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ARMY EDUCATIONAL OUTREACH PROGRAM

GEMS

2019 Annual Program Evaluation Report Findings

April 2020

ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

AEOP Goals

Goal 1: STEM Literate Citizenry. Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators. Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure. Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

This report documents the evaluation study of one of the AEOP elements, Gains in the Education of Mathematics and Science (GEMS). GEMS is administered on behalf of the Army by the National Science Teaching Association (NSTA). The evaluation study was performed by NC State 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 and centers on site or in close coordination off site with the area Army laboratories and centers (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 or center 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 and centers. 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 or center, and sites may set, in addition to the overall program goals, individual laboratory or center 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 centers; 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 ten states (see Table 1). In 2019, GEMS enrolled 2,985 students at 14 sites. This number represents a 12% decrease in enrollment compared to 2018 when 3,341 students were enrolled at 15 sites and a 5% increase over 2017 enrollment when 2,845 students participated in GEMS.

GEMS sites continued to receive applications from more qualified students than they could serve. A total of 5,296 student applications were submitted to GEMS sites in 2019, a 4% decrease compared to the 5,500 applications received in 2018 and a 12% increase as compared to 2017 when 4,653 applications were submitted. Table 2 provides the application and participation data by GEMS site for 2019.

In addition to student participants, 351 adults worked with the program (note that NPMs are included with adult participants although some may be high school students), a 70% decrease from the 595 who participated in 2018 and a 45% decrease as compared to 2017 when 510 adults participated. Of the adults participating in 2019, 128 were NPMs, 175 were S&Es, and 33 were Resource Teachers.

Table 1. 2019 GEMS Sites		
Laboratory or Center	**Command***	**Location**
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 Development Command – C5ISR Center	CCDC/ USAMRDC	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)	USAMRDC	Fort Rucker, AL
U.S. Army Medical Research and Material Command at Fort Detrick (MRDC-Ft. Detrick)	USAMRDC	Fort Detrick, MD
U.S. Army Research Institute for Surgical Research (USAISR)	USAMRDC	San Antonio, TX
U.S. Army Research Institute for Environmental Medicine (USARIEM)	USAMRDC	Natick, MA
Walter Reed Army Institute of Research (WRAIR)	USAMRDC	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. 2019 GEMS Site Applicant and Enrollment Numbers			
Command	**2019 GEMS Site**	**Number of Applicants**	**Number of Enrolled Participants**
CCDC	U.S. Army Combat Capabilities Development Command –Aviation and Missile Center –(Huntsville)	179	168
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Aberdeen Proving Ground (ARL-APG)	625	297
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Adelphi (ARL-Adelphi)	486	115
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - Orlando (ARL-Orlando)	167	126
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - West (ARL-West-Playa Vista, CA)	166	48
	U.S. Army Combat Capabilities Development Command - Army Research Laboratory - White Sands Missile Range (ARL-WSMR)	298	123
MRDC	U.S. Army Aeromedical Research Laboratory (USAARL-Fort Rucker)	600	460
	U.S. Army Medical Research and Material Command at Fort Detrick (USAMRDC-Ft. Detrick)	924	605
	U.S. Army Research Institute for Surgical Research (USAISR – San Antonio, TX)	163	106
	U.S. Army Research Institute for Environmental Medicine (USARIEM-Natick)	370	218
	Walter Reed Army Institute of Research (WRAIR-Silver Spring)	1,022	540
USACE	Engineer Research & Development Center - Construction Engineering Research Laboratory (ERDC-CERL-Champaign, IL)	126	57
	Engineer Research & Development Center - Mississippi (ERDC-MS)	170	122
ATEC	U.S. Army Test and Evaluation Command (ATEC) - Yuma Proving Ground (YPG)[1]	105	63
TOAL		**5,296**	**2,985**

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

Table 3 displays demographic information for the 2,380 GEMS student participants for whom demographic data were available. Some participants participated in more than one GEMS program, however those participants were counted only once in the student profile.

Overall student demographics for 2019 are similar to those of previous years. As in 2018 and 2017, nearly half of participants were female (47% in 2019, 2018, and 2017). The proportion of students identifying as White increased somewhat in 2019 (44% in 2019, 40% in 2018, and 38% in 2017). The proportion of Asian students continues a slight downward trend, with 14% of students identifying as Asian in 2019, compared to 17% in 108 and 18% in 2017. There is also a slight downward trend in participation of Black or African American students with 23% of students identifying themselves as Black or African American in 2019 as compared to 24% in 2018 and 26% in 2017. The proportion of students identifying themselves as Hispanic or Latino/a remained at 2018 levels (9% in both 2019 and 2018), a slight increase as compared to 2017 (7%). Relatively few students (13%) reported being eligible for free-or reduced price school lunch (FARMS), a commonly used indicator of socioeconomic status, nearly all (97%) spoke English as their first language, and few (9%) would be first generation college attendees. A somewhat larger proportion of students (42%) met the AEOP definition of underserved (U2) in 2019 as compared to 2018 (35%).

Table 3. 2019 GEMS Enrolled Student Profile		
Demographic Category	GEMS Participants	
Respondent Gender (n=2,380)*		
Female	1,135	47%
Male	1,239	52%
Choose not to report	6	<1%
Respondent Race/Ethnicity (n=2,380)		
Asian	336	14%
Black or African American	555	23%
Hispanic or Latino	217	9%
Native American or Alaska Native	8	<1%
Native Hawaiian or Other Pacific Islander	7	<1%
White	1050	44%
Other race or ethnicity	113	4%
Choose not to report	94	4%
School Location (n=2,066)		
Urban	518	25%
Rural	215	10%
Suburban	1,199	58%
Department of Defense School	8	<1%
Frontier or Tribal School	1	<1%
Home School	101	5%
Online School	3	<1%
Choose not to report	21	1%
Free and Reduced Lunch Status (n=2,380)		

Yes	1,970	83%
No	326	13%
Choose not to report	84	4%
English as First Language (n=2,380)		
Yes	2,301	97%
No	67	2%
Choose not to report	12	1%
Parent Graduated from College (n=2,380)		
Yes	2,120	89%
No	214	9%
Choose not to report	46	2%
Underserved[2] (n=2,380)		
Yes	997	42%
No	1,383	58%

*Note – demographic data were available for 2,426 participants. Of these, 46 had participated in more than one GEMS program, and duplicate data were removed, leaving data for 2,380 unique participants.

Table 4 summarizes 2019 GEMS program costs. The total cost of the program was $1,206,887. The cost per student participant was $404.

Table 4. 2019 GEMS Program Costs	
Total Cost	$1,206,887
CCDC Cost	$161,559
IPA Cost	$1,045,328
CCDC Travel	$0
IPA Travel	$9,755
Participant Travel	$0
Total Awards	$775,267
Student Awards/Stipends	$270,800
Adult/Teacher/Mentor Awards	$504,467
Cost Per Student	$404

[2] AEOP's definition of underserved (U2) 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

NC State 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 or centers operating at 14 sites in 10 states • 2,985 Students participating in GEMS programs • 351 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 of Army S&Es serving as mentors in GEMS • Number of, Near Peers serving as mentors in GEMS • Number 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, four focus groups with students, three focus groups with mentors, and an Annual Program Report (APR) and other program information 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. 2019 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
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 21^{st} 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. 2019 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. 2019 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. 2019 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. 2019 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.

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).

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. The upward trend in the mentor response rate in recent years was not continued for 2019 (6% in 2015, 8% in 2016, 11% in 2017, 12% in 2018, and 8% in 2019). The student response rate for 2019, however, was substantially higher than in 2018 (93% in 2019 as compared to 56% in 2018, 76% in 2017, and 74% in 2016).

Some GEMS sites utilized Cvent to administer the survey to participants (n=735). The remainder of the GEMS participant population completed the evaluation questionnaire using a paper (Scantron) version of the survey at the GEMS sites (n=1,509) for a total respondent population of 2,244. Slightly more than half of survey respondents (1,442 out of 2,224 respondents) provided demographic data on their survey responses.

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

Table 10. 2019 GEMS Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants* (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence[4]**
Students	2,224	2,380	93%	±.53%
Mentors	27	351	8%	±18.15%

* Cvent participation data are used for statistical analyses of student data throughout this report

Four student focus groups and three mentor focus groups were conducted at three GEMS sites. Student focus groups included 40 students (24 males and 16 females). Over half of students (21) were rising eight graders. One student was in fifth grade, six in sixth grade, four in seventh grade, eight in ninth grade, and one in tenth grade. Over half (24) had participated in GEMS the previous year, while two had participated twice previously, and one student had participated for three previous years. Thirteen of the students were participating in GEMS for the first time. The three mentor focus groups included nine mentors, six of whom were NPMs and three of whom were S&Es. Six of these mentors had served as GEMS mentors once previously, and three had mentored for over five years previously. 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

Table 11 displays demographic information for students who responded to the GEMS evaluation survey and for whom demographic information were available. Gender was relatively evenly distributed with approximately half of students indicating they were female (52%) and slightly fewer that they were male (46%). More than a third of students indicated they were White (37%) followed by Black/African American (27%), Asian (14%), and Hispanic/Latino (10%). Two-thirds (66%) of students reported not being eligible for free or reduced lunch. Half of students indicated they attended a suburban school (51%). Nearly all students reported speaking English as a first language (98%) and having a parent who graduated from college (81%). Slightly less than half of GEMS students (47%) completing the evaluation survey met the

[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.

AEOP definition of U2. These demographics are similar to those of the overall enrolled population of GEMS students.

