolio emphasize supporting participants' STEM identities. Because of this, the student questionnaire included a series of items intended to measure the impact GEMS had on apprentices' STEM identities, defined as their feelings of confidence and self-efficacy in terms of STEM achievement (Table 34). After participating in GEMS, most students (72% - 85%) either somewhat agreed or agreed with each statement

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[15] The 21st Century Skills composite (6 items) has a Cronbach's alpha reliability of 0.909.

[16] Two-tailed Independent Samples t-test: 21st Century differences by Gender $t(2057)=3.88$, $p<.001$.

[17] 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.

related to their STEM identities. For example, 85% of students somewhat agreed or agreed that they felt like they had accomplished something in STEM and 76% that they were thinking creatively about a STEM project or activity. Comparing results on a composite created from these STEM Identity items,[18] there significant differences found in STEM identity based on gender (females reported higher) and race/ethnicity (non-minority students reported higher) with small effect sizes for both (Gender – d = 0.142 standard deviations; Race/Ethnicity – d =0.180 standard deviations).[19]

Table 34. Student Report of Impacts on STEM Identity (n=2,050-2,064)

	Strongly disagree	Disagree	Don't agree or disagree	Somewhat agree	Agree	Response Total
I am interested in a new STEM topic	4%	6%	17%	29%	44%	
	77	125	358	591	912	**2063**
I am thinking about pursuing a STEM career	3%	5%	20%	23%	48%	
	71	111	405	473	998	**2058**
I feel like I accomplished something in STEM	2%	3%	9%	23%	62%	
	40	66	187	485	1286	**2064**
I feel more prepared for more challenging STEM activities	2%	2%	10%	25%	61%	
	36	46	203	517	1252	**2054**
I am thinking creatively about a STEM project or activity	2%	6%	16%	26%	50%	
	40	118	321	541	1037	**2057**
I have a desire to build relationships with mentors who work in STEM	2%	5%	20%	27%	46%	
	42	105	405	559	942	**2053**
I have connected a STEM topic or field to my personal values	2%	6%	20%	27%	45%	
	47	125	405	558	915	**2050**

Interest and Future Engagement in STEM

A key goal of the AEOP 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

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[18] The Cronbach's alpha reliability for these 7 Identity items was 0.873.

[19] Independent samples t-test for STEM Identity: Gender $t(1643)=3.01$, $p=.003$; Race/Ethnicity $t(1941)=3.96$, $p<.001$.

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 (Table 35). A majority of students (53% - 70%) indicated that they were more likely or much more likely to engage in each activity, with the exception of watching or reading non-fiction STEM (51% were neither more likely nor less likely to do this). While many students reported no change in their likelihood of engaging in activities such as working on solving mathematical or scientific puzzles (40%) and using a computer to design or program something (40%), few students reported being less likely to engage in any activity (4% - 9%).

In an analysis of a composite created from these Likelihood to Engage in STEM Activities items[20] by subgroup, non-minority students reported being more likely to engage in comparison to minority students (small effect, d = 0.156 standard deviations).[21] There were no significant differences found by gender.

Table 36 displays responses to an item asking students how interested they are in participating in other AEOP programs in the future. A large majority (88%) of respondents indicated being at least a little interested in participating in GEMS again and 75% indicated being at least somewhat interested in participating as NPMs in the future. Interestingly, 11% of students reported having never heard of GEMS and 21% reported never having heard of the GEMS NPM program. Many students (48% - 74%) had not heard of the other AEOPs about which they were asked, including JSS (48% had not heard of it), eCybermission (68% had not heard of it), and JSHS (72% had not heard of it). Most students who were familiar with the programs reported being at least a little interested in them, however, and relatively few indicated being "not at all" interested in future participation in any program. For example, only 9% of students were "not at all" interested in participating in JSS, 7% in eCybermission, and 5% in JSHS.

Table 35. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=2,027-2,057)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	4%	5%	51%	25%	15%	
	77	95	1048	524	313	**2057**
Tinker (play) with a mechanical or electrical device	2%	3%	33%	35%	27%	
	38	69	675	711	562	**2055**
	3%	3%	40%	31%	23%	

[20] The Cronbach's alpha reliability for these 10 Likelihood to Engage items was 0.896.

