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ARMY EDUCATIONAL OUTREACH PROGRAM

eCYBERMISSION

2018 Annual Program Evaluation Report

Evalutation Findings

September 2019

aeop ARMY EDUCATIONAL OUTREACH PROGRAM

eCybermission ACCEPT THE CHALLENGE

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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.

This report documents the evaluation of one of the AEOP elements, the eCYBERMISSION program (eCM), which is administered on behalf of the Army by the National Science Teachers Association (NSTA). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

eCM is sponsored by the U.S. Army and managed by the National Science Teachers Association (NSTA). Since the program's inception in 2002, nearly 200,000 students from across the United States, U.S. territories, and Department of Defense Educational Activities (DoDEA) schools worldwide have participated in eCM. The program is a web-based STEM competition designed to engage sixth- to ninth-grade students in real-world problem solving through Mission Challenges that address local community needs through the use of either scientific practices or the engineering design process. eCM teams work collaboratively to research and implement their projects, which are documented and judged via the submission of Mission Folders hosted on the eCM website. Regional winners receive an expense-paid trip to the National Judging & Educational Event (NJ&EE) in Washington, D.C.

In FY18, the five eCM regional sites registered 20,004 students, a 6% decrease from the 21,277 students who participated in FY17 and a 3% decrease from the 20,607 students who participated in FY16 (Table 1).

Table 1. 2018 eCM State-Level Participation

State/DoDEA/ Territories	No. of Participants	State/DoDEA/ Territories	No. of Participants
AE-E	59	**NH**	6
AK	4	**NJ**	1454
AL	182	**NM**	23
AP	258	**NV**	280
AR	150	**NY**	550
AZ	647	**OH**	626
CA	1594	**OK**	28
CO	494	**OR**	69
CT	112	**PA**	1043
DC	113	**PR**	4
DE	13	**RI**	1
FL	4473	**SC**	145
GA	1330	**SD**	86
GU	124	**TN**	390

HI	258	**TX**	757
IA	91	**UT**	281
ID	1	**VA**	536
IL	234	**VT**	93
IN	154	**WA**	272
KS	57	**WI**	400
KY	10	**WV**	269
LA	117	**WY**	22
MA	174	**INTER**	7
MD	184		
ME	52	**Total Participation**	**20004**
MI	681		
MN	186		
MO	448		
MS	167		
MT	39		
NC	204		
ND	24		
NE	27		

Table 2 summarizes demographic information for students who competed at regional competitions and for those who competed at the NJ&EE. As in FY17, 51% of regional participants were female and 49% were male. Slightly less than half (45%) of regional students identified themselves as White (48% in FY17) with another 18% identifying themselves as Hispanic or Latino/a (19% in FY17). While 8% of students chose not to report their race/ethnicity, 13% identified themselves as Black or African American (10% in FY17) and 9% as Asian (10% in FY17). As in FY17, Native American students comprised less than

1% of the students reporting their race/ethnicity, and less than 1% were Native Hawaiian or Pacific Islanders. Slightly over half of students met the AEOP definition of underserved.[1]

Over half of the 78 national finalists for whom data are available were female (62%). Over half of NJ&EE participants (52%) were Asian, while 33% were White, 4% were Hispanic or Latino/a, and 3% were Black or African American (in FY17, 47% White, 30% Asian, 5% Hispanic or Latino/a, and 4% Black or African American). Data for eCM Team Advisors by type of school location they are from is included in Table 3.

Table 2. 2018 eCM Student Profile

Demographic Category	Overall Participants (n=19,860)		eCM-NJ&EE Participants (n=78)	
Participant Gender				
Female	10,060	51%	48	62%
Male	9,800	49%	30	38%
Participant Race/Ethnicity				
Asian	1,790	9%	40	52%
Black or African American	2,635	13%	2	3%
Hispanic or Latino	3,577	18%	3	4%
Native American or Alaska Native	142	<1%	1	1%
Native Hawaiian or Other Pacific Islander	132	<1%	0	0%

[1] AEOP's definition of underserved (U2) includes **at least two** of the following: Underserved populations include low-income students (FARMS); students belonging to race and ethnic minorities that are historically underrepresented in STEM (HUR) (i.e., Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders); students with disabilities (ADA); students with English as a second language (ELLs); first-generation college students (1stGEN); students in rural, frontier, or other federal targeted outreach schools (GEO); and females in certain STEM fields (Gender) (e.g., physical science, computer science, mathematics, or engineering).