Table 11. 2019 GEMS Student Respondent Profile		
Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 1,442)		
Female	755	52.4%
Male	669	46.4%
Choose not to report	18	1.2%
Respondent Race/Ethnicity (n = 1,437)		
Asian	199	13.8%
Black or African American	381	26.5%
Hispanic or Latino	137	9.5%
Native American or Alaska Native	12	1.0%
Native Hawaiian or Other Pacific Islander	3	<1%
White	533	37.1%
Other race or ethnicity	51	3.5%
Choose not to report	121	8.4%
Respondent Grade Level (n = 1,426)		
3rd	0	0%
4th	0	0%
5th	87	6.1%
6th	152	10.7%
7th	257	18.0%
8th	244	17.1%
9th	234	16.4%
10th	189	13.3%
11th	150	10.5%
12th	70	4.9%
First-Year College Student	0	0.0%
Choose not to report	43	3.0%
Respondent Eligible for Free/Reduced-Price Lunch (n = 1,423)		
Yes	278	19.5%
No	943	66.3%
I don't know	196	13.8%
Choose not to report	6	<1%
School Location (n = 1,430)		
Urban	358	25.0%
Suburban	722	50.5%
Rural	198	13.8%
Department of Defense School	0	0%
Home School	9	<1%
I don't know	143	10.0%
English First Language (n = 1,433)		
Yes	1,410	98.4%
No	22	1.5%

Choose not to report	1	<1%
Parent Graduated from College (n = 1,434)		
Yes	1,159	80.8%
No	111	7.7%
I don't know	160	11.2%
Choose not to report	4	<1%
Underrepresented (U2 Classification) (n = 1,450)		
Yes	679	46.8%
No	771	53.2%

Mentor Demographics

Table 12 summarizes demographics for mentors who responded to the evaluation survey. More than half of mentors who responded to the questionnaire were female (59%) and White (52%). More than a third of respondents were scientists, engineers, or mathematicians in training (41%). Most mentor respondents served as NPMs (85%) and 15% served as resource teachers.

Table 12. 2019 GEMS Mentor Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 27)		
Female	16	59.3%
Male	11	40.7%
Respondent Race/Ethnicity (n = 27)		
Asian	3	11.1%
Black or African American	4	14.8%
Hispanic or Latino	4	14.8%
White or Caucasian	14	51.9%
Other	2	7.4%
Respondent Occupation (n = 27)		
Teacher	8	29.7%
Other school staff	1	3.7%
University educator	0	0%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	11	40.7%
Scientist, Engineer, or Mathematics professional	0	0%
Other	7	25.9%

Respondent Role in GEMS (n = 27)		
Instructor (typically a University or Army Scientist or Engineer)	0	0%
Classroom Assistant	0	0%
Resource teacher (RT)	4	14.8%
Near peer mentor (NPM)	23	85.2%
Assistant Near peer mentor	0	0%
Other	0	0%

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 evaluation survey asked students how often they engaged in various STEM practices (see Table 13). More than half of students (56%-99%) reported engaging in all STEM practices at least once during GEMS. Activities engaged with frequently (most or every day) by approximately two-thirds of students or more were working with others as part of a team (86%), using laboratory tools and steps to do an experiment (68%), and examining data to make a conclusion (64%).

Table 13. Student Engagement in STEM Practices in GEMS (n=1,881-1,900)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Work with a person who works in a STEM job on their real-world project	23.4%	16.2%	15.4%	12.5%	32.3%	
	446	309	293	238	614	**1,900**
Work with a person who works in a STEM job on a project assigned by my teacher	25.2%	15.0%	15.7%	15.3%	28.8%	
	474	282	295	288	542	**1,881**
Plan my own research based on my ideas	22.2%	20.2%	22.5%	16.7%	18.2%	
	422	384	427	317	345	**1,895**
Present a project to a judge or someone from the community	41.4%	22.9%	15.4%	8.9%	10.9%	
	783	433	291	169	207	**1,883**
Talk with people working in STEM careers	8.2%	15.5%	18.9%	15.9%	41.1%	
	156	295	358	301	781	**1,891**
Use laboratory tools and steps to do an experiment	7.3%	8.3%	16.0%	20.7%	47.5%	
	138	158	304	392	901	**1,893**
Find questions or problems to investigate	7.0%	12.8%	17.9%	21.6%	40.5%	
	133	243	339	409	768	**1,892**

Plan and do an investigation or experiment	7.7%	12.7%	17.8%	19.3%	42.4%	
	145	241	338	365	803	**1,892**
Examine data or information to make a conclusion or decision	5.9%	12.0%	17.9%	22.5%	41.5%	
	112	226	338	425	784	**1,885**
Work with others as part of a team or group	1.2%	3.1%	9.0%	15.4%	71.0%	
	23	58	169	291	1,341	**1,882**
Use a computer to make a model of something	44.4%	17.2%	13.0%	9.3%	16.0%	
	837	324	246	175	301	**1,883**
Solve real-world problems	14.3%	17.7%	20.1%	18.3%	29.6%	
	271	336	381	347	560	**1,895**

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. This 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.

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"[7]. Chart 1 shows scores were significantly higher "in GEMS" compared to "in school" with a large effect size (d = 1.01).[8]

[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.

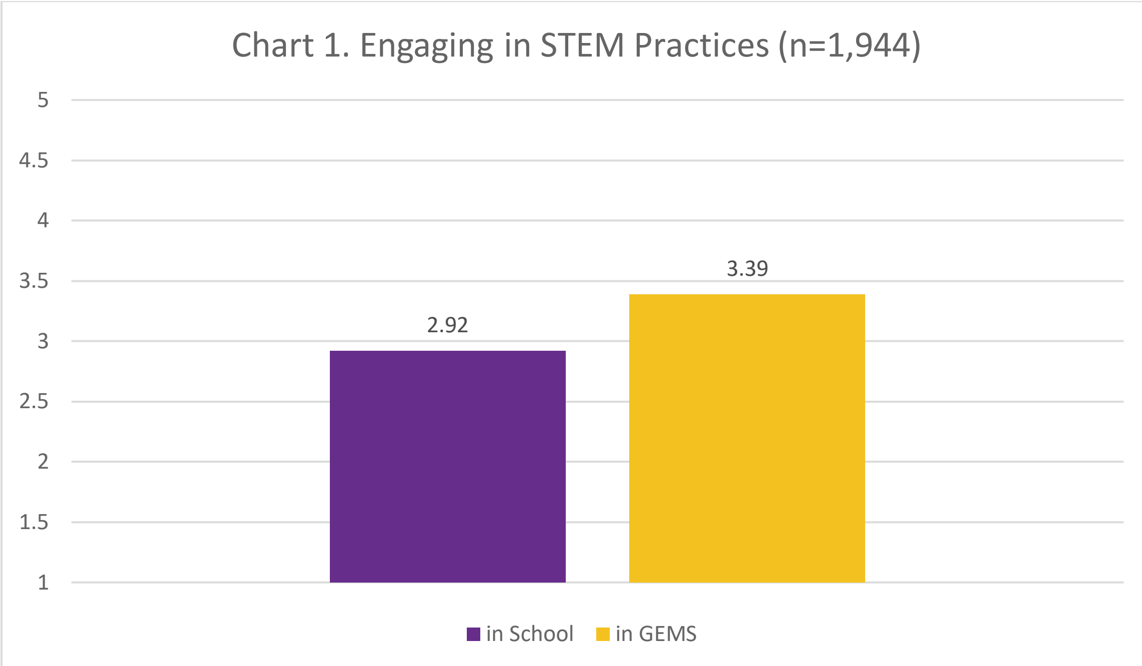
[6] The Cronbach's alpha reliability for the Engaging in STEM Practices in GEMS items was 0.872.

[7] Cronbach's alpha reliability for the Engage in STEM Practices in School items was 0.887.

[8] STEM Engagement dependent samples t-test: t(1,943)=22.15, p=.000.

Table 14. Student Engagement in STEM Practices in School (n=1,895-1,952)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Work with a person who works in a STEM job on their real-world project	38.3%	21.7%	23.0%	5.9%	11.1%	
	748	423	448	116	217	**1,952**
Work with a person who works in a STEM job on a project assigned by my teacher	43.2%	22.3%	18.9%	8.3%	7.3%	
	835	430	365	160	141	**1,931**
Plan my own research based on my ideas	15.1%	18.8%	35.6%	21.4%	9.1%	
	294	367	693	416	178	**1,948**
Present a project to a judge or someone from the community	43.4%	19.1%	26.4%	7.1%	4.0%	
	822	362	501	135	75	**1,895**
Talk with people working in STEM careers	18.3%	22.0%	34.8%	11.7%	13.3%	
	355	426	675	226	257	**1,939**
Use laboratory tools and steps to do an experiment	8.7%	12.0%	39.7%	24.3%	15.3%	
	169	233	771	471	296	**1,940**
Find questions or problems to investigate	9.1%	14.3%	29.3%	27.4%	19.9%	
	175	276	563	528	382	**1,924**
Plan and do an investigation or experiment	9.7%	16.2%	35.9%	23.7%	14.5%	
	187	314	695	458	280	**1,934**
Examine data or information to make a conclusion or decision	7.4%	10.3%	30.9%	32.7%	18.6%	
	143	198	594	628	357	**1,920**
Work with others as part of a team or group	4.0%	3.2%	19.1%	40.0%	33.7%	
	77	62	367	769	649	**1,924**
Use a computer to make a model of something	27.7%	23.9%	26.3%	14.0%	8.1%	
	533	460	506	269	156	**1,924**
Solve real-world problems	15.4%	17.4%	26.6%	19.4%	21.2%	
	299	337	515	375	411	**1,937**



Students also shared information about how their GEMS experiences compared with their typical in-school experiences in their responses to open-ended questionnaire items. Students cited differences in the type and depth of learning they experienced in GEMS as compared to in school, the opportunity to explore careers, and the access to materials they had in GEMS. For example,

> *"I learned many things that I wouldn't have learned at school."* (GEMS Student)

> *"I got to experience more about the various fields of STEM than in school."* (GEMS Student)

> *"I don't usually work with the materials that there [are available] in GEMS at school."* (GEMS Student)

> *"I learned more about STEM than I usually do in school and this program has helped me think more seriously about pursuing a STEM-related career."* (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 indicated some level of STEM learning as a result of the GEMS program (Table 15). A majority of students (60%-84%) reported that they "learned more than a little" or "learned a lot" in each area. For example, 84% learned at this level about new knowledge of a STEM topic, and 79%

reported this level of learning about how scientists and engineers work on real problems in STEM. A large majority reported learning at least “a little” in each area (88%-98%).