[21] Independent samples t-test for Likelihood to Engagement in STEM activities: Race/Ethnicity t(1932)=3.42, p=.001.

Work on solving mathematical or scientific puzzles	52	69	817	640	469	**2047**
Use a computer to design or program something	3%	4%	40%	28%	25%	
	53	91	811	577	513	**2045**
Talk with friends or family about STEM	2%	3%	28%	34%	33%	
	32	58	578	699	682	**2049**
Mentor or teach other students about STEM	3%	5%	31%	33%	28%	
	61	99	640	679	568	**2047**
Help with a community service project related to STEM	2%	3%	34%	34%	27%	
	39	69	693	693	547	**2041**
Participate in a STEM camp, club, or competition	1%	3%	25%	32%	38%	
	28	66	508	661	780	**2043**
Take an elective (not required) STEM class	2%	4%	31%	31%	32%	
	50	77	629	635	644	**2035**
Work on a STEM project or experiment in a university or professional setting	2%	3%	29%	34%	32%	
	36	69	586	684	652	**2027**

Table 36. Student Interest in Future AEOP Programs (n=493)

	I've never	Not at all	A little	Very much	Response
Camp Invention	55.0%	7.5%	21.5%	16.0%	
	271	37	106	79	**493**
eCYBERMISSION	67.5%	6.5%	17.8%	8.1%	
	333	32	88	40	**493**
Junior Solar Sprint (JSS)	48.1%	8.9%	28.6%	14.4%	
	237	44	141	71	**493**
Gains in the Education of Mathematics and Science (GEMS)	11.2%	1.2%	14.2%	73.4%	
	55	6	70	362	**493**
UNITE	74.4%	3.4%	13.4%	8.7%	
	367	17	66	43	**493**
Junior Science & Humanities Symposium (JSHS)	71.6%	5.1%	12.6%	10.8%	
	353	25	62	53	**493**
	58.0%	2.6%	17.0%	22.3%	

Science & Engineering Apprenticeship Program	286	13	84	110	**493**
Research & Engineering Apprenticeship Program (REAP)	60.4%	4.1%	16.0%	19.5%	
	298	20	79	96	**493**
High School Apprenticeship Program (HSAP)	61.9%	3.7%	14.0%	20.5%	
	305	18	69	101	**493**
College Qualified Leaders (CQL)	69.6%	3.9%	12.2%	14.4%	
	343	19	60	71	**493**
GEMS Near Peer Mentor Program	20.7%	4.7%	32.5%	42.2%	
	102	23	160	208	**493**
Undergraduate Research Apprenticeship Program (URAP)	66.5%	4.1%	14.4%	15.0%	
	328	20	71	74	**493**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	57.8%	2.4%	15.8%	23.9%	
	285	12	78	118	**493**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	68.2%	3.0%	12.6%	16.2%	
	336	15	62	80	**493**

In order to gauge what methods are most effective for informing students about AEOPs, students were asked to indicate rate the impact of various resources on their awareness of AEOPs (see Table 37). Students indicated that participating in GEMS was most likely to impact their awareness "somewhat" or "very much" (86%). Their mentors (74%) and invited speakers or career events (44%) were other resources frequently cited as being at least somewhat impactful on their awareness of AEOPs. Many students had never heard of AEOP resources such as the AEOP on social media (79%), and the AEOP brochure (62%).

Table 37. Impact of Resources on Student Awareness of AEOPs (n=493)

	I've never	Not at all	A little	Very much	Response
Camp Invention	55.0%	7.5%	21.5%	16.0%	
	271	37	106	79	**493**
eCYBERMISSION	67.5%	6.5%	17.8%	8.1%	
	333	32	88	40	**493**
Junior Solar Sprint (JSS)	48.1%	8.9%	28.6%	14.4%	
	237	44	141	71	**493**
Gains in the Education of Mathematics and Science (GEMS)	11.2%	1.2%	14.2%	73.4%	
	55	6	70	362	**493**
UNITE	74.4%	3.4%	13.4%	8.7%	