White	8,940	45%	26	33%
Other race or ethnicity (self-reported, some more than 1 race)	1,052	5%	1	1%
Choose not to report	1,592	8%	5	6%
Participant Grade Level				
6th	5,560	28%	16	20%
7th	5,760	29%	24	30%
8th	6,355	32%	19	25%
9th	2,185	11%	19	25%
Participant Eligible for Free/Reduced-Price				
Yes	5,598	28%	8	10%
No	10,272	52%	62	80%
Choose not to report	3,990	20%	8	10%
English is a first language				
Yes	16,311	82%	66	85%
No	2,531	13%	12	15%
Choose not to report	1,018	5%	0	0%
One parent/guardian graduated from college				
Yes	14,891	75%	75	96%

No	2,588	13%	2	1%
Choose not to report	2,381	12%	1	3%
School Location				
Urban	6,691	34%	21	27%
Suburban	9,586	48%	44	56%
Rural	1,360	7%	6	8%
DoDEA	423	2%	1	1%
Frontier/Tribal School	23	<1%	0	0%
Home School	62	<1%	1	1%
Online School	27	<1%	0	0%
Choose not to report	1,688	9%	5	7%
Underserved/Underrepresented Status				
Yes	10,248	52%	25	32%
No	9,612	48%	53	68%

Table 3. 2018 eCM Team Advisor Participation by School Location

School Location Type	No. of total Participants
Team Advisors from DoDEA	14
Team Advisors from Home School	6
Team Advisors from Online School	2
Team Advisors Rural	133
Team Advisors Suburban	349
Team Advisors Urban	339
Choose not to report	26
No responses	0
Total	**869**

The total cost of the 2018 eCM program was $3,189,980, including $785,674 provided in mini-grants and savings bonds. The average cost per student participant for 2018 eCM was $159 (Table 4).

Table 4. 2018 eCM Program Costs	
2018 eCM – Summative Cost Breakdown	
Administrative/Overhead & Indirect	$1,436,761
Travel, Conference & Outreach	$386,091
National Event	$351,811
Mini-grants and Savings Bonds	$785,674
Other Operational Costs	$133,859
Travel Costs – Paid for S&E's	$47,892
Total Cost	$3,189,980
Cost per Student Participant	$159

4 | Evaluation At-A-Glance

Purdue University, in collaboration with NSTA, conducted a comprehensive evaluation of eCM. The Unite logic model below presents a summary of the expected outputs and outcomes for NSTA in relation to the AEOP and eCM-specific priorities. This logic model provided guidance for the overall eCM evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)

• NSTA providing oversight for all aspects of the competition • Students participating in state, regional and national levels competitions • STEM professionals and educators serving as Team Advisors, judges, CyberGuides, and Ambassadors • Awards for student competitors and teams. All students who submit a mission folder also receive recognition. • Centralized branding and comprehensive marketing • Centralized evaluation		• Students conduct "authentic" STEM and humanities research, often with Team Advisors • Students recognize the real-life applications of STEM • Teams of three or four students ask questions or define problems and then construct explanations or design solutions based on identified problems in their community • Team Advisors oversee the student led projects • STEM professionals judge the top 60 teams during the regional judging • Regional winners advance to the NJ&EE • 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 programs • Number and diversity of STEM professionals and educators serving as Team Advisors, CyberGuides, and Ambassadors • Number and diversity of DoD scientists and engineers and other military personnel engaged in programs • Number and Title 1 status of schools served through participant engagement • Students, Team Advisors, and NSTA contributing to evaluation		• Increased participant knowledge, skills and abilities, and confidence in STEM • Increased student interest in future STEM engagement • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in DoD STEM research and careers • Implementation of evidence-based recommendations to improve eCM regional and national programs	• Increased student participation in other AEOP and DoD-sponsored 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 DoD STEM careers • Continuous improvement and sustainability of eCM

The eCM evaluation gathered information from multiple participant groups about eCM 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 eCM program objectives.