Table 15. Student Report of Impacts on STEM Knowledge (n=1,923-1,938)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
New knowledge of a STEM topic	2.4%	13.8%	28.6%	55.2%	
	46	267	554	1,071	**1,938**
How to do research on a STEM topic	11.6%	27.9%	28.7%	31.5%	
	225	539	554	609	**1,927**
How scientists and engineers work on real problems in STEM	4.7%	16.7%	27.3%	51.2%	
	91	321	526	985	**1,923**
What research work is like in STEM	5.6%	17.2%	27.5%	49.7%	
	108	331	529	958	**1,926**

These items were combined into a composite variable[9] to test for differential impacts for overall U2 classification and across subgroups of students. No significant differences were found by individual demographic variables or overall U2 status.

Students were also asked about how GEMS impacted their STEM competencies or skills (Table 16). Two-thirds or more of students (66%-89%) reported learning at least a little on all STEM competencies. Areas where students indicated they learned the most (more than a little or a lot) were how to use knowledge and creativity to come up with a solution (73%), how to ask questions that could be answered with experiments (62%), and how to design steps for an experiment that work (61%).

Composite scores were calculated for STEM competencies[10] to examine whether the GEMS program had differential impacts on student based on U2 classification and by subgroups of students. Significant differences were not found in STEM competences by overall U2 classification or any individual demographic variables.

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[9] The Cronbach’s alpha reliability for STEM Knowledge items was 0.814.

[10] The STEM Competencies composite had a Cronbach’s alpha reliability of 0.946.

Table 16. Students Reporting Gains in their STEM Competencies – Science Practices (n=1,800-1,889)

	No new learning	Learned a little	Learned More than a little	Learned A lot	Response Total
How to explain a problem that can be solved by developing something new	11.4%	28.1%	32.5%	27.9%	
	215	531	615	528	**1,889**
How to ask a question that could be answered with experiments	13.5%	24.8%	29.7%	32.0%	
	253	466	559	602	**1,880**
How to use knowledge and creativity to come up with a solution to a problem	7.7%	19.8%	30.1%	42.4%	
	144	368	560	790	**1,862**
How to make a model to show how something works	14.5%	26.5%	25.6%	33.2%	
	272	499	481	625	**1,877**
How to design steps for an experiment that work	14.0%	24.9%	28.7%	32.1%	
	262	468	539	602	**1,871**
How to identify the limitations of steps and tools used for collecting data	14.4%	25.5%	28.9%	30.8%	
	270	477	542	577	**1,866**
How to do an experiment and record data correctly	15.8%	23.9%	26.7%	33.6%	
	293	444	497	625	**1,859**
How to create charts or graphs to show data and find patterns	29.4%	27.2%	22.3%	20.8%	
	548	506	415	388	**1,857**
How to consider different views of data to decide if something works as planned	15.3%	27.5%	28.9%	28.1%	
	283	511	537	522	**1,853**
How to support my explanation with STEM knowledge or data from experiments	15.9%	26.9%	27.5%	29.5%	
	296	500	511	549	**1,856**
How to identify the strengths and limitations of data or arguments in technical or scientific books	28.9%	28.2%	21.4%	21.4%	
	537	523	397	398	**1,855**
How to present an argument that uses data and/or findings from an experiment	24.2%	27.1%	23.7%	24.6%	
	450	504	441	458	**1,853**

How to defend an argument with data	28.8%	26.9%	19.5%	24.6%	
	536	501	364	459	**1,860**
How to use information from books or other sources to support my explanation of an experiment or solution to a problem	33.6%	26.6%	19.0%	20.8%	
	625	494	353	386	**1,858**

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). Nearly half or more of students (48%-74%) reported that they learned more than a little or a lot in all of these skills except for how to create social media (22%) and how to analyze media (37%). Items for which at least two-thirds of students indicated learning at this level were how to think about how systems work and how parts interact with each other (74%), how to work creatively with others (71%), how to use their creative ideas to make something (71%), and how to work with others effectively (70%).

Table 17. Student Report of Impacts on 21st Century Skills (n=1,809-1,866)

	No new learning	Learned a little	Learned More than a little	Learned A lot	Response Total
How to think creatively	11.0%	22.9%	26.7%	39.3%	
	206	427	499	734	**1,866**
How to work creatively with others	8.3%	21.1%	27.0%	43.6%	
	155	393	503	813	**1,864**
How to use my creative ideas to make something	10.0%	19.5%	26.9%	43.6%	
	184	360	497	804	**1,845**
How to think about how systems work and how parts interact with each other	6.7%	19.6%	30.5%	43.2%	
	123	361	562	796	**1,842**
How to evaluate other people's evidence, arguments, and beliefs	19.4%	26.7%	28.7%	25.1%	
	360	495	533	466	**1,854**
How to solve problems	8.9%	21.6%	26.4%	42.8%	
	165	400	488	791	**1,844**
	19.8%	26.8%	26.1%	27.2%	

How to communicate clearly in speaking and writing forms with others	364	494	480	500	**1,838**
How to work with others effectively	10.0%	20.3%	27.2%	42.3%	
	183	373	499	775	**1,830**
How to interact effectively with others in a respectful and professional manner	13.2%	21.5%	24.8%	40.4%	
	240	392	452	737	**1,821**
How to get and evaluate information and the sources of information in an acceptable time period	16.0%	26.7%	27.9%	29.3%	
	293	489	510	537	**1,829**
How to use and manage information or data accurately, creatively, and ethically	13.9%	26.4%	27.4%	32.2%	
	255	485	503	592	**1,835**
How to analyze media (the news) to understand the different points of view of people	40.1%	22.4%	18.4%	18.9%	
	736	411	337	347	**1,831**
How to create videos, blogs, and social media posts	64.1%	13.2%	8.2%	14.0%	
	1,174	242	151	256	**1,823**
How to use technology to do research, organize my ideas, evaluate things, and communicate information	26.6%	25.8%	22.4%	25.1%	
	486	470	409	457	**1,822**
How to adapt to change when things don't go as planned	11.4%	25.6%	27.5%	35.2%	
	208	467	503	643	**1,821**
How to use feedback on my work effectively	17.1%	26.0%	25.0%	31.8%	
	310	472	454	578	**1,814**
How to set goals and use my time wisely	17.4%	23.2%	26.8%	32.4%	
	316	421	486	586	**1,809**
How to work alone and complete tasks on time	28.7%	23.7%	18.6%	28.9%	
	521	430	338	525	**1,814**
How to get started and do work without being told to	25.4%	24.9%	21.7%	27.9%	
	461	453	394	507	**1,815**
How to manage projects to complete them on time	17.5%	24.4%	24.2%	33.7%	

	318	442	440	612	**1,812**
How to stick with work until it is finished to produce results	15.0%	23.3%	26.3%	35.2%	
	272	423	476	638	**1,809**
How to lead and guide others in a team or group	16.7%	22.0%	27.8%	33.3%	
	302	398	503	602	**1,805**
How to be responsible to others - thinking about the larger community good	14.7%	23.0%	26.0%	36.1%	
	264	415	469	651	**1,799**

The 21st Century skills items were combined into a composite variable[11] to test for differential impacts by overall U2 classification and across subgroups of students; no differences were found.

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[12], GEMS and other programs in the AEOP portfolio emphasize supporting participants' STEM identities. Because of this, the student evaluation survey included items intended to measure the impact of GEMS on students' STEM identities (Table 18). After participating in GEMS, 70% or more of students (70%-87%) either somewhat agreed or agreed with each statement related to the impact of GEMs on their STEM identities. GEMS impacted 80% or more of students in the following areas: interest in a new STEM topic (80%), feeling more prepared for more challenging STEM activities (85%), and feeling like they accomplished something in STEM (87%). Comparing results on a composite created from these STEM Identity items,[13] there were no significant differences by overall U2 status or any individual student demographics.

[11] The 21st Century Skills composite has a Cronbach's alpha reliability of 0.966.

[12] 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.

[13] The Cronbach's alpha reliability for these Identity items was 0.836.

Table 18. Student Report of Impacts on STEM Identity (n=1,826-1,851)

	Strongly disagree	Disagree	Don't agree or disagree	Somewhat agree	Agree	Response Total
I am interested in a new STEM topic	2.9%	4.1%	12.8%	28.4%	51.8%	
	54	76	237	526	958	**1,851**
I am thinking about pursuing a STEM career	4.2%	7.4%	15.6%	20.6%	52.0%	
	77	137	289	381	960	**1,844**
I feel like I accomplished something in STEM	1.7%	1.7%	9.1%	25.3%	62.0%	
	31	31	167	466	1,140	**1,835**
I feel more prepared for more challenging STEM activities	1.5%	3.1%	10.6%	27.3%	57.3%	
	28	56	194	501	1,051	**1,830**
I am thinking creatively about a STEM project or activity	2.0%	4.9%	15.5%	25.7%	51.8%	
	37	90	283	469	947	**1,826**
I have connected a STEM topic or field to my personal values	3.6%	6.5%	19.9%	25.1%	44.9%	
	65	119	364	459	821	**1,828**

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:[14]

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.

[14] 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.

More than 80% of mentors (85%-100%) reported using each strategy to help make the learning activities in GEMS relevant to students (Table 19) with the exception of selecting readings/activities that relate to students' backgrounds (48%). Strategies used most frequently were asking students to relate real-life events/activities to topics covered in GEMS (100%), becoming familiar with students' background/interests at the beginning of GEMS (96%), and helping students become aware of the roles STEM plays in their everyday lives (96%).