	367	17	66	43	**493**
Junior Science & Humanities Symposium (JSHS)	71.6%	5.1%	12.6%	10.8%	
	353	25	62	53	**493**
Science & Engineering Apprenticeship Program (SEAP)	58.0%	2.6%	17.0%	22.3%	
	286	13	84	110	**493**
Research & Engineering Apprenticeship Program (REAP)	60.4%	4.1%	16.0%	19.5%	
	298	20	79	96	**493**
High School Apprenticeship Program (HSAP)	61.9%	3.7%	14.0%	20.5%	
	305	18	69	101	**493**
College Qualified Leaders (CQL)	69.6%	3.9%	12.2%	14.4%	
	343	19	60	71	**493**
GEMS Near Peer Mentor Program	20.7%	4.7%	32.5%	42.2%	
	102	23	160	208	**493**
Undergraduate Research Apprenticeship Program (URAP)	66.5%	4.1%	14.4%	15.0%	
	328	20	71	74	**493**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	57.8%	2.4%	15.8%	23.9%	
	285	12	78	118	**493**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	68.2%	3.0%	12.6%	16.2%	
	336	15	62	80	**493**

Attitudes toward DoD Research

Student attitudes about the importance of DoD research are an important prerequisite to their continued interest in the field and potential involvement in the future. Students were therefore asked to rate their level of agreement with several statements about DoD researchers and the value of DoD research (Table 38). Large majorities of students (80% - 85%) agreed or strongly agreed with each statement, suggesting that they have positive opinions about DoD researchers and research after their GEMS experiences. Very few students disagreed with any statement (2% - 3%).

Table 38. Student Opinions about DoD Researchers and Research (n=2,010-2,016)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	2%	1%	17%	20%	60%	
	32	19	333	413	1218	2015

DoD researchers develop new, cutting edge technologies	1%	1%	16%	20%	61%	
	21	29	326	409	1229	2014
DoD researchers solve real-world problems	1%	1%	13%	15%	70%	
	23	15	265	306	1407	2016
DoD research is valuable to society	1%	1%	14%	15%	69%	
	22	23	289	297	1379	2010

Educational Aspirations

Students were also asked to consider the impact of GEMS on their educational aspirations (Table 39). A large majority of students (95%) reported wanting to at least finish college (get a Bachelor's degree), and over half (59%) indicated that they aspired to continue their education after college after participating in GEMS.

Table 39. Student Education Aspirations After GEMS (n=2,024)

	Response Percent	Response Total
Graduate from high school	1.73%	35
Go to a trade or vocational school	0.44%	9
Go to college for a little while	2.92%	59
Finish college (get a Bachelor's degree)	35.67%	722
Get more education after college	59.24%	1,199

Overall Impact

Finally, students were asked to respond to an item gauging the impacts of participating in GEMS more broadly (Table 40). Students' responses suggest that GEMS contributed substantially to students' interest in, awareness of, and confidence in a number of STEM-related areas. Most students (67% - 93%) reported that GEMS contributed to each area. For example, 93% of students reported that GEMS contributed to their confidence in their STEM knowledge, skills, and abilities, 80% that they were more aware of Army or DoD STEM research and careers, and 75% that they were more interested in earning STEM degrees as a result of their GEMS experiences. Mentors responded to a parallel item, and their reports about the impact of GEMS on their students was similar to students' self-reports. These Overall Impact of GEMS items were combined into a composite variable[22] to test for differences among subgroups of students. No

[22] The Cronbach's alpha reliability for these 10 Overall GEMS Impact items was 0.916.

significant differences were found by gender. However, non-minority students reported significantly higher levels of Overall Impact in comparison to minority students (small effect size, d = 0.131 standard deviations).[23]

Findings from the outcomes evaluation indicate that GEMS students experienced growth in their STEM knowledge and skills as a result of participating in GEMS and were positively impacted by their experiences in a variety of ways. Students reported gains in their 21st Century Skills as a result of GEMS and grew in terms of their STEM identities and confidence as well. Students reported increased likelihood of participating in a number of STEM-related activities after their GEMS experiences. Although many students had not heard of other AEOPs, they reported being interested in participating in AEOPs in the future. Apprentices had positive opinions about DoD research and researchers and overall had educational aspirations that would prepare them for STEM careers in the future.

