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ARMY EDUCATIONAL OUTREACH PROGRAM

GEMS

2018 Annual Program Evaluation Report
Findings

June 2019

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ARMY EDUCATIONAL OUTREACH PROGRAM

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1 | AEOP Consortium Contacts

U.S. Army Contacts

Matthew Willis, Ph.D.
Director, Laboratory Management
Office of the Deputy Assistant Secretary of the Army for Research and Technology
matthew.p.willis.civ@mail.mil

Andrea Simmons
Army Educational Outreach Program (AEOP) Director
Office of the Deputy Assistant Secretary of the Army for Research and Technology
andrea.e.simmons.ctr@mail.mil

AEOP Cooperative Agreement Manager

Christina Weber
AEOP Cooperative Agreement Manager
U.S. Army Combat Capabilities Development Command (CCDC)
christina.l.weber.civ@mail.mil

Battelle Memorial Institute – Lead Organization

David Burns
Project Director, AEOP CA
Director of STEM Innovation Networks
burnsd@battelle.org

GEMS Program Administrators

Sue Whitsett
NSTA Director of AEOP
National Science Teachers Association (NSTA)
swhitsett@nsta.org

Zach Pekor
GEMS Program Administrator
National Science Teachers Association (NSTA)
zpekor@nsta.org

Evaluation Team Contacts – NC State University

Carla C. Johnson, Ed.D.
Evaluation Director, AEOP CA
carlacjohnson@ncsu.edu

Toni A. Sondergeld, Ph.D.
Assistant Director, AEOP CA
tonisondergeld@metriks.com

Janet B. Walton, Ph.D.
Assistant Director, AEOP CA
walton25@purdue.edu

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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.

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 18 Army research centers and laboratories operating in 11 states (see Table 1). In 2018, GEMS enrolled to 3,341 students at 15 sites. This number represents a 15% increase over enrollment in 2017 when 2,845 students participated and an increase of 27% over 2016 when 2,427 students participated in GEMS.

GEMS sites continued to receive applications from more qualified students than they could serve. A total of 5,500 student applications were submitted for 2018 GEMS programs, a 15% increase as compared to

2017 when 4,653 applications were submitted an increase of 20% over 2016 when GEMS programs received 4,414 applications. Table 2 provides the application and participation data by GEMS site for 2018. In addition to student participants, 595 adults worked with the program in various capacities, a 14% increase over 2018 when 510 adults participated, and a 42% increase over adult participation in 2016. Of the adults participating in 2018, 151 were NPMs and 68 were Resource Teachers.

Table 1. 2018 GEMS Sites		
Laboratory	**Command***	**Location**
U.S. Army Combat Capabilities Development Command – Armament Center	CCDC	Picatinny Arsenal, NJ
U.S. Army Combat Capabilities Development Command – Aviation and Missile Center	CCDC	Huntsville, AL
U.S. Army Combat Capabilities Development Command - Army Research Laboratory –Aberdeen Proving Ground (ARL-APG)/ US Army Medical Research Institute of Chemical Defense (USAMRICD)/ U.S. Army Combat Capabilities Developemnt Command – C5ISR Center	CCDC/ USAMRMC	Aberdeen, MD
U.S. Army Combat Capabilities Development Command - Army Research Laboratory- Adelphi (ARL-Adelphi)	CCDC	Adelphi, MD
U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Orlando (ARL - Orlando)	CCDC	Orlando, FL
U.S. Army Combat Capabilities Development Command - Army Research Laboratory - White Sands Missile Range (ARL-WSMR) and Army Test and Evaluation Command (ATEC - WSMR)	CCDC / ATEC	White Sands, NM
U.S. Army Combat Capabilities Development Command - Army Research Laboratory - West (ARL-West)	CCDC	Playa Vista, CA
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
U.S. Army Test and Evaluation Command (ATEC) - Yuma Proving Ground (YPG) and U.S Army Combat Capabilities Development Command (CCDC)	CCDC / ATEC	Yuma, AZ

Table 2. 2018 GEMS Site Applicant and Enrollment Numbers			
Command	**2018 GEMS Site**	**Number of Applicants**	**Number of Enrolled Participants**
CCDC	U.S. Army Combat Capabilities Development Command – Armaments Center	334	259
	U.S. Army Combat Capabilities Development Command – Aviation and Missile Center	244	162
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Aberdeen Proving Ground (ARL-APG)*	639	265
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Adelphi (ARL-Adelphi)	263	181
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Orlando (ARL-Orlando)	138	101
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - West (ARL-West)	39	28
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - White Sands Missile Range (ARL-WSMR)**	352	103
MRMC	U.S. Army Aeromedical Research Laboratory (USAARL)	591	429
	U.S. Army Medical Research and Material Command at Fort Detrick (USAMRMC-Ft. Detrick)	993	649
	U.S. Army Research Institute for Surgical Research (USAISR)	179	83
	U.S. Army Research Institute for Environmental Medicine (USARIEM)	297	204
	Walter Reed Army Institute of Research (WRAIR)	1057	641
USACE	Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL)	87	58
	Engineer Research & Development Center - Mississippi (ERDC-MS)	189	111
ATEC	U.S. Army Test and Evaluation Command (ATEC) - Yuma Proving Ground (YPG)[1]	84	68
TOTAL		**5,486**	**3,341**

*Note – this includes ARL-APG, MRICD, and CSISR

**Note – this includes ARL-WSMR and ATEC-WSMR

[1] The YPG GEMS program is a joint effort lead by CCDC and executed by ATEC, YPG.

Table 3 displays demographic information for enrolled FY18 GEMS student participants. There were some participants that participated in more than one GEMS program. Therefore, those participants are counted only once in the student profile, resulting in a net of 3,251 unique participants for FY18.

Overall student demographics for 2018 are similar to those of 2017. As in 2017, nearly half of participants were female (47% in both 2017 and 2018). Likewise, the proportion of students identifying as White changed very little (38% in 2017, 40% in 2018) and there was little change in participation of Black or African American students in 2018 (24%) compared to 2017 (26%). Asian students comprised 17% of enrolled participants (18% in 2017) and 9% of students identified themselves as Hispanic or Latino (compared to 7% in 2017). Over a third of students (35%) met the AEOP definition of underserved.

Table 3. 2018 GEMS Enrolled Student Profile		
Demographic Category	GEMS Participants	
Respondent Gender (n=3,251)*		
Female	1,521	47%
Male	1,723	53%
Choose not to report	7	<1%
Respondent Race/Ethnicity (n=3,251)		
Asian	559	17%
Black or African American	764	24%
Hispanic or Latino	292	9%
Native American or Alaska Native	15	<1%
Native Hawaiian or Other Pacific Islander	6	<1%
White	1,284	40%
Other race or ethnicity	174	5%
Choose not to report	157	4%
School Location (n=3,251)		
Urban	360	11%
Rural	179	6%
Suburban	1,039	32%
Department of Defense School	10	<1%
Frontier or Tribal School	1	<1%
Choose not to report	1,578	49%
Free and Reduced Lunch Status (n=3,251)		
Yes	477	15%
No	2,604	80%
Choose not to report	170	5%
English as First Language (n=3,251)		
Yes	3,057	94%
No	163	5%
Choose not to report	31	1%
Parent Graduated from College (n=3,251)		

Yes	2,899	89%
No	287	9%
Choose not to report	65	2%
Underserved[2] (n=3,251)		
Yes	1,122	35%
No	2,129	65%

*Note – there 3,251 unique paricipants in GEMS for FY18. Some participated in more than one GEMS program resulting in the total "participants" number of 3,341.

Table 4 summarizes 2018 GEMS program costs. The cost per student for FY18 was $436.00. The total cost of the program was $1,456,996.

Table 4. 2018 GEMS Program Costs	
2018 GEMS Students – Cost Per Participant	
Number of Students	3,341
Total Cost	$1,456,996
Cost Per Participant (Student)	**$436**
2018 GEMS Cost Breakdown	
Administratative/Overhead/Indirect/Procurement Fee Costs	$250,898
Participant Stipends (Students, NPMs & RTs)	$951,772
Other Operational Costs	$53,448
Supplies/Equipment/Transportation ODCs sent directly to Labs	$191,771
Travel Costs – paid for S&E's	$9,107.68
Total	$1,456,996

[2] 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.

4 | 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 18 Army research laboratories operating at 15 sites in 11 states • 3,342 Students participating in GEMS programs • 595 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, 6 focus groups with students, 4 focus groups with mentors and 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, 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, 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

The GEMS Evaluation included examination of participant outcomes and other areas that would inform continuous program improvement. A focus of the evaluation is on 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 technological 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 evaluation also collected data about participant perspectives on program processes, resources, and activities for the purpose of recommending improvements as the program moves forward.

Findings are presented in alignment with the three AEOP priorities. The findings presented herein include several components related to AEOP and program objectives, including impacts on students' STEM competencies (e.g., knowledge and skills), STEM identity and confidence, interest in and intent for future STEM engagement (e.g., further education, careers), attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[3] STEM competencies are necessary for a

[3] 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.

STEM-literate citizenry and include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are 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.

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data are summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and footnotes providing results from tests for significance. The student and mentor focus group protocols are provided in Appendix B (student) and Appendix C (mentor); and student and mentor questionnaire instruments are located in Appendix D (student) and Appendix E (mentor).

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). We use the number of unique participants (3,251) for determining the participation rate in the questionnaire, as it is not expected for a student to complete the survey more than once if they participate in the program multiple times.

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, 11% in 2017, and 12% in 2018. The student response rate for 2018 (56%) was lower than in previous years (76% in 2017; 74% in 2016).

A few GEMS sites utilized Cvent to administer the survey to participants (n=186). The remainder of the GEMS participant population completed the evaluation questionnaire using tablets at the GEMS laboratory sites (n=1,679) for a total respondent population of 1,865. There were 1,806 who provided demographic data on their survey resposes.