Table 19. Mentors Using Strategies to Establish Relevance of Learning Activities (n=27)

	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	96.3%	3.7%	
	26	1	**27**
Giving students real-life problems to investigate or solve	88.9%	11.1%	
	24	3	**27**
Selecting readings or activities that relate to students' backgrounds	48.1%	51.9%	
	13	14	**27**
Encouraging students to suggest new readings, activities, or projects	88.9%	11.1%	
	24	3	**27**
Helping students become aware of the role(s) that STEM plays in their everyday lives	96.3%	3.7%	
	26	1	**27**
Helping students understand how STEM can help them improve their own community	85.2%	14.8%	
	23	4	**27**
Asking students to relate real-life events or activities to topics covered in GEMS	100.0%	0.0%	
	27	0	**27**

Half or more of mentors (52%-100%) reported using all strategies to support the diverse needs of students as learners (Table 20). All mentors indicated they used a variety of teaching/mentor activities to meet the needs of all students (100%) and interacted with students the same way regardless of their backgrounds (100%).

Table 20. Mentors Using Strategies to Support Diverse Needs of Students as Learners (n=27)

	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	77.8%	22.2%	
	21	6	**27**
Interact with students and other personnel the same way regardless of their background	100.0%	0.0%	
	27	0	**27**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	27	0	**27**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	63.0%	37.0%	
	17	10	**27**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	63.0%	37.0%	
	17	10	**27**
Directing students to other individuals or programs for additional support as needed	70.4%	29.6%	
	19	8	**27**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	51.9%	48.1%	
	14	13	**27**

More than 85% of mentors (89%-100%) reported using each strategy associated with supporting students' development of collaboration and interpersonal skills (see Table 21). All mentors reported having students listen to ideas of others with an open mind (100%), having students work on collaborative activities/projects as a team member (100%), and allowing students to resolve conflicts within their team (100%).

Table 21. Mentors Using Strategies to Support Development of Collaboration and Interpersonal Skills (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	88.9%	11.1%	
	24	3	**27**
Having my student(s) explain difficult ideas to others	92.6%	7.4%	
	25	2	**27**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	27	0	**27**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	96.3%	3.7%	
	26	1	**27**
Having my student(s) give and receive constructive feedback with others	88.9%	11.1%	
	24	3	**27**
Having students work on collaborative activities or projects as a member of a team	100.0%	0.0%	
	27	0	**27**
Allowing my student(s) to resolve conflicts and reach agreement within their team	100.0%	0.0%	
	27	0	**27**

More than two-thirds of mentors (70%-100%) reported using each strategy associated with supporting student engagement in “authentic” STEM activities (Table 22) except having students search for and review technical literature to support their work (37%). All or nearly all mentors reported demonstrating laboratory/field techniques, procedures, and tools for students (100%), encouraging students to learn collaboratively (96%), and encouraging students to seek support from other team members (96%).

Table 22. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n=27)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	70.4%	29.6%	
	19	8	**27**
Having my student(s) search for and review technical research to support their work	37.0%	63.0%	
	10	17	**27**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	27	0	**27**
Supervising my student(s) while they practice STEM research skills	92.6%	7.4%	
	25	2	**27**
Providing my student(s) with constructive feedback to improve their STEM competencies	92.6%	7.4%	
	25	2	**27**
Allowing students to work independently to improve their self-management abilities	88.9%	11.1%	
	24	3	**27**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	96.3%	3.7%	
	26	1	**27**
Encouraging students to seek support from other team members	96.3%	3.7%	
	26	1	**27**

Half or more of mentors (52%-96%) indicated they used all strategies to support students' STEM educational and career pathways (see Table 23) with the exception of helping students with their resume, application, personal statement, and/or interview preparation (44%). Strategies with the greatest use by mentors were asking students about their educational/career goals (96%) and providing guidance about educational pathways that will prepare students for a STEM career (85%).

Table 23. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=27)

	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	96.3%	3.7%	
	26	1	**27**
Recommending extracurricular programs that align with students' goals	77.8%	22.2%	
	21	6	**27**
Recommending Army Educational Outreach Programs that align with students' goals	59.3%	40.7%	
	16	11	**27**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	85.2%	14.8%	
	23	4	**27**
Discussing STEM career opportunities within the DoD or other government agencies	77.8%	22.2%	
	21	6	**27**
Discussing STEM career opportunities in private industry or academia	70.4%	29.6%	
	19	8	**27**
Discussing the economic, political, ethical, and/or social context of a STEM career	59.3%	40.7%	
	16	11	**27**
Recommending student and professional organizations in STEM to my student(s)	70.4%	29.6%	
	19	8	**27**
Helping students build a professional network in a STEM field	51.9%	48.1%	
	14	13	**27**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	44.4%	55.6%	
	12	15	**27**

Program Features and Feedback/Satisfaction

Students and mentors were asked how satisfied they were with a number of features of the GEMS program. More than half of students (56%-86%) indicated they were at least somewhat satisfied with all program features (Table 24). Program features with which the most students reported satisfaction at the somewhat or very much satisfied levels were the teaching/mentoring provided during GEMS (86%) and STEM topics included in GEMS (86%).

Table 24. Student Satisfaction with GEMS Program Features (n=1,802 – 1,829)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
The location(s) of GEMS program	2.5%	4.8%	14.3%	23.2%	55.2%	
	45	87	262	425	1,010	**1,829**
The STEM topics included GEMS	0.8%	2.5%	10.9%	22.8%	63.1%	
	14	46	198	415	1,149	**1,822**
Teaching or mentoring provided during GEMS activities	1.2%	2.2%	10.0%	19.1%	67.3%	
	21	40	182	347	1,223	**1,813**
Educational materials (e.g., workbooks, online resources, etc.) used during program activities	6.0%	4.1%	14.4%	23.6%	51.9%	
	109	74	260	426	938	**1,807**
Invited speakers events	10.9%	4.1%	15.7%	20.0%	49.2%	
	197	74	284	363	892	**1,810**
Field trips or laboratory tours	26.0%	5.0%	12.5%	15.1%	41.2%	
	471	91	227	274	747	**1,810**

Students also responded to an open-ended item on the questionnaire asking them about their overall satisfaction with their GEMS experiences. Of the 100 students whose responses were sampled, all made positive comments and a large majority (83%) commented only on positive aspects of the program. These comments focused on the topics and materials available to them, students' relationship with their mentors or NPMs, the real-world relevance of their learning, increases in interest or motivation for STEM, the career information they received, making friends, having fun, and appreciation for the stipend. Students said, for example:

"My GEMS experience was great. I got to meet new people and learn how to do things I can do at home…My mentors were very nice and helped me whenever I needed them to. The [speakers] they brought in were really cool and showed us a lot of cool stuff." (GEMS Student)

"I really had a fun time at GEMS. and had a good time conducting experiments with friends. I liked learning more about the world's problems today and how we can solve them with science." (GEMS Student)

"[GEMS] taught me new things and how it applies to life today. I was able to learn how to code and code directly and even to make my own projects by myself! The people here are great and they love talking to you about STEM careers and things to do in the future. This was a great week for me and I would love to do GEMS again." (GEMS Student)

"Having the Near-Peers as people who are a little older than us is one of the biggest reasons why I love GEMS. I love that I can connect with my teachers and Near-Peers and have lots of fun with them as well." (GEMS Student)

Another 17 responses (17%) included positive comments, but also included some caveats. These caveats included comments about being periodically bored; requests for more hands-on activities, more topics, or more student choice in topics or activities; comments that the program was too short; comments about the survey; and comments about mentors (e.g., some mentors threatened to revoke students' stipends as a disciplinary measure). For example,

"I really liked GEMS…[It] GEMS gives young kids/teens opportunities to experience new careers in STEM. One thing I would like to improve are the STEM options for the different age groups." (GEMS Student)

"It was a fun experience and I would do it again. I would prefer we could do more experiments and less lectures." (GEMS Student)

"I loved the GEMS experience and hope to be able to come back next year. There are some things that could be improved…they should stop making us do exactly what they want by threatening to revoke our [stipend]... Except for that I loved the opportunities GEMS gave us and the friends I made." (GEMS Student)

Another open-ended questionnaire item asked students to list three benefits of participating in GEMS. Of the 100 responses analyzed, the most frequently mentioned benefits, mentioned by more than half of respondents, were the career information they gained (54%) and the STEM learning they experienced (51%). Nearly half of students (49%) mentioned specific STEM skills they gained and/or the hands-on activities as benefits of STEM. Around a quarter of respondents (24%) cited teamwork as a benefit of

GEMS, and 16% of respondents mentioned meeting new people and making friends, and increasing their interest and motivation for STEM as benefits of participating in GEMS. Benefits mentioned by 10%-14% of respondents included having access to resources not available to them at school, the problem solving skills they gained, and the opportunity to learn about the DoD.