[23] Independent samples t-test for Overall GEMS Impact: Race/Ethnicity $t(1662)=2.68$, $p=.008$.

Table 40. Student Opinions of GEMS Impacts (n=1,063-1,309)

	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	3%	5%	8%	85%	
	28	48	82	905	**1063**
I am more interested in participating in STEM activities outside of school requirements	8%	10%	6%	76%	
	85	108	68	825	**1086**
I am more aware of other AEOPs	18%	9%	5%	69%	
	230	114	60	897	**1301**
I am more interested in participating in other AEOPs	15%	9%	5%	72%	
	189	110	60	922	**1281**
I am more interested in taking STEM classes in school	8%	14%	6%	73%	
	81	146	63	776	**1066**
I am more interested in earning a STEM degree	11%	14%	6%	69%	
	120	149	66	755	**1090**
I am more interested in pursuing a career in STEM	10%	15%	6%	69%	
	112	157	64	746	**1079**
I am more aware of Army or DoD STEM research and careers	11%	10%	5%	75%	
	138	128	61	982	**1309**
I have a greater appreciation of Army or DoD STEM research	8%	8%	5%	79%	
	102	106	64	1023	**1295**
I am more interested in pursuing a STEM career with the Army or DoD	23%	16%	5%	57%	
	285	199	59	718	**1261**

8 | Findings and Recommendations

Summary of Findings

The 2017 evaluation of GEMS collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the Table 41.

Table 41. 2017 GEMS Evaluation Findings	
Participant Profiles	
GEMS enrollment grew in 2017, and the program continued to serve students from populations historically underrepresented in STEM.	Enrollment in GEMS grew 15% from 2016 to 2017 (2,427 students in 2016; 2,845 students in 2017), exceeding the 2017 program goal of 2,550 participants. Nearly half of GEMS students (47%) were female in 2017 (46% in 2016), a population underrepresented in some STEM fields. GEMS continued to serve students from racial and ethnic groups historically underrepresented and underserved in STEM at rates similar to 2016. There was a slight increase in participation of Black or African American students in 2017 (26% compared to 23% in 2016); 7% of students identified themselves as Hispanic or Latino (compared to 8% in 2016).
	The proportion of students receiving free or reduced-price lunch, a commonly used indicator of low-income status, was similar in 2017 (12%) to 2016 (10%).
GEMS attracted more applicants in FY17 as compared to previous years.	GEMS sites continued to receive applications from more qualified students than they could serve. A total of 4,653 applications were submitted in 2016, exceeding the program goal of 4,600 applicants. This is an increase of 5% from 2016 when there were 4,414 applicants, an increase of 10% over 2015 when there were 4,161 applicants, and an increase of 28% over 2014 when 3,343 students submitted GEMS applications.
Actionable Program Evaluation	
GEMS marketed the program in a number of ways, however students continued to report learning about AEOP primarily through personal connections.	NSTA and GEMS sites employed multiple strategies to disseminate information about the GEMS program, and implemented efforts to reach underserved and underrepresented populations such as incorporating stories and photos of GEMS participants from underserved and underrepresented backgrounds into marketing materials.
	Other than past participation in the program (37%), the most frequently reported sources of information about AEOP were personal connections, including friends (43%), family members (41%), past participants of the program (37%), and family members (34%).