Table 10. 2018 GEMS Questionnaire Participation				
Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[4]
Students	1,806	3,251	56%	±1.54%
Mentors	26	595	4%	±18.81%

Six student focus groups and 4 mentor focus groups were conducted at 3 GEMS sites. Student focus groups included 57 students (24 females and 33 males). Most participants were in the eighth (20) and ninth (21) grades. One student was a seventh grader, 7 were in the tenth grade, 4 were in the eleventh grade, and 4 were twelfth graders. Slightly less than half of focus group students who reported their years of experience in GEMS indicated that they were participating in GEMS for the first time (26), while 13 had participated in GEMS once before and 16 had participated twice before. The 4 mentor focus groups were also conducted at 3 sites and included 19 NPMs and 8 assistant NPMs (14 females and 13 males). 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. Approximately one-third to two-thirds of survey respondent choose not to respond to various demographic questions. Thus, it is difficult to determine of the survey sample is similar in terms of demographics to the overall GEMS population. Approximately a third of students indicated they were female (35%), about a third male (34%), and about another third did not respond (31%). While 44% of students chose not to respond about their race/ethnicity, 29% reported being White and over 10% indicated they were Asian (13%) or Black/African American (13%). A majority of students reported not being eligible for free or reduced lunch (57%), speaking English as a first language (66%), and having a parent who graduated from college (62%). With such a large number of missing demographic responses for the questionnaire, we cannot be certain that underrepresented classification data are accurate.

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

Further, based on the data that were collected, significantly less U2 students completed the survey (23%) compared to the overall GEMS population (35%).

Table 11. 2018 GEMS Student Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 1,806)		
Female	632	35%
Male	611	34%
Choose not to report	563	31%
Respondent Race/Ethnicity (n = 1,806)		
Asian	241	13%
Black or African American	231	13%
Hispanic or Latino	119	7%
Native American or Alaska Native	9	<1%
Native Hawaiian or Other Pacific Islander	1	<1%
White	519	29%
Other race or ethnicity	67	4%
Choose not to report	619	44%
Respondent Grade Level (n = 1,806)		
3rd	4	<1%
4th	33	2%
5th	106	6%
6th	194	11%
7th	269	15%
8th	245	14%
9th	175	10%
10th	121	7%
11th	77	4%
12th	23	1%
First-Year College Student	1	<1%
Choose not to report	558	31%
Respondent Eligible for Free/Reduced-Price Lunch (n = 1,806)		
Yes	168	9%
No	1,020	57%
Choose not to report	558	31%
School Location (n = 1,806)		
Urban	113	6%
Suburban	353	20%
Rural	71	4%
Department of Defense School	3	<1%
Home School	40	2%
Choose not to report	1,226	68%
English First Language (n = 1,806)		

Yes	1,185	66%
No	53	3%
Choose not to report	568	31%
Parent Graduated from College (n = 1,806)		
Yes	1,115	62%
No	111	6%
Choose not to report	580	32%
Underrepresented (U2 Classification)		
Yes	406	23%
No	1,400	77%

Mentor Demographics

Table 12 summarizes demographics, occupations, and roles in GEMS for responding mentors. Most mentors who responded to the questionnaire were female (53%) and over a third (42%) identified themselves as Black or African American, while 37% identified themselves as White and 11% as Asian. Approximately a quarter of respondents were scientists, engineers, or mathematicians in training (27%) or scientists, engineers, or mathematics professionals (23%). Over half (58%) of mentor respondents served as NPMs in the program and 23% served as instructors. For some demographic items there were 26 responses and others less, depending on if the mentor elected to complete the item or leave it blank.

Table 12. 2018 GEMS Mentor Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 19)		
Female	10	53%
Male	9	47%
Respondent Race/Ethnicity (n = 19)		
Asian	2	11%
Black or African American	8	42%
Hispanic or Latino	1	5%
White or Caucasian	7	37%
Other	1	5%
Respondent Occupation (n = 26)		
Teacher	2	8%
Other school staff	1	4%
University educator	0	0%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	7	27%
Scientist, Engineer, or Mathematics professional	6	23%
Other	10	38%

Respondent Role in GEMS (n = 26)		
Instructor (typically a University or Army Scientist or Engineer)	6	23%
Classroom Assistant	0	0%
Resource teacher (RT)	3	12%
Near peer mentor (NPM)	15	58%
Assistant Near peer mentor	0	0%
Other	2	8%

5 | Priority #1 Findings

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

STEM Practices

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 13). A large majority of students (76% - 99%) reported engaging in all STEM practices at least once during GEMS. Approximately three-quarters of students had engaged at least a few times during GEMS in practices such as presenting STEM research to a panel of judges from industry or the military (74%); interacting with scientists or engineers (75%); and working with a STEM researcher or company on a real world STEM research project (76%).

Table 13. Student Engagement in STEM Practices in GEMS (n=1,846-1,862)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Apply STEM learning to real-life situations	2%	6%	15%	25%	53%	
	32	105	280	458	984	**1859**
Learn about new discoveries in STEM	5%	6%	16%	26%	47%	
	95	119	296	475	872	**1857**
Interact with scientists or engineers	4%	11%	42%	33%	10%	
	71	213	777	613	179	**1853**
Use laboratory procedures and tools	4%	10%	35%	35%	16%	
	72	179	650	648	297	**1846**
Work in or with a team	1%	2%	8%	15%	74%	
	16	44	152	278	1370	**1860**
Find questions or problems to investigate	8%	21%	44%	20%	7%	
	152	384	812	367	136	**1851**
Plan an investigation or experiment	24%	24%	27%	15%	10%	
	444	450	497	285	180	**1856**
Do an investigation or experiment	23%	24%	26%	16%	10%	
	436	445	487	301	187	**1856**
Examine or analyze data or information	5%	7%	12%	23%	54%	
	92	123	219	430	998	**1862**
Use a computer to make a model of something	2%	2%	6%	14%	76%	
	40	39	108	253	1419	**1859**

Work with a STEM researcher or company on a real world STEM research project.	3%	6%	32%	44%	15%	
	49	101	543	734	247	**1674**
Work with a STEM researcher on a research project assigned by your teacher.	6%	16%	40%	27%	10%	
	104	271	673	450	171	**1669**
Present your STEM research to a panel of judges from industry or the military.	4%	10%	38%	36%	12%	
	60	173	630	599	208	**1670**

A composite score[5] was calculated for this set of items entitled "Engaging in STEM Practices in GEMS"[6]. 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 overall U2 Classification and all relevant demographics (i.e., gender, race/ethnicity, school location, ELL, 1st Generation Status, and FARMS). Differences in STEM Practices Engagement were not found by U2 classification or any individual student demographics except for school location. Students from urban/rural/frontier schools reported engaging in STEM practices significantly more than suburban students (small effect size of d = 0.215).[7]

Table 14. Student Engagement in STEM Practices in School (n=186-1,865)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Apply STEM learning to real-life situations	6%	14%	19%	24%	38%	
	109	254	346	449	703	**1861**
Learn about new discoveries in STEM	6%	17%	48%	22%	7%	
	107	323	888	408	135	**1861**
Learn about different careers that use STEM	9%	15%	48%	20%	7%	
	167	286	895	377	139	**1864**
Interact with scientists or engineers	26%	34%	27%	8%	5%	
	491	640	503	141	88	**1863**
Communicate with other students about STEM	3%	7%	16%	20%	55%	
	64	122	291	368	1017	**1862**

[5] 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.

[6] The Cronbach's alpha reliability for the Engaging in STEM Practices in GEMS items was 0.788.

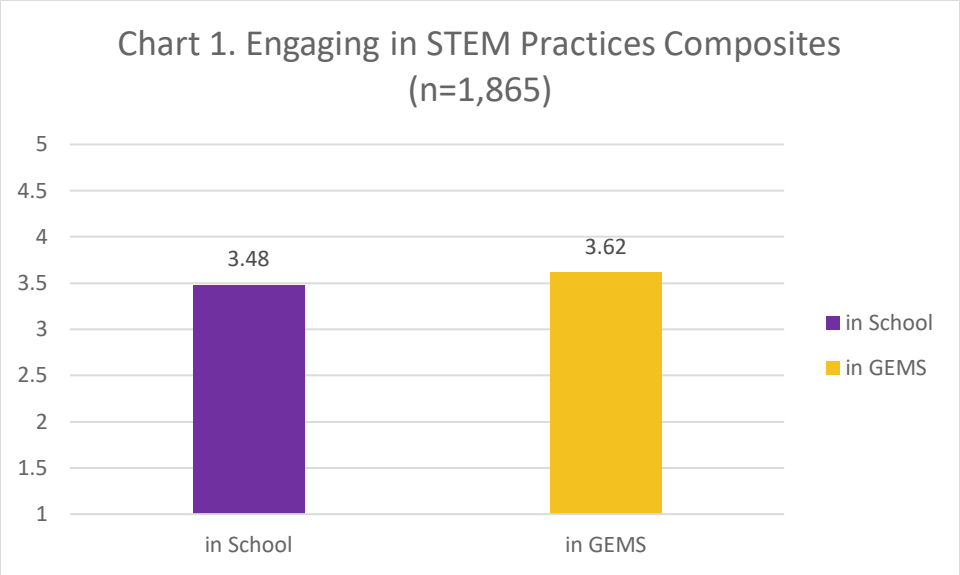
[7] Independent samples t-test for STEM Engagement in GEMS: School Location; t(578)=2.59, p=.010.

Use laboratory procedures and tools	13%	19%	35%	21%	12%	
	236	359	647	384	230	**1856**
Do hands-on STEM activities	3%	11%	49%	27%	10%	
	6	20	91	50	19	**186**
Work in or with a team	2%	5%	20%	33%	39%	
	42	102	379	618	722	**1863**
Find questions or problems to investigate	5%	18%	45%	24%	7%	
	100	331	846	450	138	**1865**
Plan an investigation or experiment	2%	6%	18%	28%	45%	
	39	111	342	527	844	**1863**
Do an investigation or experiment	2%	6%	18%	29%	45%	
	31	109	334	542	847	**1863**
Examine or analyze data or information	3%	8%	24%	32%	34%	
	47	151	451	589	628	**1866**
Make a decision or conclusion about the results of an investigation or experiment	6%	12%	37%	32%	13%	
	11	23	68	60	24	**186**
Discuss an explanation or solution with others or in writing	9%	15%	35%	31%	10%	
	17	27	65	58	19	**186**
Use a computer to make a model of something	5%	9%	19%	24%	44%	
	86	159	347	443	825	**1860**
Work with a STEM researcher or company on a real world STEM research project.	2%	5%	35%	36%	22%	
	35	81	592	601	377	**1686**
Work with a STEM researcher on a research project assigned by your teacher.	5%	13%	44%	28%	10%	
	87	220	743	465	167	**1682**
Present your STEM research to a panel of judges from industry or the military.	9%	22%	46%	19%	5%	
	143	370	768	313	85	**1679**

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 (see Table 14). These responses were also combined into a composite variable "Engaging in STEM Practices in School"[8]. 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 medium effect size (d = 0.479 standard deviations).[9]

[8] Cronbach's alpha reliability for the Engage in STEM Practices in School items was 0.809.