Students participating in focus groups were also asked to share their opinions about the benefits of the GEMS program. These students cited similar benefits as did questionnaire respondents, focusing on the opportunities for STEM learning, the opportunities to work in teams, and the career information they gained. Students said, for example,

> *"[At GEMS], I learn the stuff, and then I'll learn the same stuff in the upcoming school year so it kind of preps me for what I'm going to learn."* (GEMS Student)
>
> *"[GEMS] has given me a good time to start thinking ahead...This is all getting me thinking about my future.*" (GEMS Student)
>
> *"I've learned about new things that I can do. I didn't even consider this whole thing about modeling and simulation until I got into this camp and was like, 'Whoa, this is a real thing. I can actually do something with it.'"* (GEMS Student)
>
> *"I learned how to open up…you work with a bunch of different people on projects that can happen to you in the real world…You know how to [do] teamwork and collaborate."* (GEMS Student)

Students were also asked in an open-ended questionnaire item to list three ways in which the program could be improved. Students suggested a wide variety of improvements in the 100 responses sampled. The most frequently suggested improvements, mentioned by more than a quarter of students, were to provide more topics (e.g., space, mathematics, or language arts) (35%), offer a longer program (29%), and provide more hands-on activities (27%). Another 19% of students suggested improvements to the program schedule such as a later start, longer or shorter hours, more recess or free time, or less free or down time. Between 8% and 14% of students mentioned the following improvements:

- more technology access
- changes to program logistics or rules (e.g., temperature of the room, amount of space, time of lunch and/or lunch facilities, and allowing students to use cell phones)
- more teamwork, more varied team composition, or student choice in teams
- more speakers
- more field trips
- more engaging or fun content
- more challenging or in-depth content

- more career information
- more program locations

Students participating in focus groups were also asked for their opinions about ways that GEMS could be improved. These students made a variety of suggestions, most of which were similar to the suggestions made by questionnaire respondents. Focus group participants also suggested better program preparation for activities, providing places for students to store their projects and work during the week, better organization of the program, providing more information about AEOPs, providing more information about program activities in advance, and grouping students by experience in the week's topic rather than by age, and more student choice in topics. Students said, for example,

> *"It would be really cool if they did a survey for the people that were accepted...Like, 'Oh, what are my interests?' Then that could be built into the lesson."* (GEMS Student)

> *"I wish that it could be a little longer because I want to learn more. I want there to be more activities, especially having to do with the subject."* (GEMS Student)

Mentors were also asked to rate their satisfaction with a number of GEMS program features (Table 25). GEMS mentors reported being somewhat or very much satisfied with all features (74%-100%). Aspects of the GEMS program all mentors reported being at least somewhat satisfied with were the application/registration process (100%), support for instruction or mentorship during program activities (100%), and communicating with GEMS organizers/site coordinators (100%).

Table 25. Mentor Satisfaction with GEMS Program Features (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	0.0%	0.0%	33.3%	66.7%	
	0	0	0	9	18	**27**
Communicating with the National Science Teachers Association (NSTA)	14.8%	7.4%	3.7%	37.0%	37.0%	
	4	2	1	10	10	**27**
Communicating with GEMS organizers / site coordinators	0.0%	0.0%	0.0%	7.4%	92.6%	
	0	0	0	2	25	**27**
The physical location(s) of GEMS's activities	0.0%	0.0%	3.7%	7.4%	88.9%	
	0	0	1	2	24	**27**
Support for instruction or mentorship during program activities	0.0%	0.0%	0.0%	11.1%	88.9%	
	0	0	0	3	24	**27**

Stipends (payment)	0.0%	0.0%	7.4%	14.8%	77.8%	
	0	0	2	4	21	**27**
Invited speakers or "career" events	0.0%	0.0%	7.4%	18.5%	74.1%	
	0	0	2	5	20	**27**
Field trips or laboratory tours	11.1%	0.0%	3.7%	14.8%	70.4%	
	3	0	1	4	19	**27**

Like students, mentors were also asked to respond to open-ended questionnaire items asking for their opinions about GEMS and were asked to comment on their overall satisfaction with GEMS. Of the 23 mentors who responded, all made positive comments about GEMS. These mentors attributed their satisfaction to the value of students' learning, the program resources, exposure to STEM topics, and the DoD and career information students receive. In addition, NPMs noted that they valued the networking opportunities and their own learning in the program. NPMs said, for example:

> *"I really enjoyed participating in GEMS as a mentor. I feel like I had the opportunity to impact a lot of kids lives because of this program. I hope that I was able to share my love for science with the kids and that they also developed a love for STEM overall. I also felt like I learned a lot through this program. I hope to be back again next year."* (GEMS NPM)

> *"Overall, I am satisfied with my GEMS experience in that the program allows the introduction of many STEM topics not taught in the traditional classroom setting. The GEMS program allows not only students but mentors to see the real world application of STEM and also the Army's role in the advancement of science and technology."* (GEMS NPM)

> *"My GEMS experience was incredible. This was my first official job and I absolutely loved it. I loved to see kids be creative and learn new things and to get to know as many students as could. I couldn't have been happier with my coworkers. We all got along very well and it made teaching easier and more fun. GEMS is an incredible program and I am very thankful that I was able to participate this year."* (GEMS NPM)

One NPM made positive comments but expressed dissatisfaction with the payment of her stipend, saying,

> *"I absolutely loved my GEMS experience; being a Near-Peer Mentor is something that I hope to do for the rest of my college summers. I was able to network, and practice skills that are applicable to my future real-world career…My only complaint is that the NSTA did not send my stipend check on time for both payments. I received my first payment 3 weeks late, and I am still awaiting my second payment."* (GEMS NPM)

Mentors were also asked to identify the three most important strengths of GEMS. The 24 mentors who responded mentioned a number of program strengths. The most frequently mentioned strengths, cited by slightly less than half of the responding mentors, were students' exposure to STEM and the research experience they gained (11, or 46%) and program features such as organization, communication, staff, the budget, and the flexibility of the program (10, or 42%). Other strengths, mentioned by between four and eight mentors (17%-33%), included the value of the hands-on activities, the networking opportunities, STEM learning, the career information students receive, increasing students' interest in STEM, and the fun participants have.

Mentors participating in focus groups were also asked to share their opinions about the value of GEMS, both to participating students and to themselves. Mentors cited a number of ways that students benefit from GEMS, focusing on students' increase in interest and confidence in STEM, the value of the hands-on experiences, the STEM learning students experience, the career information they gain, and the relationships students form with the NPMs. Mentors said, for example,

> *"[GEMS students experience] a light bulb moment where you know what? Science is not boring or geeky; [they learn] that there's science behind things that can be cool that they find interesting* (GEMS Mentor)

> *"Showing [GEMS students] that you can be part of the Department of Defense, and not be in a uniform, and still serve in a way that's meaningful and impactful is really cool. I don't think they realize that exists."* (GEMS Mentor)

> *"[GEMS] cultivates a love for and passion for STEM. These kids [apply] because they like math, they like science. They join this community of a ton of kids who are the same kind of way. They can talk with them."* (GEMS NPM)

> *"You can see the light bulbs going off inside of them. [GEMS is] giving them the idea of a future career."* (GEMS NPM)

Mentors participating in focus groups also discussed the benefits they personally experience from participating in GEMS. Adult mentors focused on the value of, as one mentor said, going "back to basics" and having fun with science as well as the challenge of creating activities that are interesting to students. NPMs cited somewhat different benefits, including learning about careers, developing life skills such as patience and communication, and the satisfaction of the feeling that they were making a difference. NPMs said, for example,

> *"I've learned a lot of things like conflict resolution, engaging students that don't want to be engaged."* (GEMS NPM)

“I really like interacting with young people, because I think I've some good things to say and I like trying to teach, as well. Teaching is the only way I'm going to get further messages across generations, so I think that's really fun to do, too. Plus, when we have our college talk for kids, the older kids…it's really cool.” (GEMS NPM)

“[As NPMs], we got to give [GEMS students] all this advice that, as that age, we would have wanted.” (GEMS NPM)

Another open-ended questionnaire item asked mentors to note three ways in which GEMS should be improved for future participants. The 22 mentors who responded suggested a wide variety of improvements. The most frequently mentioned improvements were related to content, with a total of 16 mentors (73%) suggesting some improvements to content such as more or different hands-on activities (6 mentors, or 27%), more interactive content or less lecturing (3 mentors, or 11%), or new curriculum (2 mentors, or 7%). Three mentors (11%) suggested providing better training and communication about safety and procedures for staff, and three suggested a different questionnaire for the youngest GEMS participants. Other improvements (none mentioned by more than two mentors), included the following:

- Conducting more outreach or advertising
- Accepting more students
- Providing larger space or classrooms
- Providing more equipment or materials
- Eliminating elementary aged students from the program
- Requiring parents to disclose the needs of special needs students
- Providing more access to technology
- Providing a longer program

Mentors participating in focus groups also suggested improvements such as lengthening the program, conducting more outreach (e.g., using NPMs as ambassadors to visit schools), expanding the range of topics available, and increasing the rigor of the program for repeat attenders. Mentors who were S&Es also suggested providing means for mentors at ERDC labs to be compensated at their regular salary rate for mentoring, providing means to pay for food items used as supplies for activities, providing better lab coats or reusable lab coats that can be distributed to students for the week (mentors noted that lab coats fell apart by the end of the week), and providing templates for documents and promotional materials. S&E mentors said, for example,

“AEOP will cover a stipend for us to work, but for[us] to do that, we have to take leave without pay, so we lose our benefits and we get paid far less. Instead, we asked to be paid on overhead but they will only allow so many hours.” (GEMS Mentor)

"A lot of our labs have food items, like today we made paint out of eggs, and raspberries, and spinach. They were all utilized as lab supplies in a laboratory. Since they are technically food, we purchased those things out of pocket." GEMS Mentor)

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

To understand which recruitment methods are most effective, students were asked when they enrolled for GEMS to indicate all the ways that they had learned about AEOP (Table 26). Aside from past participation in the program (45%), the most frequently reported sources of information about AEOP were personal connections, including friends (37%) and family members (37%). Other sources of information with more than 10% endorsement included the AEOP website (24%); school or university newsletter, email, or website (15%); and someone who works with the DoD (13%).

Table 26. How Students Learned about AEOP (n=182)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	23.6%	43
AEOP on Facebook, Twitter, Instagram, or other social media	3.8%	7
School or university newsletter, email, or website	14.8%	27
Past participant of program	44.5%	81
Friend	36.8%	67
Family Member	36.8%	67
Someone who works at the school or university I attend	8.8%	16
Someone who works with the program	4.4%	8
Someone who works with the DoD (Army, Navy, Air Force, etc.)	12.6%	23
Community group or program	4.9%	9
Choose Not to Report	0%	0

Mentors were also asked how they learned about AEOP (see Table 27). The most commonly reported sources of information were past participation in GEMS (61%) and a family member (57%). More than a quarter of mentors also indicated that they learned about AEOP through someone who works with the DoD (30%); a friend (26%); and school/university communications (26%).