The assessment strategy for eCM included student and Team Advisor questionnaires, two focus groups with eCM students at the NJ&EE, one focus group with Team Advisors at the NJ&EE, observations at the NJ&EE, and the Annual Program Report (APR) prepared by NSTA. Findings are reported herein for students who competed at the regional level (referred to as Regional students, eCM-R students, or overall students, since all participants competed at this level) and for students who competed at the NJ&EE (referred to as National students, eCM-N students or NJ&EE students). Tables 5-9 outline the information collected in student and Team Advisor questionnaires and focus groups as well as information from the APR that is relevant to this evaluation report.

Key Evaluation Questions

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

Table 5. 2018 Student Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Student Experience:** In-school vs. In-program experience
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, 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 AEOP, impact of AEOP resources
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies (students respond to a subset)
	Comprehensive Marketing Strategy: 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. 2018 Mentor Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of HSAP, satisfaction with and suggestions for improving HSAP programs, benefits to participants
AEOP Goal 1	**Capturing the Student Experience:** In-program experience
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	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 AEOP in changing student AEOP metrics
	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 AEOP in changing student Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: how mentors learn about AEOP, usefulness 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 7. 2018Student Focus Group Interviews	
Category	**Description**
Satisfaction & Suggestions	Awareness of HSAP, motivating factors for participation, awareness of implications of research topics, satisfaction with and suggestions for improving HSAP 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. 2018 Team Advisor Focus Group Interviews

Category	Description
Satisfaction & Suggestions	Perceived value of HSAP, benefits to participants suggestions for improving HSAP programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose apprentices 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 HSAP

Table 9. 2018 Annual Program Report	
Category	**Description**
Program	Description of symposia categories and activities
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 – Exposure to Army STEM research and careers (varies by regional, national event); Participation of Army engineers and/or Army research facilities in event activities (varies by regional, national event)
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

The eCM Evaluation included examination of participant outcomes and other areas that would inform program continuous improvement. A focus of the evaluation is on efforts toward the long-term goal of eCM and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. Thus, it is important to consider how eCM is marketed and ultimately recruits student participants, the factors that motivate students to participate in eCM, 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.[2] STEM competencies are necessary for a 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 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 eCM 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.

Also included is an evaluation of the Next Generation STEM Teaching Project (NGSTP), a teacher professional development program that targeted eCM teachers in 2018 as part of a pilot program to expand teachers' capacity in STEM content and practices.This program was funded by the National Defense Education Program. The funding for this program is not included in program costs. A description of the NGSTP, the evaluation study sample, and findings from the evaluation are included within the section of this report that contains findings related to AEOP Priority #2, STEM Savvy Educators, that articulates the goal of supporting and empowering educators with unique Army research and technology resources.

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

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

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

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

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

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

21st Century Skills Assessment instrument is provided in Appendix F, and the NGSTP interview protocol is provided in Appendix G. Major trends in data and analyses are reported herein.

Study Sample

Questionnaire responses for the FY18 eCM evaluation included 686 regional eCM participants, 72 national students, and 274 Team Advisors. Table 10 shows the distribution of student respondents on the regional evaluation survey by site gathered from program registration data that could be linked to the evaluation questionnaire. Team Advisors indicated their region on the evaluation questionnaire (Table 11).

Table 10. Student Participation on Regional Questionnaire as a Percentage of Total Participants

State/DoDEA/ Territories	No. of Participants Overall	No. of Questionnaire Participants	State/DoDEA/ Territories	No. of Participants	No. of Questionnaire Participants
AE-E	59	0 (0%)	**NH**	6	0 (0%)
AK	4	0 (0%)	**NJ**	1454	1 (<1%)
AL	182	0 (0%)	**NM**	23	1 (<1%)
AP	258	4 (1%)	**NV**	280	2 (<1%)
AR	150	0 (0%)	**NY**	550	2 (<1%)
AZ	647	78 (21%)	**OH**	626	3 (1%)
CA	1594	114 (31%)	**OK**	28	1 (<1%)
CO	494	1 (<1%)	**OR**	69	1 (<1%)
CT	112	0 (0%)	**PA**	1043	29 (8%)
DC	113	0 (0%)	**PR**	4	0 (0%)
DE	13	0 (0%)	**RI**	1	0 (0%)
FL	4473	72 (19%)	**SC**	145	0 (0%)
GA	1330	0 (0%)	**SD**	86	0 (0%)
GU	124	0 (0%)	**TN**	390	0 (0%)
HI	258	9 (2%)	**TX**	757	7 (2%)