[9] STEM Engagement dependent samples t-test: t(1801)=10.17, p<.001.



Students participating in focus groups were also asked to share their opinions about how their GEMS experiences compared with their typical in school experiences. Students who responded all indicated that they believed that their GEMS experiences were substantially different than their typical school STEM experiences. Students indicated that GEMS provided more hands-on learning opportunities, more career information, more orientation toward problem-solving, more exposure to and experience in engineering, and more in-depth learning opportunities than their school experiences. For example,

> *"Learning in school sometimes is not as memorable [as in GEMS]. Doing all the hands on activities and seeing how it really works is beneficial."* (GEMS Student)
>
> *"You get to learn from people who really work with this kind of stuff in real life."* (GEMS Student)
>
> *"I've gotten a deeper understanding of some topics that we haven't gone through in the school yet or we unable to touch the surface on."* (GEMS Student)
>
> *"We had civil engineering which we don't really do [that] in our school."* (GEMS Student)
>
> *"Most of the things in school are learning this equation and this is what it does, but here we actually do it. We do all activities about it. Do fun games with it. It's really much better than school."* (GEMS Student)
>
> *"This program does a really good job of explaining things. It really helps in school. Sometimes school does a very bad job explaining why things happen and just expect you to understand it…there's also a lot of hands on learning and you can really take what you learn in school and*

figure out how it fits in the real world, and [not] just learning it for the sake of learning it and passing grades." (GEMS Student)

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 15). A majority of students (70% - 85%) reported that they learned "more than a little" or "learned a lot" in each area. For example, 85% learned more than a little or a lot about a STEM topic and 80% experienced this level of learning about how scientists and engineers work on real problems in STEM.

Table 15. Student Report of Impacts on STEM Knowledge (n=1,862-1,865)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
Knowledge of new STEM topics	1%	15%	31%	54%	
	1	279	578	1,007	**1,865**
How to do researchconducted in a STEM topic or field	9%	22%	31%	39%	
	150	410	578	726	**1,864**
Knowledge of how scientists and engineers work on real problems in STEM	3%	17%	25%	55%	
	109	281	464	1,008	**1,862**

These items were combined into a composite variable[10] to test for differential impacts for overall U2 classification and across subgroups of students. A significant difference was found in STEM knowledge by U2 classification with underrepresented students reporting significantly greater impact on their STEM knowledge as a result of GEMS (small effect size, d=0.323).[11] No significant differences were found by individual demographic variables.

Students were also asked about how GEMS impacted their STEM competencies or skills (Table 16). Half or more of students (55% - 82%) reported learning more than a little or a lot on all STEM competencies

[10] The Cronbach's alpha reliability for STEM Knowledge items was 0.749.

[11] Independent samples t-test for STEM Knowledge: U2 t(167)=2.09, p=.038.

except how to use computer models (42%) and how to present data in charts or graphs to find patterns or relationships (43%). Areas where students indicated they learned the most (more than a little or a lot) were how to consider different interpretations of data to answer a question (82%) and how to use knowledge to guess how an experiment will turn out (73%).

Composite scores were calculated for STEM competencies[12] to examine whether the GEMS program had differential impacts on student based on U2 classification and by subgroups of students. There were no significant differences found in STEM Competences by U2 classification. However, there were significant differences in STEM Competencies by a few demographic variables: first generation status (first generation students significantly higher – effect size is small, d=0.121); race/ethnicity (minority students significantly higher – effect size is small, d=0.170); and FARMS (FARMS students significantly higher – effect size is small, d=0.222).[13]

Table 16. Students Reporting Gains in their STEM Competencies – Science Practices (n=1,829-1,852)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
How to use knowledge to guess (hypothesis) how an experiment will turn out	8%	19%	33%	40%	
	147	361	607	737	**1852**
How to make a model of an object or system to show its parts and how they work	9%	24%	35%	33%	
	166	432	634	600	**1832**
How to carry out procedures for an experiment and recording data accurately	10%	20%	32%	38%	
	191	364	595	690	**1840**
How to use computer models of things	37%	21%	18%	24%	
	669	391	325	444	**1829**
How to present data in charts or graphs to find patterns or relationships	28%	29%	22%	21%	
	516	524	406	385	**1831**
How to consider different interpretations of data to answer a question	4%	13%	29%	53%	
	82	236	543	986	**1847**
How to support an explanation for an observation with data from an experiment	10%	20%	34%	37%	
	183	363	620	671	**1837**
How to defend an argument with data	9%	20%	35%	36%	
	172	367	639	667	**1845**

[12] The STEM Composite had a Cronbach's alpha reliability of 0.948.

[13] Independent samples t-test for STEM Competencies: First Generation Status t(1218)=2.11, p=.035; Race/Ethnicity t(1111)=2.84, p=.005; FARMS t(1180)=3.82, p<.001.

How to communicate about experiments and explanations in different ways (talking, writing, graphics)	10%	22%	30%	37%	
	190	403	559	688	**1840**

Students were 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 17). More than half of students (54% - 70%) reported that they learned more than a little or a lot in all of these skills. Items for which at least two-thirds of students indicated learning at this level were: how to include others' ideas when making decisions (70%); how to make changes when things do not go as planned (67%); and learning to view failure as an opportunity to learn (66%).

Table 17. Student Report of Impacts on 21st Century Skills (n=1,640-1,831)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
How to stick with a task until it is finished	13%	27%	30%	30%	
	236	494	557	544	**1831**
How to make changes when things do not go as planned	10%	23%	33%	34%	
	188	417	597	622	**1824**
Learn to work well with students from all backgrounds	12%	24%	30%	34%	
	197	398	488	557	**1640**
How to include others' ideas when making decisions	8%	22%	33%	37%	
	154	395	596	683	**1828**
How to communicate well with others	21%	25%	26%	28%	
	378	456	481	512	**1827**
Learn to view failure as an opportunity to learn	9%	26%	33%	33%	
	150	422	537	534	**1643**

The 21st Century Skills items were combined into a composite variable[14] to test for differential impacts by overall U2 classification and across subgroups of students. There was not a significant difference in 21st Century Skills by U2 classification. However, there were significant differences in 21st Century Skills impact from GEMS by FARMS, with students who received free and reduced prices lunch reporting significantly greater gains (effect size is small, d=0.182).[15] No significant differences were found by any other student demographic variables.

[14] The 21st Century Skills composite has a Cronbach's alpha reliability of 0.913.

[15] Two-tailed Independent Samples t-test: 21st Century differences by FARMS $t(1170)=3.12$, $p<.002$.

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[16], 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 18). After participating in GEMS, most students (67% - 91%) either somewhat agreed or agreed with each statement related to their STEM identities. For example, 91% of students somewhat agreed or agreed that they felt like they had accomplished something in STEM and 88% that they felt more prepared for challenging STEM activities. Comparing results on a composite created from these STEM Identity items,[17] there were no significant differences by U2 or any of the individual student demographics.

Table 18. Student Report of Impacts on STEM Identity (n=1,862-1,865)

	Strongly disagree	Disagree	Don't agree or disagree	Somewhat agree	Agree	Response Total
I am interested in a new STEM topic	3.8%	2.2%	12.4%	26.3%	55.4%	
	74	58	223	485	1,025	**1,865**
I am thinking about pursuing a STEM career	1.6%	5.9%	17.7%	18.8%	55.9%	
	64	111	330	335	1,025	**1,865**
I feel like I accomplished something in STEM	1.1%	1.1%	6.5%	25.8%	65.6%	
	20	20	111	484	1,230	**1,865**
I feel more prepared for more challenging STEM activities	1.6%	4.3%	5.9%	19.4%	68.8%	
	61	74	109	353	1,266	**1,863**
I am thinking creatively about a STEM project or activity	0.5%	4.3%	13.4%	27.4%	54.3%	
	17	81	252	502	1,010	**1,862**
	1.6%	5.9%	25.8%	23.1%	43.5%	

[16] 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.

[17] The Cronbach's alpha reliability for these Identity items was 0.866.

I have connected a STEM topic or field to my personal values	29	109	480	434	810	**1,862**

6 | Priority #2 Findings

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

Mentor Strategies and Support

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:[18]

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.

Tables 19-23 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.

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

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

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

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

A majority of responding mentors (54% - 96%) reported using each strategy to help make the learning activities in GEMS relevant to students (Table 19). For example, 96% of mentors reported helping students become aware of the role(s)that STEM plays in their everyday lives, and 96% asking students to relate real-life events to topics covered in GEMS.

Table 19. Mentors Using Strategies to Establish Relevance of Learning Activities (n=26)

	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	88.5%	11.5%	
	23	3	**26**
Giving students real-life problems to investigate or solve	76.9%	23.1%	
	20	6	**26**
Selecting readings or activities that relate to students' backgrounds	53.8%	46.2%	
	14	12	**26**
Encouraging students to suggest new readings, activities, or projects	57.7%	42.3%	
	15	11	**26**
Helping students become aware of the role(s) that STEM plays in their everyday lives	96.2%	3.8%	
	25	1	**26**
Helping students understand how STEM can help them improve their own community	84.6%	15.4%	
	22	4	**26**
Asking students to relate real-life events or activities to topics covered in GEMS	96.2%	3.8%	
	25	1	**26**

Many mentors also reported using all strategies to support the diverse needs of students as learners (42% - 92%). Table 20 shows mentor responses to this questionnaire item. Nearly all mentors (92%) reported using a variety of teaching and/or mentoring strategies to meet the needs of all students, and 92% 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 (73%) and identifying the different learning styles students may have (54%).

Table 20. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=26)

	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	53.8%	46.2%	
	14	12	**26**
Interact with students and other personnel the same way regardless of their background	92.3%	7.7%	
	24	2	**26**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	92.3%	7.7%	
	24	2	**26**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	46.2%	53.8%	
	12	14	**26**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	53.8%	46.2%	
	14	12	**26**
Directing students to other individuals or programs for additional support as needed	73.1%	26.9%	
	19	7	**26**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	42.3%	57.7%	
	11	15	**26**

Two-thirds or more of mentors (65% - 100%) reported using each strategy associated with supporting students' development of collaboration and interpersonal skills (see Table 21). For example, all mentors (100%) reported having students listen to the ideas of others with an open mind, and 96% had students work on collaborative activities or projects as a member of a team.