GEMS students were motivated to participate in the program primarily by learning opportunities, fun, the opportunity to gain laboratory experience, and career interests.	Students' most frequently cited motivators for participating in GEMS were the desire to learn something new or interesting (92%), an interest in STEM (90%), and the opportunity to learn in ways not possible in school (82%). Three-quarters of responding students (75%) indicated that having fun motivated them to participate in GEMS. The opportunity to use advanced laboratory technology (65%) and the desire to expand laboratory or research skills (64%) were also relatively frequently mentioned motivators. Over half of students also cited career interest and information as motivators, including figuring out education or career goals (57%) and exploring a unique work environment (54%) as motivators for GEMS participation.
GEMS students learned about STEM careers in general and, to a lesser extent, about DoD STEM careers, during their GEMS experiences.	Nearly all students (97%) reported learning about at least one STEM job/career, and most (58%) reported learning about five or more. A smaller number (81%) reported learning about at least one DoD STEM job/career and 28% reported learning about 5 or more DoD STEM careers. These data are similar to student responses for 2015 and 2016.
	Students reported that the most impactful resource for learning about DoD STEM careers was simply participating in GEMS, with 72% of students reporting this as being somewhat or very much impactful. Over half of respondents (64%) indicated that their mentors were somewhat or very much impactful and 40% that invited speakers or career events were at least somewhat impactful in learning about DoD STEM careers. Over a third of students reported that they had not experienced other resources. Such as invited speakers or career events (38%), the AEOP website (40%), and the AEOP brochure (64%).
	80% of students indicated that they were more aware of Army or DoD STEM research and careers as a result of participating in GEMS, and 62% were more interested in pursuing a STEM career with the Army or DoD after participating.
GEMS students engaged in a variety of STEM practices on a regular basis during their apprenticeships and reported significantly higher levels of engagement in these practices in GEMS as compared to their typical school experiences.	A large majority of students (76% - 93%) reported engaging in most STEM practices at least once during GEMS. Three-quarters or more of students had engaged at least a few times during GEMS in practices such as using laboratory procedures and tools (88%), analyzing data or information and drawing conclusions (84%), and communicating with other students about STEM (78%).
	Students' engagement in STEM practices was significantly greater in GEMS than in their typical school experiences (large effect size, d = 1.79 standard deviations), suggesting that GEMS provides a unique experience with more intensive STEM engagement than students typically experience in school.
GEMS mentors used strategies associated with all areas of effective mentoring in their work with students.	A large majority of responding mentors (67% - 94%) reported using each strategy to help make the learning activities in GEMS relevant to students with the exception of selecting readings or activities that relate to students' backgrounds (48% used this strategy).
	Most mentors (52% - 98%) reported using all mentoring strategies to support the diverse needs of students as learners.
	Large majorities of mentors (83%-98%) reported using each strategy associated with supporting students' development of collaboration and interpersonal skills.
	A large majority of mentors (76% - 98%) reported using each strategy associated with supporting student engagement in authentic STEM activities with the

	exception of having students search for and review technical literature to support their work (35% used this strategy).
	Between 44% and 89% of mentors reported using each strategy associated with supporting students' STEM educational and career pathways. The wide variation in ages of GEMS students may account for the variable use of some of these mentoring strategies.
Students and mentors expressed high levels of satisfaction with their GEMS experience	Most students (56% - 91%) indicated that they were somewhat or very much satisfied with all program features. For example, 89% were at least somewhat satisfied with the variety of STEM topics available to them in GEMS, 91% with the teaching or mentoring during program activities, and 91% with the stipend.
	Students identified several benefits of GEMS, including the impact on their learning or knowledge in STEM students' learning or knowledge in STEM, the laboratory or hands-on experience students gained, and the opportunity to develop their 21st Century Skills (e.g., teamwork, communication, problem solving).
	Students' suggestions for program improvement included making the program longer and/or providing more time to complete projects, providing more options for program topics, and providing more hands-on activities.
	Large majorities of mentors (79% - 98%) were somewhat or very much satisfied with each feature of the program with the exception of communicating with the NSTA (44% had not experienced this). For example, 98% were at least somewhat satisfied with the location of GEMS activities and with communicating with GEMS organizers, and 91% with the support or mentorship they received during program activities.
	Mentors identified as particular strengths of GEMS the STEM learning GEMS students experience; the lab experiences and hands-on, real-world applications of knowledge GEMS offers; networking opportunities; speakers and field trips or lab tours; and the career information students receive.
	Mentors' suggestions for program improvement included having more or more engaging speakers, improving curriculum to enhance activities or make it more age-appropriate, providing a larger space and/or more resources for program activities, incorporating more field trips and/or lab tours, and ensuring better technology access.
Outcomes Evaluation	
GEMS had positive impacts on students' STEM knowledge and skills.	A majority of students (81% - 87%) reported learning in each area of STEM knowledge. For example, 87% learned "more than a little" or "learned a lot" about a STEM topic and 84% experienced similar levels of learning about how scientists and engineers work on real problems in STEM.
	GEMS impacted students' STEM competencies, including their science and engineering practices. For students in science-focused GEMS programs, the greatest gains were in communicating about experiments and explanations in different ways (68% learned more than a little or learned a lot) and supporting an explanation for an observation with data from experiments (67% learned more than a little or learned a lot). For students in engineering-focused GEMS