Table 27. How Mentors Learned About AEOP (n=23)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	17.4%	4
AEOP on Facebook, Twitter, Instagram, or other social media	8.7%	2
School or university newsletter, email, or website	26.1%	6
Past participant of program	60.9%	14
Friend	26.1%	6
Family Member	56.5%	13
Someone who works at the school or university I attend	13.0%	3
Someone who works with the program	21.7%	5
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	30.4%	7
Community group or program	8.7%	2
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 shows student responses to an evaluation survey item asking them to select factors that motivated them to participate in GEMS. A large majority of students reported that the learning opportunities, their interest in STEM, and having fun motivated their participation. Three-quarters or more of students cited an interest in STEM (91%), the desire to learn something new or interesting (89%), and the opportunity to learn in ways not possible in school (75%) as motivators. Three-quarters of students (76%) also reported that the opportunity to have fun motivated them to participate in GEMS.

Student focus group participants were also asked to share their reasons for choosing to participate in GEMS. Students offered a variety of motivations for participating. Some noted that they had previously participated and enjoyed the experience, and others reported being motivated by the opportunity to try something new, learn about STEM topics, have fun, meet new people, and explore careers and interests. As one student said,

> *"It's a great opportunity for kids that don't know what [they want] to do, but they're interested in something [STEM-related]."* (GEMS Student)

Table 28. Factors Motivating Student Participation in GEMS (n=182)

	Response Percent	Response Total
Teacher or professor encouragement	17.6%	32
An academic requirement or school grade	<1%	1
Desire to learn something new or interesting	89.0%	162
The mentor(s)	12.1%	22
Building college application or résumé	45.6%	83
Networking opportunities	32.4%	59
Interest in science, technology, engineering, or mathematics (STEM)	90.7%	165
Interest in STEM careers with the Army	39.6%	72
Having fun	75.8%	138
Earning stipends or awards for doing STEM	31.9%	58
Opportunity to do something with friends	37.4%	68
Opportunity to use advanced laboratory technology	68.1%	124
Desire to expand laboratory or research skills	62.6%	114
Learning in ways that are not possible in school	75.3%	137
Serving the community or country	35.2%	64
Exploring a unique work environment	57.7%	105
Figuring out education or career goals	61.0%	111
Seeing how school learning applies to real life	48.4%	88
Recommendations of past participants	26.9%	49
Choose Not to Report	0.0%	0

Previous Program Participation & Future Interest

Table 29 shows students' self-reported previous program participation. Slightly more than half (55%) indicated being past GEMS participants. Smaller proportions reported having participated in Camp Invention (7%), JSS (2%), eCM (2%), and JSHS (<1%). Approximately a quarter (24%) indicated they had participated in other STEM programs in the past.

Table 29. Student Past Participation in AEOP Programs (n=182)

	Response Percent	Response Total

Camp Invention	7.1%	13
eCYBERMISSION	1.6%	3
Junior Solar Sprint (JSS)	2.2%	4
Gains in the Education of Mathematics and Science	54.9%	100
UNITE	0%	0
Junior Science & Humanities Symposium (JSHS)	<1%	1
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	35.2%	64
Other STEM Program	24.2%	44

Mentors were asked which of the AEOPs they explicitly discussed with their students during GEMS (Table 30). All mentors reported discussing GEMS (100%) and a large majority discussed GEMS NPMs (89%) with their students. Approximately half of mentors (52%) reported discussing AEOPs generally with students but without reference to any specific program.

Table 30. Mentors Explicitly Discussing AEOPs with Students (n=27)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	100.0%	0.0%	
	27	0	**27**
UNITE	3.7%	96.3%	
	1	26	**27**
Junior Science & Humanities Symposium (JSHS)	11.1%	88.9%	
	3	24	**27**
eCYBERMISSION	5	22	**27**
	22.2%	77.8%	
Science & Engineering Apprenticeship Program (SEAP)	18.5%	81.5%	
	5	22	**27**
Research & Engineering Apprenticeship Program (REAP)	22.2%	77.8%	
	6	21	**27**
High School Apprenticeship Program (HSAP)	7.4%	92.6%	
	2	25	**27**
College Qualified Leaders (CQL)	11.1%	88.9%	
	3	24	**27**
GEMS Near Peer Mentor Program	88.9%	11.1%	
	24	3	**27**
Undergraduate Research Apprenticeship Program (URAP)	3.7%	96.3%	
	1	26	**27**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	11.1%	88.9%	
	3	24	**27**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	14.8%	85.2%	
	4	23	**27**
I discussed AEOP with my student(s) but did not discuss any specific program	48.1%	51.9%	
	13	14	**27**

Table 31 displays responses to an item asking students how interested they are in participating in other AEOPs in the future. With the exception of GEMS and GEMS NPM, a majority of students reported having never heard of each AEOP about which they were asked (58%-75%). Most students were, however, at least a little interested in participating in GEMS again (80%) and in GEMS NPM (57%), and relatively few (5%-9%) indicated having no interest in participating in other AEOPs.

Table 31. Student Interest in Future AEOP Programs (n=1,755 -1,777)

	I've never heard of this program	Not at all	A little	Very much	Response Total
Camp Invention	59.0%	8.6%	19.2%	13.1%	
	1,044	152	340	232	**1,768**
eCYBERMISSION	69.0%	7.4%	13.5%	10.0%	
	1,227	132	240	178	**1,777**
Junior Solar Sprint (JSS)	64.1%	8.5%	15.1%	12.2%	
	1,120	149	264	214	**1,747**
Gains in the Education of Mathematics and Science (GEMS)	15.8%	4.6%	18.5%	61.1%	
	277	80	324	1,069	**1,750**
UNITE	74.6%	5.6%	10.9%	9.0%	
	1,316	98	193	158	**1,765**
Junior Science & Humanities Symposium (JSHS)	70.2%	5.9%	13.0%	10.9%	
	1,239	105	230	192	**1,766**
Science & Engineering Apprenticeship Program (SEAP)	59.9%	4.8%	15.5%	19.8%	
	1,064	85	276	352	**1,777**
Research & Engineering Apprenticeship Program (REAP)	63.1%	5.5%	14.6%	16.9%	
	1,118	98	258	299	**1,773**
High School Apprenticeship Program (HSAP)	65.1%	5.2%	12.6%	17.0%	
	1,154	93	223	302	**1,772**
College Qualified Leaders (CQL)	68.3%	6.1%	11.5%	14.1%	
	1,209	108	204	249	**1,770**
GEMS Near Peer Mentor Program	35.8%	7.3%	22.4%	34.5%	
	630	128	394	606	**1,758**

Undergraduate Research Apprenticeship Program (URAP)	68.1%	6.4%	12.0%	13.5%	
	1,196	112	211	238	**1,757**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	57.6%	4.9%	12.8%	24.7%	
	1,018	86	227	436	**1,767**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	66.6%	5.2%	13.1%	15.0%	
	1,169	92	230	264	**1,755**

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 summarizes longitudinal trends of these data (2016 - 2019). Similar to past years, in 2019 nearly all students (96%) reported learning about at least one STEM job/career, and slightly more than half (52%) reported learning about five or more. A slightly smaller number of students (85%) reported learning about at least one DoD STEM job/career and 25% reported learning about five or more DoD STEM careers.

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)**	**2019 (n=1,802)**	**2016 (n=1,102)**	**2017 (n=2,029)**	**2018 (n=1,806)**	**2019 (n=1,789)**
None	3%	3%	4%	4%	16%	19%	11%	15%
1	5%	4%	4%	5%	14%	10%	9%	16%
2	11%	8%	11%	10%	19%	16%	16%	18%
3	12%	15%	16%	16%	18%	17%	18%	18%
4	10%	12%	13%	13%	8%	10%	12%	8%
5 or more	59%	58%	52%	52%	25%	28%	35%	25%

Students participating in focus groups at all sites indicated that they had learned about STEM careers during GEMS. In regard to DoD STEM careers specifically, focus group participants at two sites reported learning about DoD STEM careers to some extent during their GEMS experiences. In particular, they noted that being at a DoD site, their mentors, speakers, and career videos had exposed them to DoD STEM careers. Students in the third focus group who were participating in a GEMS program hosted at a high school, indicated that they had not been exposed to STEM careers specifically within the DoD.

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 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 (83%-86%) agreed or strongly agreed with each statement, suggesting that they have positive opinions about DoD researchers and research after their GEMS experiences.

Table 33. Student Opinions about DoD Researchers and Research (n=1,722 – 1,733)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.6%	0.5%	14.3%	37.5%	45.8%	
	10	9	251	658	805	**1,733**
DoD researchers develop new, cutting edge technologies	0.5%	0.6%	15.2%	36.9%	45.6%	
	8	11	265	645	797	**1,726**
DoD researchers solve real-world problems	0.5%	0.4%	11.8%	31.9%	54.1%	
	9	7	207	557	945	**1,725**
DoD research is valuable to society	0.4%	0.7%	13.8%	31.0%	52.9%	
	7	12	241	540	922	**1,722**

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. As such, students were asked about changes in their likelihood of engaging in STEM outside of required school activities as a result of their GEMS experience (Table 34). More than half of students (54%-70%) reported being more likely or much more likely to engage in each activity except for watching or reading non-fiction STEM (43%). Approximately two-thirds or more of students reported an increase in likelihood that they would participate in the following activities after GEMS: participating in a STEM camp, club, or competition (61%); working on a STEM project/ experiment in a university/professional setting (65%); and talking with friends or family about STEM (65%).

In an analysis of a composite created from these Likelihood to Engage in STEM Activities items[15] no significant differences by overall U2 classification or individual demographics were found.

[15] The Cronbach's alpha reliability for these Likelihood to Engage items was 0.913.