Table 21. Mentors Using Strategies to Support Development of Collaboration and Interpersonal Skills (n=26)

	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	65.4%	34.6%	
	17	9	**26**
Having my student(s) explain difficult ideas to others	84.6%	15.4%	
	22	4	**26**

Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	26	0	**26**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	92.3%	7.7%	
	24	2	**26**
Having my student(s) give and receive constructive feedback with others	80.8%	19.2%	
	21	5	**26**
Having students work on collaborative activities or projects as a member of a team	96.2%	3.8%	
	25	1	**26**
Allowing my student(s) to resolve conflicts and reach agreement within their team	92.3%	7.7%	
	24	2	**26**

Mentors were also asked about the strategies they used to support student engagement in authentic STEM activities (see Table 22). A large majority of mentors (85% - 96%) 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 (39% used this strategy). For example, nearly all responding mentors (96%) reported providing students with constructive feedback to improve their STEM competencies, encouraging students to learn collaboratively (92%), and demonstrated laboratory/field techniques, procedures, and tools for students (92%).

Table 22. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=26)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	84.6%	15.4%	
	22	4	**26**
Having my student(s) search for and review technical research to support their work	38.5%	61.5%	
	10	16	**26**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	92.3%	7.7%	
	24	2	**26**
Supervising my student(s) while they practice STEM research skills	88.5%	11.5%	
	23	3	**26**
	96.2%	3.8%	

Providing my student(s) with constructive feedback to improve their STEM competencies	25	1	**26**
Allowing students to work independently to improve their self-management abilities	84.6%	15.4%	
	22	4	**26**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	92.3%	7.7%	
	24	2	**26**
Encouraging students to seek support from other team members	84.6%	15.4%	
	22	4	**26**

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 23). Responses were varied for this area of mentoring, with between 39% and 92% of mentors using each strategy. For example, 92% of mentors reported asking students about their educational and/or career goals, and 89% reported providing guidance about educational pathways that will prepare their students for a STEM career. Fewer mentors reported helping students build a professional network in a STEM field (39%), and helping students with their resume, application, personal statement, and/or interview preparations (42%). 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 23. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=26)

	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	92.3%	7.7%	
	24	2	**26**
Recommending extracurricular programs that align with students' goals	69.2%	30.8%	
	18	8	**26**
Recommending Army Educational Outreach Programs that align with students' goals	76.9%	23.1%	
	20	6	**26**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	88.5%	11.5%	
	23	3	**26**
Discussing STEM career opportunities within the DoD or other government agencies	80.8%	19.2%	
	21	5	**26**

Discussing STEM career opportunities in private industry or academia	80.8%	19.2%	
	21	5	**26**
Discussing the economic, political, ethical, and/or social context of a STEM career	65.4%	34.6%	
	17	9	**26**
Recommending student and professional organizations in STEM to my student(s)	69.2%	30.8%	
	18	8	**26**
Helping students build a professional network in a STEM field	38.5%	61.5%	
	10	16	**26**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	42.3%	57.7%	
	11	15	**26**

Program Features and Feedback/Satisfaction

Students and mentors were asked how satisfied they were with a number of features of the GEMS program. Most students (75% - 91%) indicated that they were somewhat or very much satisfied with all program features (Table 24) except for field trips or laboratory tours, which 42% had not experienced. For example, 91% were at least somewhat satisfied with the teaching or mentoring during program activities, and 88% with the STEM topics included in GEMS. Many students reported having not experienced field trips or laboratory tours (43%). This question was only asked of participants who completed the Cvent version of the survey for FY18.

Table 24. Student Satisfaction with GEMS Program Features (n=186)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
The location(s) of GEMS program	2.2%	1.6%	9.1%	26.3%	60.8%	
	4	3	17	49	113	**186**
The STEM topics included GEMS	1.6%	1.6%	9.1%	21.0%	66.7%	
	3	3	17	39	124	**186**
Teaching or mentoring provided during GEMS activities	0.5%	1.1%	7.5%	18.8%	72.0%	
	1	2	14	35	134	**186**
Educational materials (e.g., workbooks, online resources,	2.7%	1.6%	10.2%	22.6%	62.9%	
	5	3	19	42	117	**186**

etc.) used during program activities						
Invited speakers events	4.8%	5.9%	14.0%	33.3%	41.9%	
	9	11	26	62	78	**186**
Field trips or laboratory tours	42.5%	4.8%	10.8%	11.8%	30.1%	
	79	9	20	22	56	**186**

Students also responded to an open-ended item on the questionnaire asking them about their overall satisfaction with their GEMS experiences. Of the 170 responses sampled, a large majority (154) commented only on positive aspects of the program, focusing on their learning, their interactions with mentors and peers, the career information they gained, and their hands-on experiences. For example:

> *"Being in GEMS was an amazing experience. I was introduced to new STEM careers and technology. For example we made some circuits, got to experience VR, and we were able to lean about moral dilemmas…I am glad that I choose to go to GEMS for a week I wish it would be longer!"* (GEMS Student)

> *"I thought GEMS was very fun and enjoyable because of the fun and frequent activities that kept me engaged. I liked the minimal teaching and the hands on activities with real lab tools and procedures. The Near Peers were nice and helped and encouraged us to participate in the activities. I liked the brief but vast learning experience and I would definitely do GEMS again."(*GEMS Student)

> *"I was very satisfied with my experience. I was never bored and always had something to do. The activities were very engaging and helped me prepare for other things in the future that would involve problem solving and perseverance. The peer mentors were very helpful and nice. They were never disrespectful and would always look to help. It was very fun and gave me more knowledge. Overall I had a great time and it will help me in the future."* (GEMS Student)

> *"I am very satisfied with this program for the overall benefit of being able to participate in the STEM field, and getting to learn about new and different career choices. It has gotten me more interested into the STEM field, and possibly a job later on. I would recommend this program to anyone who want to further their knowledge into the STEM field, and have fun while doing it."* (GEMS Student)

Another 14 responses (8%) included positive comments, but also included some caveats. These caveats included observations that the students felt that the program content could be more interesting or

challenging, particularly for repeat attenders, that more choices of topics could be offered, and that more outdoor time or less seat time would be improvements to the program.

Only 2 responses included no positive comments. Both of these students indicated that they were bored with program activities.

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 benefits were GEMS' impact on students' learning or knowledge in STEM (mentioned by 59 students), the career information provided during GEMS (mentioned by 50 students), and the STEM or hands-on skills students gained (mentioned by 48 students). Many students also noted that having fun and making friends was a benefit (mentioned by 31 students) and that GEMS increased their interest in or motivation for STEM (mentioned by 22 students). Other benefits that were mentioned relatively frequently included teamwork (mentioned by 17 students) and problem-solving skills (mentioned by 14 students

Students participating in focus groups were also asked to share their opinions about the benefits of the GEMS program and generally echoed the themes from questionnaire responses. Responses focused on the benefits of STEM learning, hands-on experiences and exposure to real-world research, career information, networking, public speaking skills, and the value of the NPMs as role models. For example,

> *"[GEMS] has really helped me and encouraged me to build my confidence with science."* (GEMS Student)
>
> "*I've increased my knowledge about certain science subjects, and the uses of these science subjects. Most people just know some facts about science and technology in STEM, but they have no way to apply it to real life or in any certain way. I feel like coming to this camp allowed me to… use my knowledge…know what it's used for, and how to use it in school.*" (GEMS Student)
>
> *"I learned more about what I wanted to do specifically when I got older."* (GEMS Student)
>
> *"You get to try a lot of new experiments and stuff, and use technology you wouldn't be able to use anywhere else."* (GEMS Student)
>
> *"[The NPMs] and all these assistants that were here, they were astounding. They were always nice, ready for you to answer your questions, look into a topic further to tell you how it works or ask people for you."* (GEMS Student)

Students were also asked in an open-ended questionnaire item to list three ways in which the program could be improved. Students offered a variety of suggestions in the 100 responses sampled. The most frequently suggested improvements were offering a larger variety and/or choice of activities and topics

(mentioned by 42 students), providing more hands on activities (mentioned by 32 students), making GEMS longer (mentioned by 26 students), and providing more in-depth and/or challenging information and activities (mentioned by 22 students). Other improvements suggested relatively frequently included providing more or better technology, particularly in coding activities (mentioned by 19 students) and improvements in the number, quality, and/or diversity of speakers and field trips or lab tours (mentioned by 16 students). Other suggestions, mentioned by 8 or fewer students included providing the following:

- more mentors
- more real world and/or career connections
- more or better materials
- more teamwork opportunities
- more opportunities for individual work
- more or longer breaks
- a shorter program day and/or a later start time
- a larger stipend
- a shorter survey

Students participating in focus groups were also asked for their opinions about ways that GEMS could be improved. Students made a variety of suggestions, including having students work in smaller groups, providing opportunities for individual work, separating older and younger students, providing a greater variety of topics, providing a unifying theme for the program activities, providing more in-depth content, adding coding, adding more mathematics content, adding interdisciplinary activities (e.g., combining art and technology), providing opportunities for students to act as junior NPMs, and adding more water breaks or providing water for outdoor activities.

Mentors were also asked to rate their satisfaction with a number of GEMS program features (Table 25). A majority of mentors (62% - 100%) were at least somewhat satisfied with each feature with the exception of communicating with the NSTA (46% had not experienced this). For example, all mentors were at least somewhat satisfied with the location of GEMS activities (100%) and with communicating with GEMS organizers (100%). Very few mentors expressed dissatisfaction with any program feature (0% - 8%).