IA	91	0 (0%)	**UT**	281	4 (1%)
ID	1	0 (0%)	**VA**	536	7 (2%)
IL	234	3 (1%)	**VT**	93	0 (0%)
IN	154	4 (1%)	**WA**	272	2 (<1%)
KS	57	1(<1%)	**WI**	400	4 (1%)
KY	10	0 (0%)	**WV**	269	1 (<1%)
LA	117	0 (0%)	**WY**	22	0 (0%)
MA	174	0 (0%)	**INTER**	7	0 (0%)
MD	184	1 (<1%)			
ME	52	0 (0%)	**Total**	**20004**	**371 (2%)**
MI	681	3 (1%)			
MN	186	0 (0%)			
MO	448	10 (3%)			
MS	167	3 (1%)			
MT	39	0 (0%)			
NC	204	3 (1%)			
ND	24	0 (0%)			
NE	27	0 (0%)			

Table 11. Team Advisor Participation by Region on Questionnaire

eCM Region	Response Percent	Response Total
West	15.69 %	43
North Central	12.41 %	34

South Central	7.66 %	21
North East	25.55 %	70
South East	25.55 %	70
Not Sure	13.14 %	36

Table 12. 2018 eCM Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[3]
eCM-R Students	686	20,004	3.43%	±3.68%
eCM-N Students	72	78	92.31%	±3.22%
Team Advisors	274	869	31.53%	±4.90%

Table 12 provides an analysis of student and Team Advisor participation in the eCM 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 regional students, national students, and team advisors are within an acceptable range, suggesting that the samples are representative of the overall population.

[3] "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.

Focus groups were conducted at the NJ&EE in Washington, DC. The two student focus groups included 23 students in grades 6 to 9, including 7 males and 15 females. One adult focus group was also conducted at the NJ&EE, which included 23 adults, 15 of whom were female and 8 of whom were male. 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 eCM's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Participant Demographics

Demographic data for eCM FY18 participants who completed the evaluation questionnire are provided in Table 13. While there were nearly 700 eCM regional students who completed the questionnaire, gender information was only given by 374 students. Overall, approximately half of the students reported being female (51%) and half male (49%). Gender composition of respondents for eCM-NJ&EE was unevenly split, with two-thirds female (66%) and a third male (34%). As in past years, more eCM questionnaire participants identified with the race/ethnicity category of White (41%) than any other single category. However, a majority of responding participants at the NJ&EE level were Asian (51%) followed by White (29%). Hispanic or Latino populations substantially increased from FY17 to FY18 overall (11% and 24% respectively), and also at the NJ&EE level (FY17, 6%; FY18, 7%). More overall respondents were 9th graders (42%) compared to any other grade level. A majority of questionnaire respondents reported that they did not qualify for free or reduced-price lunch (FRL)—a common indicator of low-income status (57% overall and 81% of NJ&EE participants).

Survey respondents' overall demographic composition was somewhat different across variables as compared to the NJ&EE respondents. Specifically, there were more female respondents from NJ&EE (66%) compared to overall (51%). A substantially greater number of Asian students completed the NJ&EE (51%) questionnaire compared to overall respondents (12%), and there were fewer racial/ethnic minority students reporting for NJ&EE (4% Black or African American, 7% Hispanic or Latino) compared to overall (10% Black or African American, 24% Hispanic or Latino). In terms of grade level, few students from 6th grade responded at either level. More overall respondents were 9th graders (42%), and grade level distribution for NJ&EE respondents was evenly distributed with 25% each for grades 7, 8, and 9, and "other." Considerably fewer NJ&EE participants reported being FRL eligible (11%) compared to the overall questionnaire sample (36%). More students reported going to a suburban school than any other school location (NJ&EE=55%, Overall = 45%). Regardless of competition level, less than 10% of students reported that they would be first generation college students (NJ&EE=1%, Overall = 9%). According to AEOP, participants are considered to be belonging to an underrepresented population (U2) if they possess two of the following demographics: female, racial/ethnic minority, FARMS, ELL, college first

generation, or attend an urban/rural/frontier school. More overall participants (28%) were identified as U2 compared to NJ&EE (21%).