Table 34. **Change in Likelihood Students Will Engage in STEM Activities Outside of School (n=1,711-1,738)**

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	6.4%	5.0%	45.2%	27.9%	15.5%	
	111	87	786	485	269	**1,738**
Play with a mechanical or electrical device	3.1%	3.4%	30.4%	33.2%	29.6%	
	54	59	529	578	515	**1,735**
Work on solving mathematical or scientific puzzles	3.7%	4.5%	38.3%	29.5%	24.0%	
	64	79	667	515	418	**1,743**
Use a computer to design or program something	4.3%	4.6%	36.6%	28.4%	26.1%	
	74	80	635	492	452	**1,733**
Talk with friends or family about STEM	3.6%	3.2%	28.1%	31.9%	33.2%	
	62	55	484	550	573	**1,724**
Mentor or teach other students about STEM	4.4%	5.0%	30.3%	31.5%	28.6%	
	77	86	524	545	495	**1,727**
Help with a community service project related to STEM	4.2%	3.8%	31.4%	35.0%	25.6%	
	73	65	542	603	442	**1,725**
Participate in a STEM camp, club, or competition	3.0%	4.0%	23.0%	34.3%	35.7%	
	52	69	395	590	615	**1,721**
Take an elective (not required) STEM class	4.5%	4.3%	30.1%	28.9%	32.2%	
	77	74	515	494	551	**1,711**
Work on a STEM project or experiment in a university or professional setting	3.7%	4.1%	27.7%	31.5%	33.0%	
	64	70	475	540	565	**1,714**

Students were also asked to consider their educational aspirations after participating in GEMS (Table 35). Nearly all students (94%) reported wanting to at least finish college (get a Bachelor's degree), and over half (56%) noted a desire to continue their education after college.

Table 35. Student Education Aspirations After GEMS (n=1,684)

	Response Percent	Response Total
Graduate from high school	1.8%	30
Go to a trade or vocational school	<1%	14
Go to college for a little while	3.4%	58
Finish college (get a Bachelor's degree)	37.6%	633
Get more education after college	56.4%	949

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). More than half of mentors (56%-92%) reported each resource was at least somewhat useful for exposing students to AEOPs with the exceptions of AEOP on social media (26%) and the AEOP brochure (44%). Participation in GEMS was most frequently rated as at least somewhat useful (93%), along with GEMS program administrators or site coordinators (85%).

Table 36. Usefulness of Resources for Exposing Students to AEOPs (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	29.6%	7.4%	7.4%	7.4%	48.1%	
	8	2	2	2	13	**27**
AEOP on Facebook, Twitter, Pinterest or other social media	48.1%	11.1%	14.8%	7.4%	18.5%	
	13	3	4	2	5	**27**
AEOP brochure	33.3%	3.7%	18.5%	11.1%	33.3%	
	9	1	5	3	9	**27**
GEMS Program Administrator or Site Coordinator	11.1%	0.0%	3.7%	18.5%	66.7%	
	3	0	1	5	18	**27**
Invited speakers or "career" events	11.1%	0.0%	11.1%	18.5%	59.3%	
	3	0	3	5	16	**27**
Participation in GEMS	3.7%	3.7%	0.0%	7.4%	85.2%	
	1	1	0	2	23	**27**

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 (85%) and the GEMS program administrator/site coordinator (85%) as at least somewhat useful for this purpose. Large proportions of mentors (82%) also indicated that invited speakers were useful. On the other hand, AEOP materials were reported as less useful with a third or more mentors (33%-48%) reporting not having experienced them.

Mentors participating in two of the focus groups indicated that their students were exposed to DoD STEM careers in GEMS, primarily from being on site at an Army lab, from information the mentors provided, from career videos, and/or from speakers. These mentors suggested that this information could be enhanced by providing program activities that explicitly connect to jobs in the DoD. One mentor, an Army S&E. said,

> *"Showing [GEMS students] that you can be part of the Department of Defense, and not be in a uniform, and still serve in a way that's meaningful and impactful is really cool. I don't think they realize that exists."* (GEMS Mentor)

NPMs participating in a focus group at a GEMS program hosted at a high school had less to say about how students had been exposed to DoD STEM careers in GEMS. They indicated that these connections had not been explicitly made, although students had participated in a video simulation of a war zone and had visited a Veterans Administration hospital training center. These NPMs suggested that bringing in speakers and taking participants on DoD-related field trips could provide information about DoD STEM careers more effectively.

Table 37. Usefulness of Resources for Exposing Student to DoD STEM Careers (n=27)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	37.0%	14.8%	11.1%	3.7%	33.3%	
	10	4	3	1	9	**27**
AEOP on Facebook, Twitter, Pinterest or other social media	48.1%	18.5%	3.7%	14.8%	14.8%	
	13	5	1	4	4	**27**
AEOP brochure	33.3%	3.7%	18.5%	14.8%	29.6%	
	9	1	5	4	8	**27**
GEMS Program Administrator or Site Coordinator	7.4%	0.0%	7.4%	14.8%	70.4%	
	2	0	2	4	19	**27**
Invited speakers or "career" events	7.4%	7.4%	3.7%	7.4%	74.1%	
	2	2	1	2	20	**27**

Participation in GEMS	3.7%	7.4%	3.7%	11.1%	74.1%	
	1	2	1	3	20	**27**

Overall Impact

The final set of evaluation survey items were related to the overall impacts of participating in GEMS (Table 38). More than 60% of students (61%-90%) reported GEMS contributed to each area of impact. Areas in which students reported the greatest impact were their confidence in personal STEM knowledge, skills, and abilities (90%); their appreciation of DoD STEM research (82%); and their interest in participating in STEM activities outside of school requirements (82%).

These Overall Impact of GEMS items were combined into a composite variable[16] 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 FARMS status. Students reporting they did not receive free/reduced lunch reported significantly greater impact from participating in GEMS compared to students reporting to receive free/reduced lunch (small effect size, d=0.121).[17]

Table 38. **Student Opinions of GEMS Impacts (n=1,699 – 1,728)**

	Disagree - This did not happen	Disagree - This happened but not because of GEMS	Agree - GEMS contributed	Agree - GEMS was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	3.5%	6.3%	55.9%	34.3%	
	61	108	966	593	**1,728**
I am more interested in participating in STEM activities outside of school requirements	6.2%	11.9%	47.4%	34.4%	
	107	204	814	591	**1,716**
I am more aware of other Army (AEOP) programs	14.3%	8.3%	37.7%	39.6%	
	247	143	650	682	**1,722**
I am more interested in participating in other Army (AEOP) programs	16.4%	12.0%	36.9%	34.8%	
	280	205	631	596	**1,712**

[16] The Cronbach's alpha reliability for Overall GEMS Impact items was 0.904.

[17] Independent samples t-test for Overall GEMS Impact: School Location t(1,068)=1.98, p=.048.

I am more interested in taking STEM classes in school	7.6%	16.6%	45.9%	30.0%	
	130	285	789	515	**1,719**
I am more interested in earning a STEM degree	11.7%	17.9%	40.9%	29.5%	
	200	307	699	505	**1,711**
I am more interested in pursuing a career in STEM	11.7%	18.6%	40.4%	29.2%	
	200	317	690	499	**1,706**
I am more aware of Army or DoD STEM research and careers	11.2%	9.7%	38.8%	40.3%	
	190	165	659	685	**1,699**
I have a greater appreciation of Army or DoD STEM research	9.6%	8.4%	41.2%	40.8%	
	163	143	702	696	**1,704**
I am more interested in pursuing a STEM career with the Army or DoD	23.0%	15.6%	33.8%	27.7%	
	391	265	575	472	**1,703**

8 | Findings and Recommendations

Summary of Findings

The 2019 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. 2019 GEMS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
GEMS continues to receive applications from more students than it can accommodate and served fewer students than in 2018.	A total of 5,296 student applications were submitted to GEMS sites in 2019, a 4% decrease compared to the 5,500 applications received in 2018 and a 12% increase as compared to 2017 when 4,653 applications were submitted.
	In 2019, GEMS enrolled 2,985 students at 14 sites. This number represents a 12% decrease in enrollment compared to 2018 when 3,341 students were enrolled at 15 sites and a 5% increase over 2017 enrollment when 2,845 students participated in GEMS.
	GEMS served students at 14 sites in 2019, as compared to 15 in 2018 (The U.S. Army Combat Capabilities Development Command – Armaments Center in Picatinny, NJ did not host a GEMS program in 2019).
GEMS continued to reach students from populations historically underrepresented and underserved in STEM, and for most program outcomes measured, there was no difference between students who met the AEOP definition of U2 and non-U2 participants.	GEMS continued to engage students from populations historically underserved or underrepresented in STEM, although there has been a slight downward trend in participation of Black or African American students with 23% of students identifying themselves as Black or African American in 2019 as compared to 2018 (24%) and 2017 (26%). The proportion of students identifying themselves as Hispanic or Latino/a remained at 2018 levels (9% in both 2019 and 2018), a slight increase as compared to 2017 (7%). As in 2018 and 2017, nearly half of participants were female (47% in 2019, 2018, and 2017). A somewhat larger proportion

	of students (42%) met the AEOP definition of underserved in 2019 as compared to 2018 (35%).
	For all but one area measured, there were no significant differences between outcomes for students who met the AEOP definition of U2 and non-U2 participants, or for any of the demographic groups comprising U2 status. The one area in which a difference was detected was in student opinions of the overall impact of GEMS, with U2 students reporting greater impact (small effect size).
Most students reported engaging in all STEM practices during GEMS and reported being more engaged in STEM practices in GEMS than in school.	More than half of students (56%-99%) reported engaging in all STEM practices at least once during GEMS. Activities students engaged with frequently (most or every day) included working with others as part of a team (86%), using laboratory tools and steps to do an experiment (68%), and examining data to make a conclusion (64%).
	Students reported significantly greater engagement in STEM practices in GEMS as compared to in school (large effect size).
Students experienced gains in STEM knowledge during GEMS.	A large majority of students (88%-98%) reported learning at least "a little" in each area of STEM knowledge. A majority (60%-84%) reported that they "learned more than a little" or "learned a lot" in each area of STEM knowledge. For example, 84% reported learning at least "more than a little" about new knowledge of a STEM topic, and 79% reported this level of learning about how scientists and engineers work on real problems in STEM.
Students experienced gains in their STEM competencies or skills during GEMS.	Two-thirds or more of students (66%-89%) reported learning at least a little on all STEM competencies. Areas where students indicated they learned the most (more than a little or a lot) were how to use knowledge and creativity to come up with a solution (73%), how to ask questions that could be answered with experiments (62%), and how to design steps for an experiment that work (61%).
Students experienced gains in their 21st Century skills during GEMS.	Nearly half or more of students (48%-74%) reported that they learned more than a little or a lot in all 21st Century skills except for how to create social media (22%) and how to analyze media (37%). Items for which at least two-thirds of students indicated learning at this level were how to think about how systems work and how parts interact with each other (74%); how to work creatively with others (71%); how to use their creative ideas to make something (71%); and how to work with others effectively (70%).
Students reported that participating in GEMS positively impacted their STEM identities - their interest in and feelings of capability about STEM.	After participating in GEMS, between 70% and 87% of students either somewhat agreed or agreed with each statement related to the impact of GEMs on their STEM identities. GEMS impacted 80% or more of students in the following areas: interest in a new STEM topic (80%), feeling more prepared for more challenging STEM activities (85%), and feeling like they accomplished something in STEM (87%).