Table 25. Mentor Satisfaction with GEMS Program Features (n=26)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	26.9%	3.8%	0.0%	11.5%	57.7%	
	7	1	0	3	15	**26**
	46.2%	7.7%	7.7%	19.2%	19.2%	

Communicating with the National Science Teachers Association (NSTA)	12	2	2	5	5	**26**
Communicating with GEMS organizers / site coordinators	0.0%	0.0%	0.0%	15.4%	84.6%	
	0	0	0	4	22	**26**
The physical location(s) of GEMS's activities	0.0%	0.0%	0.0%	34.6%	65.4%	
	0	0	0	9	17	**26**
Support for instruction or mentorship during program activities	3.8%	0.0%	0.0%	15.4%	80.8%	
	1	0	0	4	21	**26**
Stipends (payment)	26.9%	0.0%	0.0%	15.4%	57.7%	
	7	0	0	4	15	**26**
Invited speakers or "career" events	23.1%	3.8%	3.8%	11.5%	57.7%	
	6	1	1	3	15	**26**
Field trips or laboratory tours	34.6%	3.8%	0.0%	11.5%	50.0%	
	9	1	0	3	13	**26**

Like students, mentors were also asked to respond to open-ended questionnaire items asking for their opinions about the program. Mentors were asked in an open-ended questionnaire item to comment on their overall satisfaction with GEMS. Of the 17 mentors who responded, all but 1 commented only on positive aspects of the program. Mentors' comments focused on student growth, the contacts with Army S&Es, and the career exposure GEMS provides for both student participants and NPMs. For example:

> *"I really enjoyed my experience with GEMS this summer. The staff was great which really helped the program flow smoothly. Talking to the scientists, engineers, and military personnel everyday gave me a greater appreciation for all the work that [this site] and other agencies do for this country. Overall I was very satisfied with the GEMS program and all of my students had great things to say about their experiences as well."* (GEMS Mentor)

> *"I love teaching students in GEMS. Not only do I see how their perspective on STEM changes towards a positive one, but I can truly see kids grow in their interests over the years. I also love that the AEOP not only helps further advance the future of the students' but they help their employees as well."*(GEMS Mentor)

> *"I am very satisfied with my GEMS experience. If I had not chosen to become a Near Peer Mentor two summers ago, I would most likely not be considering a career with the DoD. Now, it is one of*

my top career options. I also enjoy exposing today's youth to topics that interest me greatly so that they can share the same joy with tomorrow's youth." (GEMS NPM)

The one mentor who made no positive comments expressed concern about the survey. She said,

"My only feedback is to do something about the horrifically long survey these students are asked to take. In an hour, not all of the students could complete this. It took entirely too much time and made the students very frustrated. Please shorten the survey to allow 12 and 13 year olds to complete within 5 minutes." (GEMS Mentor)

Another open-ended questionnaire item asked mentors to identify the three most important strengths of GEMS. The 21 mentors who responded mentioned a number of program strengths. The most frequently mentioned strength, cited by 13 of the responding mentors, was exposure to STEM and the STEM learning students experience during GEMS. Mentors also noted the value of the career information provided (mentioned by 8 mentors), having first-hand contact with Army S&Es (mentioned by 8 mentors), and students' opportunities for hands-on learning (mentioned by 7 mentors). Other strengths, mentioned by 5 or fewer mentors, included the near-peer mentors and the mentor to student ratio, that GEMS is engaging and fun for students, the opportunity for students to connect with peers with similar interests, and the teamwork students experience.

NPMs participating in focus groups were also asked to share their opinions about the value of GEMS, both to participating students and to themselves. The NPMs cited a number of benefits of GEMS for participating students including STEM learning, increasing their interest in STEM, providing opportunities for hands-on experiences and exposure to real-world research, learning about careers, networking with STEM professionals, and providing a gateway to other AEOPs. For example,

"We get a lot of kids that maybe don't love their science classes at school exceptionally. But when they come to us, they see how cool science can be and they see a wide variety of different scientific topics whether that be related to bio, chemistry, or physics." (GEMS NPM)

"[GEMS] exposes kids to a lot of different areas of science or engineering that they wouldn't necessarily get out of a traditional high school Chemistry or Biology course." (GEMS NPM)

"[In] a lot of schools, you're either doing simple experiments or you're reading out of a textbook. [GEMS gives students] the chance to do complex experiments as well as understanding what they're trying to tell you in a textbook." (GEMS NPM)

The NPMs participating in focus groups also discussed the benefits to them of serving as NPMs. These NPMs and assistant NPMs cited their own STEM learning, networking opportunities, exposure to careers,

experience in working with children, leadership, the stipend, and the satisfaction of impacting younger students as benefits of being NPMs. For example,

> *"I too have been able to talk to scientists and engineers about their field and what they do, and get an idea for what I want to do in the future. The paycheck is nice."* (GEMS NPM)

> *"It pushed me to learn the material in order to be able to reproduce that and teach the students that. It brought me into an environment that I otherwise would have never had the opportunity to do so. I live right around here, but I have no other reason to be on this base."* (GEMS NPM)

> *"I'm seeing what other people do, what nontraditional jobs there are that I wasn't aware of. If I was a student before, in this program, I would have probably chosen a different major going into college."* (GEMS NPM)

Mentors were also asked in an open-ended questionnaire item to note three ways in which GEMS should be improved for future participants. The 17 mentors who responded suggested a wide variety of improvements. The most frequently mentioned improvements were suggestions to have more guest speakers or more time with guest speakers (mentioned by 4 mentors) and suggestions for space and logistical improvements, such as providing better spaces for labs (mentioned by 3 mentors). Other improvements, mentioned by 1 or 2 mentors, included providing more tours, more choices of topics, more hands-on activities, better materials or technology, being more selective about participants, accommodating more participants, and shortening the survey.

NPMs participating in focus groups also made several suggestions for program improvements. These suggestions included:

- providing funding for more NPMs
- creating curriculum that draws on competencies of the Army lab hosting the program
- creating networks between GEMS sites to share curriculum and best practices
- providing a larger range of topics (e.g. technology, computers, and mathematics)
- taking students on lab tours
- providing more AEOP information by having representatives of other AEOPs speak to students, including AEOPs in NPM training, and highlighting AEOPs either at the start of or conclusion of the program activities
- expanding GEMS by hosting the program at sites other than Army labs
- providing a materials budget for the program
- providing a NPM panel for older students to ask questions about college.
- simplifying and/or shortening the student questionnaire

7 | Priority #3 Findings

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

How Participants Found out About AEOP

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 26 summarizes students' responses. Aside from past participation in the program (66%), the most frequently reported sources of information about GEMS were personal connections, including friends (25%) and family members (32%). Other sources of information included the AEOP website (11%) and a school or university newsletter, email, or website (14%). This question was collected in the Cvent registration system, was optional, and had only 59 respondents, however some selected more than one answer.

Table 26. How Students Learned about AEOP (n=59)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	11%	7
AEOP on Facebook, Twitter, Instagram, or other social media	<1%	1
School or university newsletter, email, or website	14%	8
Past participant of program	66%	39
Friend	25%	15
Family Member	32%	19
Someone who works at the school or university I attend	3%	2
Someone who works with the program	4%	3
Someone who works with the DoD (Army, Navy, Air Force, etc.)	5%	4
Community group or program	4%	3
Choose Not to Report	0%	0

Student focus group participants were asked how they had learned about GEMS. Most students who responded indicated that they had learned about GEMS through a personal relationship (relative or friend). Several students indicated that they learned about GEMS from a teacher or from a school email. Two students reported that either they or a parent found out about GEMS online, and 1 student learned about GEMS through a booth at a convention.

Mentors were also asked how they learned about AEOP (see Table 27). The most commonly reported sources of information were past participation in GEMS (42%) and a family member (42%). A third of mentors also indicated the AEOP website (32%) and someone who works with the program (32%) helped them to learn about AEOP. This question was collected in the Cvent registration system, was optional, and had only 19 respondents, however some selected more than one answer.

Table 27. How Mentors Learned About AEOP (n=19)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	32%	6
AEOP on Facebook, Twitter, Instagram, or other social media	0%	0
School or university newsletter, email, or website	11%	2
Past participant of program	42%	8
Friend	21%	4
Family Member	42%	8
Someone who works at the school or university I attend	11%	2
Someone who works with the program	32%	6
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	26%	5
Community group or program	0%	0
Choose Not to Report	0%	0

Students were asked both at enrollment and in focus groups what motivated them to participate in GEMS. Table 28 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 (89%), an interest in STEM (93%), and the opportunity to learn in ways not possible in school (75%). More than three-quarters of responding students (77%) indicated that having fun motivated them to participate in GEMS. This question was collected in the Cvent registration system, was optional, and had only 59 respondents, however some selected more than one answer.

Table 28. Factors Motivating Student Participation in GEMS (n=59)

	Response Percent	Response Total
Teacher or professor encouragement	11%	6
An academic requirement or school grade	4%	2
Desire to learn something new or interesting	89%	51
The mentor(s)	14%	8
Building college application or résumé	30%	17
Networking opportunities	7%	4
Interest in science, technology, engineering, or mathematics (STEM)	93%	53
Interest in STEM careers with the Army	32%	18
Having fun	77%	44
Earning stipends or awards for doing STEM	23%	13
Opportunity to do something with friends	30%	17
Opportunity to use advanced laboratory technology	56%	32
Desire to expand laboratory or research skills	51%	29
Learning in ways that are not possible in school	75%	43
Serving the community or country	26%	15
Exploring a unique work environment	33%	19
Figuring out education or career goals	47%	27
Seeing how school learning applies to real life	37%	21
Recommendations of past participants	23%	13
Choose Not to Report	0%	0

Student focus group participants mentioned a variety of motivations for participating in GEMS. While some noted that they had previously participated and enjoyed the experience, others specifically mentioned being motivated by the opportunity to learn about STEM topics, learn about careers and explore their interests, have hands-on experiences, have fun, and make friends. For example:

> *"[GEMS] teaches science in a way that's a lot more interactive and digestible than really at school. Very visual. You see the scientific principles in action and it's so wide variety of topics."* (GEMS Student)

> *"I'm going to be a senior this year. It's a way for me to explore my interests because I'm an undecided major for [college] right now."* (GEMS Student)

"I believe that GEMS, mostly science, technology, engineering, and mathematics, it's a new beginning, it's our future. I truly wanted to be a part of that. I wanted to know what was going on. We usually see things from the outside, but I wanted to be a part of how everything works, and I wanted to take it step by step." (GEMS Student)

Previous Program Participation & Future Interest

A small sample of students reported on their past participation in AEOP programs (Table 29). Almost two-thirds (63%) indicated being a past GEMS participant and 11% said they had participated in Camp Invention. Participants reported participating in no other AEOPs. This question was collected in the Cvent registration system, was optional, and had only 59 respondents, however some selected more than one answer.

Table 29. Student Past Participation in AEOP Programs (n=59)

	Response Percent	Response Total
Camp Invention	11%	6
eCYBERMISSION	0%	1
Junior Solar Sprint (JSS)	0%	0
Gains in the Education of Mathematics and Science	63%	36
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation	0%	0
I've never participated in any AEOP programs	32%	18

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 (81%) and GEMS NPMs (65%) (Table 30). Almost half (46%) reported discussing SMART with students. More than half of mentors

(62%) reported discussing AEOPs generally with students but without reference to any specific program. Relatively few mentors discussed other AEOPs specifically.