	programs, the greatest areas of learning (students reporting learning more than a little or learning a lot) were in carrying out procedures for an experiment (72%) and making a model of an object or system to show its parts and how they work (71%).
GEMS had positive impacts on students' 21st Century Skills.	Nearly three-quarters or more of responding students (71% - 78%) reported that they learned more than a little or learned a lot in all areas of 21st Century Skills including making changes when things do not go as planned (78%) and communicating effectively with others (77%).
GEMS had positive impacts on students' identities in STEM, and in their interest in engaging in STEM in the future.	After participating in GEMS, most students (72% - 85%) agreed that GEMS had impacted their STEM identities, or feelings of confidence and self-efficacy in terms of STEM achievement. For example, 85% of students somewhat agreed or agreed that they felt like they had accomplished something in STEM and 76% that they were thinking creatively about a STEM project or activity.
	A majority of students (53% - 70%) indicated that they were more likely or much more likely to engage in most STEM activities, including participating in a STEM camp or club (70%) working on a STEM project or experiment in a university or professional setting (66%).
	Over three-quarters of students indicated that after participating in GEMS they were more interested in participating in STEM activities outside of school (82%) and that they were more interested in taking STEM classes in school (79%).
	A large majority of students (93%) were more confident in their STEM knowledge, skills, and abilities after participating in GEMS.
Although GEMS students have limited awareness of other AEOP initiatives, students expressed interest in participating in AEOPs in the future and cited GEMS participation, their mentors, and invited speakers or career events as sources of AEOP information.	Most students reported that they were more aware of other AEOPs after participating in GEMS (74%) and were more interested in participating in other AEOPs (77%) as a result of participating.
	A large majority (88%) of students indicated being at least a little interested in participating in GEMS again and 75% indicated being at least somewhat interested in participating as GEMS NPMs in the future.
	Many students (48% - 74%) had not heard of the other AEOPs, including JSS (48% had not heard of it), eCM (68% had not heard of it), and JSHS (72% had not heard of it). Most students who were familiar with the programs reported being at least a little interested in them, however, and relatively few indicated being "not at all" interested in future participation in any program. For example, only 9% of students were "not at all" interested in participating in JSS, 7% in eCM, and 5% in JSHS.
	Students indicated that participating in GEMS was most likely to impact their awareness of AEOPs "somewhat" or "very much" (86%). Their mentors (74%) and invited speakers or career events (44%) were other resources frequently cited as being at least somewhat impactful on their awareness of AEOPs.
	Mentors most frequently discussed GEMS (96%) and GEMS NPMs (80%) with students. More than half of mentors (52%) reported discussing AEOPs generally with students but without reference to any specific program. Relatively few mentors discussed other AEOPs specifically. For example, only 15% discussed JSHS, 15% discussed SEAP, and 7% discussed Unite with their students.

	Mentors most frequently rated participation on GEMS (93%) as at least somewhat useful for informing students about AEOPs. GEMS program administrators or site coordinators (88%) and invited speakers or career events (76%) were also at least somewhat useful. Over a third of mentors (35%) had not experienced the AEOP website, and 28% had not experienced the AEOP brochure.
GEMS students had positive opinions of DoD research and DoD researchers.	Large majorities of students (80% - 85%) agreed or strongly agreed with a series of positive statements about DoD researchers and research.
	A large majority of students (84%) reported that they have a greater appreciation of Army or DoD STEM research after participating in GEMS.
GEMS fostered students' aspirations for education that would prepare them for STEM careers.	A large majority of students (95%) reported wanting to at least finish college (get a Bachelor's degree), and over half (59%) indicated that they aspired to continue their education after college.
	Three-quarters of students (75%) were more interested in earning STEM degrees after participating in GEMS.