Priority #2: ***Support and empower educators with unique Army research and technology resources.***	
Mentors reported using a range of mentoring strategies with students.	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 (85%-100%) with the exception of selecting readings/activities that relate to students' backgrounds (48%) • Strategies to support the diverse needs of students as learners (52%-100%) • Strategies to support students' development of collaboration and interpersonal skills (89%-100%) • Strategies to support student engagement in authentic STEM activities (70% -100%) with the exception of having students search for and review technical literature to support their work (37%) • Strategies to support students' STEM educational and career pathways (52%-96%%) with the exception of helping students with their resume, application, personal statement, and/or interview preparation (44%).
Most students expressed high levels of satisfaction with their GEMS experiences and cited various benefits of participating; students had a variety of suggestions for program improvement.	More than half of students (56%-86%) indicated they were at least somewhat satisfied with all program features. Program features with which the most students reported satisfaction at the somewhat or very much satisfied levels were the teaching/mentoring provided during GEMS (86%) and STEM topics included in GEMS (86%).
	Students were overwhelmingly positive in their comments about their satisfaction in a sample of responses to open-ended questions. All respondents made positive comments. These comments focused on the topics and materials available to them, students' relationship with their mentors or NPMs, the real-world relevance of their learning, increases in interest or motivation for STEM, the career information they received, making friends, having fun, and appreciation for the stipend.
	Among the various benefits of GEMS mentioned by students in open-ended responses, the most frequently mentioned benefits were the career information they gained, the STEM learning they experienced, the STEM skills they gained, and the hands-on activities in GEMS. Around a quarter of respondents also cited teamwork as a benefit of GEMS
	Students made a wide variety of suggestions for program improvement. The most frequently suggested improvements were providing more topics, offering a longer program, and providing more hands-on activities.
Mentors reported satisfaction with GEMS features and noted a number of strengths of GEMS. Mentors also made	GEMS mentors reported being somewhat or very much satisfied with all program features (74%-100%). Aspects of the GEMS program all mentors reported being at least somewhat satisfied with were the application/registration process (100%), support for instruction or

suggestions for program improvement.	mentorship during program activities (100%), and communicating with GEMS organizers/site coordinators (100%).
	All mentors responding to open-ended questions made positive comments about their satisfaction with GEMS, attributing their satisfaction to the value of students' learning, the program resources, exposure to STEM topics, and the DoD and career information students receive. In addition, NPMs noted that they valued the networking opportunities and their own learning in the program
	The program strengths most frequently cited by GEMS mentors regarding students were students' exposure to STEM, the research experience they gained, and program features (e.g., organization, communication, staff, the budget, and the flexibility of the program). Mentors also cited benefits to themselves, including going "back to basics" and having fun with science as well as the challenge of creating activities that are interesting to students. NPMs cited learning about careers, developing life skills such as patience and communication, and the satisfaction of the feeling of making a difference as benefits they experienced from participating in GEMS.
	Mentors suggested a range of program improvements. The most frequently mentioned improvements were related to content, such as providing more or different hands-on activities and more interactive content or less lecturing. Other suggestions included providing better training and communication about safety and procedures for staff.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students who provided information about how they learned about AEOP primarily cited past participation and personal connections; mentors reported similar sources of information.	In addition to past participation in the program (45%), the most frequently reported sources of information about GEMS were personal connections, including friends (37%) and family members (37%).
	The most commonly reported sources of information about AEOP for mentors were past participation in GEMS (61%) and a family member (57%). More than a quarter of mentors also indicated that they learned about AEOP through someone who works with the DoD (30%), a friend (26%), and school/university communications (26%).
Students reported being motivated to participate in GEMS primarily by the learning opportunities, their interest in STEM, and the opportunity to have fun.	Three-quarters or more of students cited interest in STEM (91%), the desire to learn something new or interesting (89%), the opportunity to learn in ways not possible in school (75%), and having fun (76%) as motivators for participating in GEMS.

Few students had participated in any AEOP other than GEMS and most had not heard of other AEOPs; few mentors discussed specific AEOPs other than GEMS and GEMS NPMs with students.	Slightly more than half (55%) of the respondents who provided information about their past AEOP participation (n=182) indicated having participated in GEMS previously. Only very small proportions reported having participated in programs such as Camp Invention (7%), JSS (2%), eCM (2%), and JSHS (<1%). Approximately a quarter (24%) indicated they had participated in other STEM programs in the past.
	A majority of students reported having never heard of each AEOP about which they were asked (58%-75%). Most students were, however, at least a little interested in participating in GEMS again (80%) and in GEMS NPM (57%), and few (5%-9%) indicated having no interest in participating in other AEOPs.
	All mentors reported discussing GEMS (100%) and a large majority GEMS NPMs (89%) with their students. Approximately half of mentors (52%) 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.	More than half of mentors (56%-92%) reported that all resources were at least somewhat useful for exposing students to AEOPs with the exceptions of AEOP on social media (26%) and the AEOP brochure (44%). Participation in GEMS was most frequently rated as at least somewhat useful (93%), along with GEMS program administrators or site coordinators (85%).
	Nearly half of mentors (48%) had not experienced AEOP on social media and a third (33%) had not experienced the AEOP brochure.
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, and slightly more than half (52%) reported learning about five or more. A slightly smaller number of students (85%) reported learning about at least one DoD STEM job/career and 25% reported learning about five or more DoD STEM careers.
	Students participating in focus group reported learning about DoD STEM careers primarily from being at a DoD site, their mentors, speakers, and career videos.
Mentors reported that GEMS participation, administrative staff , and speakers 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 (85%), the GEMS program administrator/site coordinator (85%), and invited speakers (82%) as at least somewhat useful for exposing students to DoD STEM careers.
	AEOP materials were reported as less useful, with a third or more of mentors reporting not having experienced resources such as AEOP on social media (48%), the AEOP website (37%) and the AEOP brochure (33%).
	Mentors participating in focus groups suggested using speakers, explicitly connecting activities to DoD careers, and incorporating DoD-related field trips into GEMS as means for exposing students to DoD STEM careers.

Students had positive perceptions of DoD researchers and research after participating in GEMS.	Large majorities of students (83%-86%) agreed or strongly agreed with each statement about DoD researchers and research, suggesting that they have positive opinions about DoD researchers and research.
Students reported being more likely to engage in STEM activities after participating in GEMS.	More than half of students (54%-70%) reported being more likely or much more likely to engage in each activity except for watching or reading non-fiction STEM (43%) after participating in GEMS. Areas with approximately two-thirds or more of students reporting an increase in likelihood of participation after GEMS were: participating in a STEM camp, club, or competition (61%); working on a STEM project/ experiment in a university/professional setting (65%); and talking with friends or family about STEM (65%).
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 (56%) 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 and interest, their appreciation for STEM research, and their interest in STEM careers; students who met the AEOP definition of U2 reported greater impacts than non-U2 students.	Most students (61%-90%) reported that GEMS contributed to each area of impact about which they were asked. Areas in which students reported the greatest impact were their confidence in personal STEM knowledge, skills, and abilities (90%); their appreciation of DoD STEM research (82%); and their interest in participating in STEM activities outside of school requirements (82%).
	Students who met the AEOP definition of U2 reported significantly greater impacts than non-U2 students (small effect size) on STEM learning and interest.

Recommendations for FY20 Program Improvement/Growth

Evaluation findings indicate that FY19 was a very successful year for the GEMS program, including growing the percentage of underserved students who participated in the program by 7% to 42% overall, compared to 2018. Additionally, GEMS participants (over 80 percent) reported growth in their STEM knowledge after participating in the program. 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 FY20 and beyond.

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

GEMS experienced a decrease in both applications (4%) and participation (12%) in FY19. Part of this decline can be attributed to having one less site (14) than in FY18. Given the significantly high demand for participation in the GEMS program, it is recommended that NSTA actively seek out potential new labs to host GEMS sites in the future as possible.

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

In FY19, GEMS students provided suggestions to improve the program that were the same as in FY18. Students suggested that the program could be improved with more student choice, hands-on activities, and more challenging content. However, in FY19, mentors also echoed the same suggestions – indicating a need to reduce the amount of lecturing and make the content of GEMS more interactive with more or different hands on activities for students. Therefore, it is recommended that NSTA conduct an examination of GEMS curricula used across sites and determine if it is possible to integrate 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

As in FY17 and FY18, many students (58%-75%) had not heard of other AEOPs. Further, more than half of mentors (52%) reported discussing AEOPs generally, but not with reference to any specific program. This means that 48% of mentors 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.