Table 30. Mentors Explicitly Discussing AEOPs with Students (n=26)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	80.8%	19.2%	
	21	5	**26**
UNITE	7.7%	92.3%	
	2	24	**26**
Junior Science & Humanities Symposium (JSHS)	11.5%	88.5%	
	3	23	**26**
Science & Engineering Apprenticeship Program (SEAP)	19.2%	80.8%	
	5	21	**26**
Research & Engineering Apprenticeship Program (REAP)	7.7%	92.3%	
	2	24	**26**
High School Apprenticeship Program (HSAP)	15.4%	84.6%	
	4	22	**26**
College Qualified Leaders (CQL)	19.2%	80.8%	
	5	21	**26**
GEMS Near Peer Mentor Program	65.4%	34.6%	
	17	9	**26**
Undergraduate Research Apprenticeship Program (URAP)	11.5%	88.5%	
	3	23	**26**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	46.2%	53.8%	
	12	14	**26**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	11.5%	88.5%	
	3	23	**26**
I discussed AEOP with my student(s) but did not discuss any specific program	61.5%	38.5%	
	16	10	**26**

Table 31 displays responses to an item asking students how interested they are in participating in other AEOPs in the future. A large majority (89%) of respondents indicated being at least a little interested in participating in GEMS again and 73% indicated being at least somewhat interested in participating as NPMs in the future. While a third or more of students reported being interested in each AEOP listed (32% - 89%), many students (48% - 65%) had not heard of the other AEOPs. Relatively few indicated being "not at all" interested in future participation in any program. For example, only 7% of students were "not at all" interested in participating in Camp Invention or JSS.

Table 31. Student Interest in Future AEOP Programs (n=1,863-1,865)

	I've never heard of this program	Not at all	A little	Very much	Response Total
Camp Invention	48.4%	6.5%	21.5%	23.7%	
	901	1,210	393	504	**1,865**
eCYBERMISSION	57.5%	4.3%	21.5%	16.7%	
	1,072	8	400	311	**1,865**
Junior Solar Sprint (JSS)	56.5%	7.0%	18.3%	18.3%	
	1,053	130	340	340	**1,863**
Gains in the Education of Mathematics and Science (GEMS)	9.7%	1.6%	15.6%	73.1%	
	184	30	290	1,361	**1,865**
UNITE	64.5%	2.7%	15.1%	17.7%	
	1,201	50	280	322	**1,863**
Junior Science & Humanities Symposium (JSHS)	61.8%	3.2%	18.8%	16.1%	
	1,153	60	350	300	**1,863**
Science & Engineering Apprenticeship Program (SEAP)	53.8%	2.2%	14.5%	29.6%	
	1,003	40	270	550	**1,863**
Research & Engineering Apprenticeship Program (REAP)	56.5%	2.7%	16.1%	24.7%	
	1,053	50	300	460	**1,863**
High School Apprenticeship Program (HSAP)	58.6%	2.7%	15.1%	23.7%	
	1,093	50	280	440	**1,863**
College Qualified Leaders (CQL)	63.4%	4.8%	12.4%	19.4%	
	1,183	90	230	360	**1,863**
GEMS Near Peer Mentor Program	21.0%	5.9%	30.1%	43.0%	
	393	110	560	800	**1,863**

Undergraduate Research Apprenticeship Program (URAP)	61.8%	2.7%	17.7%	17.7%	
	1,153	50	330	330	**1,863**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	50.0%	4.3%	12.4%	33.3%	
	933	80	230	620	**1,863**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	57.0%	3.2%	18.8%	21.0%	
	1,063	60	350	390	**1,863**

Awareness of STEM Careers & DoD STEM Careers & Research

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 32 provides summaries of these data from 2016 through 2018. As in 2016 and 2017, nearly all students (96%) reported learning about at least one STEM job/career, and most (52%) reported learning about five or more. A slightly smaller number (90%) reported learning about at least one DoD STEM job/career and 35% reported learning about 5 or more DoD STEM careers. Student responses for DoD STEM jobs/careers learning were higher in 2018 than in 2016 and 2017.

Table 32. Number of STEM Jobs/Careers Students Learned About During GEMS

	STEM Jobs/Careers			DoD STEM Jobs/Careers		
	2016 (n=1,102)	**2017 (n=2,037)**	**2018 (n=1,835)**	**2016 (n=1,102)**	**2017 (n=2,029)**	**2018 (n=1,806)**
None	3%	3%	4%	16%	19%	11%
1	5%	4%	4%	14%	10%	9%
2	11%	8%	11%	19%	16%	16%
3	12%	15%	16%	18%	17%	18%
4	10%	12%	13%	8%	10%	12%
5 or more	59%	58%	52%	25%	28%	35%

Most students participating in focus groups reported learning about DoD STEM careers to some extent during their GEMS experiences. They cited being physically present at a DoD site and exposure to military personnel, tours, and making real-life connections with their program activities as the primary sources of career information. For example,

> *"We went on a lot of tours at GEMS. I actually learned that there's a lot more STEM involved in the Army than I expected."* (GEMS Student)

"The different types of exposure that you get here that you can't get other places, especially when you learn about what you can do with what you've learned. That shows you, 'That's why I'd like to go into the military.'" (GEMS Student)

"Pretty much every lesson we did, they tied it back to how it can be used in the military." (GEMS Student)

"All the labs had a way of tying into Army research." (GEMS Student)

"It's cool because there's a lot of jobs that are technically part of the Army, but you're not actually fighting. You're just doing the research and stuff behind it." (GEMS Student)

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 33). Large majorities of students (76% - 87%) 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 (3% - 7%).

Table 33. Student Opinions about DoD Researchers and Research (n=1,821-1,826)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	7%	0%	17%	25%	51%	
	127	0	316	455	928	**1,826**
DoD researchers develop new, cutting edge technologies	3%	0%	9%	24%	63%	
	59	3	171	437	1,151	**1,821**
DoD researchers solve real-world problems	3%	0%	9%	26%	61%	
	52	1	172	480	1,116	**1,821**
DoD research is valuable to society	5%	0%	16%	28%	51%	
	92	0	287	515	929	**1,823**

Interest & 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 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 34). A majority of students (51% - 71%) indicated that they were more likely or much more likely to engage in each activity. While more than a third of students reported no change in their likelihood of engaging in activities such as playing with mechanical or electrical devices (37%) and working on solving

mathematical or scientific puzzles (41%), few students reported being less likely to engage in any activity (4% - 10%).

In an analysis of a composite created from these Likelihood to Engage in STEM Activities items[19] no significant differences by U2 classification were found. However, there were significant differences found by gender (females higher – small effect, d=0.154) and race/ethnicity (minority students lower, small effect, d = 0.130).[20] There were no significant differences found by any other individual student demographics.

Table 34. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=1,833-1,841)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	2%	4%	33%	37%	24%	
	28	73	612	678	447	**1,838**
Play with a mechanical or electrical device	2%	4%	37%	33%	24%	
	38	76	673	615	436	**1,838**
Work on solving mathematical or scientific puzzles	3%	5%	41%	29%	22%	
	49	101	754	537	396	**1,837**
Use a computer to design or program something	2%	2%	25%	36%	35%	
	29	42	459	668	635	**1,833**
Talk with friends or family about STEM	2%	4%	33%	37%	24%	
	42	66	616	673	444	**1,841**
Mentor or teach other students about STEM	2%	4%	34%	36%	24%	
	36	68	618	671	446	**1,839**
Help with a community service project related to STEM	2%	3%	25%	35%	34%	
	41	64	461	647	623	**1,836**
Participate in a STEM camp, club, or competition	3%	4%	31%	33%	29%	
	53	68	574	600	538	**1,833**
Take an elective (not required) STEM class	2%	3%	28%	36%	30%	
	41	59	520	660	557	**1,837**

Students were also asked to consider the impact of GEMS on their educational aspirations (Table 35). A large majority of students (94%) reported wanting to at least finish college (get a Bachelor's degree), and

[19] The Cronbach's alpha reliability for these Likelihood to Engage items was 0.903.

[20] Independent samples t-test for Likelihood to Engagement in STEM activities: Gender t(1223)=2.69, p=.007; Race/Ethnicity t(1100)=2.16, p=.031.

over half (57%) indicated that they aspired to continue their education after college after participating in GEMS.

Table 35. Student Education Aspirations After GEMS (n=1,824)

	Response Percent	Response Total
Graduate from high school	1.70%	31
Go to a trade or vocational school	0.38%	7
Go to college for a little while	3.56%	65
Finish college (get a Bachelor's degree)	36.90%	673
Get more education after college	57.46%	1,048

Resources

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 36). Participation in GEMS was most frequently rated as "somewhat" or "very much" useful (85%), along with GEMS program administrators or site coordinators (89%). While half of mentors (50%) indicated that the AEOP website was at least somewhat useful for this purpose, more (42%) had not experienced the website or the AEOP brochure (42%). Likewise, over half of mentors (54%) had not experienced AEOP on social media and 65% had no experience with the It Starts Here! Magazine.

Table 36. Usefulness of Resources for Exposing Students to AEOPs (n=26)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	42.3%	3.8%	3.8%	11.5%	38.5%	
	11	1	1	3	10	**26**
AEOP on Facebook, Twitter, Pinterest or other social media	53.8%	3.8%	7.7%	23.1%	11.5%	
	14	1	2	6	3	**26**
AEOP brochure	42.3%	3.8%	7.7%	19.2%	26.9%	
	11	1	2	5	7	**26**
It Starts Here! Magazine	65.4%	15.4%	7.7%	3.8%	7.7%	
	17	4	2	1	2	**26**
GEMS Program administrator or site coordinator	11.5%	0.0%	0.0%	7.7%	80.8%	
	3	0	0	2	21	**26**

Invited speakers or "career" events	30.8%	3.8%	0.0%	11.5%	53.8%	
	8	1	0	3	14	**26**
Participation in GEMS	11.5%	0.0%	3.8%	3.8%	80.8%	
	3	0	1	1	21	**26**

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 37). Again, mentors were most likely to rate participation in GEMS as at least somewhat useful (85%). A large majority of mentors (73%) indicated that the GEMS program administrator or site coordinator was somewhat or very much useful, and 62% 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, 42% indicated that the AEOP brochure was at least somewhat useful (42% had not experienced it), and 27% indicated that AEOP social media was at least somewhat useful (58% had not experienced it).