Responsiveness to FY17 Evaluation Recommendations

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

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: The capacity of existing sites was increased, most notably at the Engineer Research and Development Center (ERDC) and at Medical Research and Materiel Command (MRMC) Headquarters. These labs expanded participation under the FY17 RFP in Vicksburg, Mississippi, and Frederick, Maryland, respectively. ERDC added 40 students and MRMC was able to add 173 students.

A new location was also added – Armament Research, Development and Engineering Center (ARDEC) in Picatinny Arsenal, New Jersey. This site will provide room for an estimated 143 participants. The expansion to ARDEC provided 34 new Near-Peer Mentors (NPM) and Resource Teachers (RT) that did not participate last year. RT, NPM, and Scientist and Engineer (S&E) staff increased from 314 in FY16 to 510 in FY17. Administrative staff support expanded at 7 of 14 labs. Support remained constant at 4 of 14 and lowered at 2 of 14. Five of the 14 labs had new Local Program Coordinators (LPC.) Three of these five labs had LPCs who had never worked on a GEMS staff prior to FY17. Physical infrastructure expanded at 4 of 12 locations. Three of these 4 expansions were through satellite locations, Northwestern High School near Walter Reed Army Institute of Research (WRAIR); Academy of Innovation in Vicksburg, Mississippi; and Frederick Community College in Frederick, Maryland. In FY17, 281 scientists and engineers participated. This is an increase from FY16, where 215 participated.

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: Targeted local marketing was encouraged by the office of the Cooperative Agreement Manager (CAM) with its release of guidelines for LPC outreach in FY17. These guidelines encouraged labs to target schools that had evidence of high percentages of members from communities that are historically underserved and underrepresented in STEM fields (U/U.) In accordance with these guidelines, the IPA cooperated with outreach partners, like DC STEM network and Prince Georges County Public Schools, to attend events in the Greater Washington, D.C. area (e.g., DC STEM network's 2017 STEM Fair). The IPA also provided Widmeyer Communications, AEOP's Marketing Partner, with stories and photos of those who participated in GEMS and came from U/U backgrounds. This was done during the program cycle and the effects will not be evident in FY17 program data, but the IPA believes providing examples of U/U inclusion will affect FY18 data.

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: There is evidence that some reduction of personally connected participants is taking place at the local level. One LPC reported that she no longer provided GEMS information through the staff newsletter that goes out to lab employees. One LPC reported that she delays putting out information to laboratory staff. Both reported that this has provided more opportunity for those that live and work outside of the laboratory's normal connections.

The IPA did not find these practices at all locations, as one local GEMS staff member reported making special accommodations on more than one occasion for those have personal connections to the lab. Interviews with LPCs during site visits revealed that it is often difficult for LPCs to turn away family of those that work in the lab due to social pressures and the need for continued support from peers and leaders inside the lab.

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

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: RT and NPM application windows were opened earlier in FY17 with the hope that more NPM would apply prior to winter break. The feedback from LPC interviews suggested that the timeline was better, but that NPM and RT recruitment was more difficult this year than in previous years. A possible cause mentioned was a perception of increased scrutiny during Childcare National Agency Checks and Inquiry (CNACI) and other lab-specific security requirements. One LPC felt like the process was a deterrent for those who wanted to participate. One LPC mentioned that potential NPMs were unable to come in for finger printing or unwilling to complete paper work.

Another LPC reported that pay was an issue. RT stipend amounts were less than local Summer School pay. This report was difficult to apply to other locations, as there seems to be inconsistency with how
RTs are paid from site to site, despite an established Stipend Rate in the GEMS Stipend Policy. The inconsistencies were reported to the CAM office and a working plan was agreed upon to increase the resolution of data for stipend rates in FY18.

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: No efforts directly mentioned regarding this finding in the FY17 GEMS APR.

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: Lead time for student stipends was lower this year than last. By the end of the first month, the median amount of business days between student roster submission and student check receipt was 7 business days. Data from last year's process was lower resolution, but the IPA estimates it was closer to 12 business days. There was an issue where reports between the IPA staff and GEMS LPC staff differ on what was sent and what was received. In the process, 93 student checks were lost. This was a risk with low probability of occurrence, but as an issue it had a large effect. The process of communicating the contents of shipments is currently in review, but will likely result in more specific data moving from the IPA to the LPC during shipments.