Table 37. Usefulness of Resources for Exposing Student to DoD STEM Careers (n=26)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	34.6%	3.8%	3.8%	26.9%	30.8%	
	9	1	1	7	8	**26**
AEOP on Facebook, Twitter, Pinterest or other social media	57.7%	7.7%	7.7%	23.1%	3.8%	
	15	2	2	6	1	**26**
AEOP brochure	42.3%	3.8%	11.5%	15.4%	26.9%	
	11	1	3	4	7	**26**
It Starts Here! Magazine	65.4%	15.4%	11.5%	3.8%	3.8%	
	17	4	3	1	1	**26**
GEMS Program administrator or site coordinator	19.2%	3.8%	3.8%	3.8%	69.2%	
	5	1	1	1	18	**26**
Invited speakers or "career" events	30.8%	3.8%	3.8%	11.5%	50.0%	
	8	1	1	3	13	**26**
Participation in GEMS	11.5%	0.0%	3.8%	7.7%	76.9%	
	3	0	1	2	20	**26**

Overall Impact

Finally, students were asked to respond to an item gauging the impacts of participating in GEMS more broadly (Table 38). Students' responses suggest that GEMS contributed substantially to students' interest in, awareness of, and confidence in a number of STEM-related areas. Most students (61% - 90%) reported that GEMS contributed to each area. For example, 90% of students reported that GEMS contributed to their interest in pursuing a STEM career, 87% that they were more aware of Army or DoD STEM research and careers, and 88% that they have a greater appreciation of Army or DoD STEM research.

These Overall Impact of GEMS items were combined into a composite variable[21] to test for overall U2 classification differences and among subgroups of students. No significant differences were found by U2 classification or any individual student demographics except for school location. Students attending urban/rural/frontier schools reported significantly greater impact from participating in GEMS (small effect size, d=0.252).[22]

Table 38. Student Opinions of GEMS Impacts (n=1,804-1,808)

	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	10%	8%	42%	40%	
	183	140	753	728	**1,804**
I am more interested in participating in STEM activities outside of school requirements	6%	14%	44%	36%	
	120	260	810	670	**1,806**
I am more aware of other Army (AEOP) programs	14%	9%	32%	46%	
	260	160	590	850	**1,806**
I am more interested in participating in other Army (AEOP) programs	15%	10%	34%	41%	
	280	180	640	760	**1,806**
I am more interested in taking STEM classes in school	7%	15%	44%	34%	
	130	280	820	630	**1,806**
I am more interested in earning a STEM degree	10%	17%	38%	35%	
	180	320	710	650	**1,806**
	3%	8%	58%	32%	

[21] The Cronbach's alpha reliability for Overall GEMS Impact items was 0.868.

[22] Independent samples t-test for Overall GEMS Impact: School Location t(562)=2.99, p=.003.

I am more interested in pursuing a career in STEM	48	143	1047	570	**1808**
I am more aware of Army or DoD STEM research and careers	7%	6%	35%	52%	
	130	110	660	960	**1,806**
I have a greater appreciation of Army or DoD STEM research	7%	5%	38%	50%	
	130	100	700	930	**1,806**
I am more interested in pursuing a STEM career with the Army or DoD	26%	12%	35%	26%	
	490	230	660	480	**1,806**
I feel like I accomplished something in STEM	4%	12%	53%	31%	
	68	190	863	508	**1629**
I am thinking creatively about a STEM project or activity	8%	10%	42%	40%	
	135	162	674	650	**1621**
I have a desire to build relationships with mentors who work in STEM	5%	16%	49%	30%	
	81	260	803	479	**1623**
I have connected a STEM topic or field to my personal values	8%	15%	51%	25%	
	129	250	831	411	**1621**

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 39.

Table 39. 2018 GEMS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
GEMS received more applicants and served more students in 2018 than in previous years and continued to reach students from populations historically underrepresented and underserved in STEM, suggesting that JSS's efforts to engage these groups has been met with some success.	Interest in GEMS continues to grow. A total of 5,486 student applications were submitted for 2018 GEMS programs, a 15% increase over 2017, and a 20% increase over 2016.
	GEMS broadened capacity to accommodate students again in FY18. GEMS served 3,341 students in 2018, a 15% increase over 2017 and a 27% increase over 2016.
	GEMS continued to engage students from undererved populations. Nearly half of GEMS participants (47%) were female, 38% identified themselves as White, 24% as Black or African American, 17% as Asian, and 9% as Hispanic or Latino. Over a third of students (35%) met the AEOP definition of underserved.
Students reported engaging in STEM practices during GEMS more frequently than in school; students from urban, rural, and frontier schools were more engaged than students from suburban schools.	GEMS engaged 14% to 76% participants in STEM practices on most days to every day.
	Students from urban, rural, and frontier schools reported significantly greater use of STEM practices compared to students from suburban schools (small effect size).
	Students reported significantly greater engagement in STEM practices in GEMS as compared to in school (medium effect size).
Students experienced gains in STEM knowledge during GEMS; underrepresented students	Nearly all responding students reported some level of STEM knowledge gains as a result of the GEMS program, and a majority of students (70% - 85%) reported that they learned "more than a little" or "learned a lot" in each area.

reported greater knowledge gains than other students.	U2 students reported significantly greater STEM knowledge gains than other student (small effect size).
Students experienced gains in their STEM competencies or skills; these gains varied by students' demographic make-up.	Half or more of students (55% - 82%) reported making gains in STEM competencies, with the exception of how to use computer models (42%) and how to present data in charts or graphs to find patterns or relationships (43%).
	As compared to the overall population of students, students who will be first generation college attenders reported significantly greater gains (small effect size), minority students reported significantly greater gains (small effect size), and students who received free or reduced price lunch reported significantly greater gains (small effect size) in STEM competencies.
Students experienced gains in their 21st Century Skills; gains varied by students' socio-economic status.	More than half of students (54% - 70%) reported that they gained more than a little or a lot in all 21st Century skills.
	Students who received free or reduced prices lunch reported significantly greater gains (small effect size) in 21st Century Skills as compared to students who did not receive free or reduced price lunch.
Students reported that participating in GEMS impacted their STEM identities, or their interest in and feelings of capability about STEM.	After participating in GEMS, most students (67% - 91%) reported improvement in their STEM identities.
	No significant differences in STEM identity gains were found by U2 status or any demographic area examined.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors reported using a range of mentoring strategies with students, although very few mentors.	A majority of mentors reported using most strategies associated with each area of effective mentoring, including: • strategies to help make the learning activities in GEMS relevant to students (54%-96%) • strategies to support the diverse needs of students as learners (42% - 92%) • strategy associated with supporting students' development of collaboration and interpersonal skills (65% - 100%) • strategies to support student engagement in authentic STEM activities (85% - 96% with the exception of having students search for and review technical literature to support their work; 39% used this strategy Responses were more varied for mentors' use of strategies to support students' STEM educational and career pathways (39% - 92%). Less frequently used strategies for this area included activities that may not be relevant for youngers students such as helping students build a professional network in a STEM field (39%), and helping students with their resume, application, personal statement, and/or interview preparations (42%)
Most students expressed high levels of satisfaction with their GEMS experiences, although	Most students (75% - 91%) indicated that they were somewhat or very much satisfied with all GEMS program features (Table 24) except for field trips or laboratory tours, which 42% had not experienced.

students also had a variety of suggestions for program improvement.	Students were overwhelmingly positive in their comments about their satisfaction in open-ended questions and in focus groups. Students particularly attributed their satisfaction to their learning, their interactions with mentors and peers, the career information they gained, their hands-on experiences, the networking opportunities, opportunities to improve public speaking skills, and the value of the NPMs as role models.
	Students made a wide variety of suggestions for program improvement. The most frequently suggested improvements were offering a larger variety and/or choice of activities and topics, providing more hands on activities, providing longer GEMS programs, and providing more in-depth and/or challenging information and activities.
Mentors reported satisfaction with GEMS features and online supports and noted a number of strengths of GEMS. Mentors also made suggestions for program improvement.	A majority of mentors (62% - 100%) were at least somewhat satisfied with each feature of the GEMS program.
	Mentors responding to open-ended questions and participating in the focus group expressed satisfaction with the program and noted a number of strengths of GEMS including students' exposure to STEM, students' STEM learning, contact with Army S&Es, the career exposure GEMS provides for both student participants and NPMs, the hands-on experiences, and students' exposure to real-world research.
	Mentors suggested a range of program improvements. The most frequently mentioned improvements were to have more guest speakers or more time with guest speakers and suggestions for space and logistical improvements, such as providing better spaces for lab activities. Other suggestions included providing funding for more NPMs, creating networks between GEMS sites to share curriculum and best practices, and simplifying or shortening the student questionnaire.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
The few students who provided information about how they learned about AEOP primarily cited past participation and personal connections; mentors reported similar sources of information.	GEMS participants learned about AEOP through past participation in GEMS (58%) primarily. This was followed by learning about GEMS/AEOP from friends (28%) and family members (35%).
	Focus group participants primarily cited personal relationships (family member or friend) as sources of information about GEMS, although several had learned about GEMS from a teacher or from a school email.
	The most commonly reported sources of information about AEOP for mentors were past participation in GEMS (42%) and a family member (42%). A third of mentors also cited the AEOP website (32%) and someone who works with the program (32%) as sources of information.

Students reported various motivations for participating in GEMS, including learning and having fun.	The relatively few students (n=57) who responded to a questionnaire items about their motivation for participating in GEMS cited a desire to learn something new or interesting (89%), an interest in STEM (93%), having fun (77%), and the opportunity to learn in ways not possible in school (75%). As motivators for participating in GEMS.
	Students in focus groups were motivated to participate in GEMS by their previous participation, and opportunities to learn about STEM topics, learn about careers and explore their interests, have hands-on experiences, have fun, and make friends.
Few students had participated in any AEOP other than GEMS and many were interested in participating in other AEOPs in the future; few mentors discussed specific AEOPs other than GEMS and SMART with students.	Of the relatively small number of students responding to a questionnaire item about their past participation in AEOPs (n=57), nearly two-thirds (63%) reported being a past GEMS participant and 11% said they had participated in Camp Invention. Participants reported no other AEOP participation.
	A large majority (89%) of respondents indicated being at least a little interested in participating in GEMS again and 73% indicated being at least somewhat interested in participating as NPMs in the future. While a third or more of students reported being interested in each AEOP listed (32% - 89%), many students (48% - 65%) had not heard of the other AEOPs. Relatively few indicated being "not at all" interested in future participation in any of the programs.
	Mentors most frequently discussed GEMS (81%) and GEMS NPMs (65%) with students, and almost half (46%) reported discussing SMART with students. More than half of mentors (62%) reported discussing AEOPs generally with students but without reference to any specific program.
Mentors reported that GEMS participation and administrative staff were useful for exposing students to AEOPs; many had not experienced other AEOP resources.	Participation in GEMS was most frequently rated as "somewhat" or "very much" useful (85%), along with GEMS program administrators or site coordinators (89%).
	While half of mentors (50%) indicated that the AEOP website was at least somewhat useful for this purpose, more (42%) had not experienced the website or the AEOP brochure (42%). Likewise, over half of mentors (54%) had not experienced AEOP on social media.
Students reported learning about STEM careers generally during their GEMS experiences and, to a somewhat lesser extent, about STEM careers within the Army or DoD; students had learned about these careers primarily from their first-hand experiences.	Nearly all students (96%) reported learning about at least one STEM job/career during GEMS, and most (52%) reported learning about five or more. A slightly smaller number (90%) reported learning about at least one DoD STEM job/career and 35% reported learning about 5 or more DoD STEM careers.
	Most students participating in focus groups reported learning about DoD STEM careers to some extent during their GEMS experiences. They cited being physically present at a DoD site and exposure to military personnel, tours, and making real-life connections with their program activities as the primary sources of career information.

Mentors reported that GEMS participation, administrative staff , and career events were useful for exposing students to DoD STEM careers; many had not experienced other AEOP resources.	Mentors were most likely to rate participation in GEMS as at least somewhat useful for exposing students to DoD STEM careers (85%). A large majority of mentors (73%) also indicated that the GEMS program administrator or site coordinator was somewhat or very much useful, and 62% indicated that invited speakers or "career" events were somewhat or very much useful for this purpose.
	Over half of mentors had not experienced AEOP on social media (58%), and over a third had not experienced the AEOP brochure (42%) and the AEOP website (35%).
Students had positive perceptions of DoD researchers and research after participating in GEMS.	Large majorities of students (76% - 87%) agreed or strongly agreed with each statement about DoD researchers and research, suggesting that they have positive opinions about DoD researchers and research. Very few students disagreed with any statement (3% - 7%).
Students reported being more likely to engage in STEM activities after participating in GEMS; females and minority students were more likely to report changes in their likelihood of future engagement.	A majority of students (51% - 71%) indicated that they were more likely or much more likely to engage in each activity about which they were asked. Others (23% - 41%) reported no change in the likelihood that they would engage in the activities listed.
	Females (small effect size) and minority students (small effect size) reported significantly more likelihood of future engagement as compared to male and non-minority students.
Students reported aspiring to at least finish college after participating in GEMS.	A large majority of students (94%) reported wanting to at least finish college (get a Bachelor's degree), and over half (57%) indicated that they aspired to continue their education after college after participating in GEMS.
GEMS had positive impacts on students in areas of their STEM learning, interest, appreciation for STEM research, and interest in STEM careers; students who attended schools in urban, rural, or frontier areas experienced greater impacts than other students.	Most students (61% - 90%) reported that GEMS contributed to each area of impact about which they were asked. Areas for which the largest percentages of students reported impact included their interest in pursuing a STEM career (90%), their awareness of Army or DoD STEM research and careers (87%), and their appreciation of Army or DoD STEM research (88%).
	Students who attended urban, rural, or frontier schools reported significantly greater impact from participating in GEMS (small effect size) than those attending suburban schools.

Responsiveness to FY17 Evaluation Recommendations

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

FY17 Finding: 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.

GEMS FY18 Efforts and Outcomes: Recruitment of students without personal connections was supported by LPC outreach activities, consortium partners' social and email media marketing activities, AEOP website content management and CI marketing activities.

LPCs consistently conduct outreach activities at local schools and after-school activities, especially at schools that serve underserved students. LPCs often combine those efforts with lab-based STEM initiatives that are outside of AEOP funding. For example, LPCs in Vicksburg, Miss., are actively involved in after-school robotics activities, and LPCs at Aberdeen, Md., support a weekly, school-time STEM-enrichment program for eighth-grade students in a nearby county.

Consortium social and email media marketing activities are designed to reach underserved communities, as Widmeyer Communication and MetriKs Amérique operate under the same goals. The IPA works to align the work of local GEMS and CI programs with the work of Widmeyer Communication and MetriKs Amérique. The IPA works to raise awareness of consortium efforts, like the Alumni Program, during meetings and site visits.

CI locations are chosen by their access to underserved communities and, in this way, build opportunities for those without personal connections to the local lab.

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

FY17 Finding: 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.

GEMS FY18 Efforts and Outcomes: The IPA continued to work alongside consortium members to support social media engagement. Members of the Widmeyer marketing team said in interviews that the IPA has often exceeded their expectations. The IPA communicates important milestones, local points of contacts, and other program events to Widmeyer Communication. The IPA communicates participation and alumni

status to MetriKs Amérique. The IPA promotes consortium opportunities, like the Alumni Spotlights, to LPCs, CLCs, and NIHF.

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

FY17 Finding: 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.

GEMS FY18 Efforts and Outcomes: The IPA continued to work with LPCs to evaluate the successfulness of different tools to support NPM and participant awareness. The "What's Next?" flyer created by Widmeyer was well received by LPC, RT, NPM, and participants, according to reports during IPA site visits. Changes to the AEOP website, also led by Widmeyer, were also reported as helpful assets for NPM awareness of AEOP programming.

Recommendations for FY19 Program Improvement/Growth

Evaluation findings indicate that FY18 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

The primary method that GEMS participants in FY18 reported learning about GEMS or AEOP was through past participation (58%) in either GEMS or Camp Invention. This was followed by learning about GEMS/AEOP through family members 25% and friends 28%. It appears that GEMS participants continue to come from the pipeline approach. As in FY17 and previous years, we strongly recommend that GEMS

work to include more new students to AEOP from groups outside the DoD and current programming (Camp Invention) in the program.

Only about a third (35%) of students in GEMS in FY18 were from underserved groups. It is also recommended that NSTA work with GEMS sites to continue to grow this percentage to provide more opportunities for students possibly outside the DoD realm a chance to experience the program and grow their knowledge of GEMS, AEOP, and DoD.

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

1. GEMS mentors reported only 39% to 96% usage of the effective mentoring strategies. This reveals that mentors are either choosing not to implement best-practice or are not equipped with the appropriate training to utilize the strategies with their participants. It is recommended that GEMS develop and implement a required training for mentors (delivered virtually) that is completed at least once when beginning to work with the program in FY19 and beyond.
2. As 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, 35% had not accessed the AEOP website and 58% had not experienced the AEOP social media outlets. It is recommended again in FY19 that 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.
3. In FY18, GEMS students suggested that the program could be improved with more student choice, hands-on activities, and more challenging content. This is important feedback from participants that should be followed up on. It is recommended that NSTA conduct an examination of GEMS curricula used across sites and determine if there is a need to provide some guidance and/or standardized cross-program activities that all GEMS program participants experience to establish more continuity of experiences and to guide more of the quality-control for GEMS.

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

1. As in FY17, many students 48-65% had not heard of other AEOP programs. Further, more than half of mentors (62%) reported discussing AEOPs generally, but not regarding any specific program. This means 38% did not discuss other AEOPs at all. It is recommended that NSTA work with GEMS sites to provide required guidance and activities for GEMS participants to learn about other appropriate AEOPs.
2. Only 35% of GEMS participants repoted learning about five or more DoD STEM careers, compared to 90% who learned about at least one. It seems that a program hosted at a DoD laboratory would

have more of a central focus on exposing students to a variety of DoD STEM careers. It is recommended that NSTA examine GEMS curricula and inquire with sites regarding their focus on DoD STEM careers as part of their programming and determine if more guidance is necessary to enable all participants to learn about five or more.

9| NSTA's Response to FY18 Evaluation Report

We strongly recommend that GEMS work to include more new students to AEOP from groups outside the DoD and current programming (Camp Invention) in the program.

- NSTA is fully supportive of Widmeyer, other IPAs, and local program coordinators when working to broaden the reach of GEMS. This includes assisting with the coordination of blogs and social media content, presenting dedicated workshops based on GEMS curriculum from a participating lab during conferences, discussing and disseminating outreach best practices during site visits and sending lists to local program coordinators of nearby target schools with low GEMS participation. NSTA continues to be mindful that some locations have an issue with too many applications and that some locations wish to maintain full control of local outreach. NSTA recognizes that gains in participation of those who have not participated are quickly diminished by the natural course of those students participating, i.e. even a static metric may be indicative of success when it comes to first-time participation.

It is also recommended that NSTA work with GEMS sites to continue to grow this percentage to provide more opportunities for students possibly outside the DoD realm a chance to experience the program and grow their knowledge of GEMS, AEOP and DoD.

- NSTA will continue to investigate barriers to growth in underserved participation. Our most common feedback on the issue is the difficulty of travel to DoD installations. We are unable to resolve this issue. NSTA will continue to monitor feedback for new issues.

It is recommended that GEMs develop and implement a required training for mentors (delivered virtually) that is completed at least once when beginning to work with the program in FY19 and beyond.

- NSTA will investigate the requirements for the recommended training and discuss impacts with stakeholders.

It is recommended again in FY19 that 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.

- NSTA has and will continue to play a participatory role in working with consortium members to provide a quality social media presence. NSTA has come to understand from Widmeyer, that the majority of our social media efforts impact parents, which are not evaluated in GEMS' evaluation methodology.

It is recommended that NSTA conduct an examination of GEMS curricula used across sites and determine if there is a need to provide some guidance and/or standardized cross-program activities that all GEMS program participants experience to establish more continuity of experiences and to guide more of the quality control for GEMS.

- NSTA set up a forum for curriculum sharing at the conclusion of the FY18 program year. The forum seemed a strong option for NSTA and stakeholders as it was a way to host useful information and increase the intra-program dialogue outside of the end-of-year meeting.

It is recommended that NSTA work with GEMS sites to provide required guidance and activities for GEMS participants to learn about other appropriate AEOPs.

- NSTA will investigate deliverables that could help participants learn about other appropriate AEOPs. Last year's "What's Next?" flyer from Widmeyer was helpful, and NSTA will consider the flyer's impact and the opportunity for betterment.

It is recommended that NSTA examine GEMS curricula and inquire with sites regarding their focus on DoD STEM careers as part of their programming and determine if more guidance is necessary to enable all participants to learn about five or more.

- Evaluation metrics on this outcome have historically been strong. NSTA is not aware of any significant changes to how local labs are incorporating Army Scientist and Engineers. The new locations for the year were very inclusive on S&E participation in the classroom. NSTA will monitor the metric to determine if the decline is correlated to any new issues.