The IPA used more structured procedures for data entry to simplify the process of NPM and RT checks, and the results were better resolution on tracking individual staff checks. This better tracking helped the IPA determine whether checks were ahead or behind schedule. Initial feedback from LPCs led the IPA to believe that it made progress towards this recommendation. Data from evaluations and continued feedback from staff will determine if these changes let to an improved perception of timeliness. There were cases in FY17 of LPCs providing rosters to the IPA without the requested six-week notice, but most of these limited cases resulted in delays of less than two weeks. An example of the lack of a six-week notice is one lab that began July 10: As of July 20th, the IPA staff had not received the roster to process GEMS staff checks.

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

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: Experiences during site visits showed that LPCs are making progress by integrating other AEOPs at the local level. During one site visit, SEAP students were completing training modules in the GEMS classroom. At the same location, a CQL student observed the GEMS students and helped answer some questions. One location continued to use a combination of the CQL and NPM programs to offer one or two college students a full-summer program. This location had two weeks of GEMS programs, so without the support of CQL, retaining NPMs through the summer would be more difficult.

The GEMS/CI IPA worked with the eCYBERMISSION (eCM) IPA to investigate the possibility of allowing NPM to act as Team Advisors (TAs) for eCM. The main issue identified was an eCM regulation that prohibited TAs from being younger than age 21. This regulation would prohibit many NPM from participating in the programs. eCM was gathering stakeholder feedback to provide a solution or workaround. The GEMS/CI IPA continued to conduct site visits to meet with local educators and administrators promote and explain AEOP. The hope is for Local Education Authorities to see local research labs as a source for STEM education and AEOP programming.

FY16 Finding: 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.

GEMS FY17 Efforts and Outcomes: Program time for student completion was provided in FY17. Purdue was also able to provide tablets that could gather data without a need for internet connectivity. One site reported a complete lack of internet connectivity for students and four sites reported intermittent or restricted internet connectivity. The IPA was encouraged by Purdue's willingness to provide solutions to place-based issues and anticipates a better completion rate in FY17. The questionnaire completion rate in FY17 is unknown at end of program year. Purdue had not received 10 of 22 boxes of evaluation tablets from LPCs by their requested deadline. Purdue provided the IPA with a data brief on September 9, 2017, with about 25% of the student population reporting and 11% of the mentor population reporting.

One LPC identified an issue with tablets containing pictures of students at other locations. These photos could be considered personally identifiable information by some stakeholders. The issue was reported to Purdue and a method of wiping data from tablets was requested. Multiple LPCs reported the evaluation was too long for students and mentors. The CAM and LO planned to investigate solutions directly with Purdue.

Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that FY17 was a very successful year for the GEMS program. Both applications to the program and participation increased for the year. Students consistently reported the impact of GEMS on their STEM knowledge, skills, interests, and future desires to participate in STEM. GEMS participants reported meaningful learning in regards to STEM careers and STEM careers within the DoD/Army specifically. In fact, 75% of participants were more interested in earning STEM degrees after participating in GEMS.

While the successes for GEMS detailed above are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY18 and beyond.

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

As in FY16, GEMS student participants continued 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 FY17 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

In FY17, GEMS participants and mentors both echoed findings that have been prevalent across the AEOP portfolio. Only a very few number of participants and mentors are accessing and/or utilizing AEOP social media, including the website. In regards to GEMS, only 40% had accessed the AEOP website. It is important for GEMS to play a role in working with the consortium overall to determine the strategy and plan for use of social media within and across the AEOPs.

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

A majority of student participants reported they had not learned about other AEOPs that would be next in their pipeline of opportunities, including JSS (48%), eCM (68%), and JSHS (72%). More than half of mentors reported only generally discussing AEOPs with participants. GEMS should invest additional effort in FY18 to provide sites with resources to use to introduce and teach participants about AEOPs in more than a one-time manner. A virtual alumni panel or using NPMs to teach GEMS participants would be good strategies to consider.