Table 13. 2018 eCM Student Respondent Profile				
Demographic Category	**eCM Questionnaire Respondents**		**eCM-NJ&EE Questionnaire Respondents**	
Respondent Gender (eCM n=374, eCM NJ&EE n=47)				
Female	191	51%	31	66%
Male	183	49%	16	34%
Choose Not to Report	0	0%	0	0%
Respondent Race/Ethnicity (eCM n=687, eCM NJ&EE n=72)				
Asian	82	12%	37	51%
Black or African American	70	10%	3	4%
Hispanic or Latino	168	24%	5	7%
Native American or Alaska Native	5	1%	1	1%
Native Hawaiian or other Pacific Islander	6	1%	0	0%
White	283	41%	21	29%
Other race or ethnicity (specify):†	39	6%	2	3%
Choose Not to Report	34	5%	3	4%
English Language Learners – ELL (eCM n=374, eCM NJ&EE n=47)				
Yes	48	13%	8	17%
No	318	85%	39	83%
Choose Not to Report	8	2%	0	0%
Respondent Grade Level Fall of Next School Year (eCM n = 687, eCM NJ&EE n=72)				
6th	13	2%	0	0%
7th	95	14%	18	25%
8th	200	29%	18	25%
9th	291	42%	18	25%
Other	88	13%	18	25%
Respondent Eligible for Free/Reduced-Price Lunch – FARMS (eCM n=687, eCM NJ&EE n=47)				
Yes	247	36%	5	11%
No	392	57%	38	81%
Choose Not to Report	48	7%	4	8%
Respondent School Location (eCM n=371, eCM NJ&EE n=47)				
Urban	157	42%	9	19%
Rural	5	1%	4	9%
Suburban	168	45%	26	55%
DoDEA	4	1%	2	4%
Home School	3	1%	0	0%
Online School	1	0%	0	0%

Choose Not to Report	33	9%	6	13%
Respondent First Generation College (eCM n=687, eCM NJ&EE n=72)				
Yes	61	9%	1	1%
No	277	40%	45	63%
Choose Not to Report	349	51%	26	36%
AEOP Defined Underrepresented – U2 (eCM n=687, eCM NJ&EE n=72)				
Yes	193	28%	15	21%
No	174	25%	32	44%
Not Enough Information	320	47%	25	35%

† Other = Asian and White; mixed: black and white; Mixed (3); White, Asian, African American; Asian Indian; African American and White; Filipino; Arab; Asian and Hispanic; Haitian, French and Turkish; Italian, Filipino; Caucasian, Indian; White/European; Black, Mexicano; Multiracial; Cocasian/Asian; Indian and Greek; Indian-American; Mexican American

Team Advisor Demographics

Adult /Team Advisor respondent demographic information is summarized in Table 14. Similar to FY17, 70% of FY18 responding Team Advisors were male in comparison to female (28%). Most of the responding Team Advisors identified themselves as White (65%) and as teachers (85%). Many adult respondents indicated that they held more than one role in eCM, with Team Advisor being the most frequently selected (89%), followed by Teacher (32%), and Research Mentor (3%).

Table 14. 2018 eCM Adult Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n=274)		
Female	77	28%
Male	193	70%
Choose not to report	4	2%
Respondent Race/Ethnicity (n=274)		
Asian	24	9%
Black or African American	32	12%
Hispanic or Latino	15	5%
Native American or Alaska Native	1	<1%
Native Hawaiian or other Pacific Islander	2	1%
White	179	65%
Other race or ethnicity, (specify):†	3	1%
Choose not to report	18	7%
Respondent Occupation (n=274)		
Teacher	232	85%
Other school staff	6	2%
University educator	2	1%

Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	1	<1%
Scientist, Engineer, or Mathematics professional	14	5%
Other, (specify):‡	19	7%
Respondent Role in eCM (n=274)*		
Research Mentor	9	3%
Team advisor	245	89%
Teacher	87	32%
Other, (specify)§	8	3%

*Note: Some adults selected more than one option for this response, resulting in than 100% response rate for this item.

‡ No responses provided.

5 | Priority #1 Findings

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

Assessed Growth in Skills – 21st Century Findings

A new component of the evaluation in FY18 for eCM was a pilot of the 21st Century Skills Assessment (Johnson & Sondergeld, 2016) for a small sample of eCM mini-grant awardees. Mentors assessed each participant in a pre/post manner. The first assessment was completed in the first days of the program (pre), and the second assessment was completed at the end of the program (post). The assessment was used to determine the growth toward mastery for each participant during their time in the eCM program. Mentors rated each participants' skills in six domains of 21st Century Skills: The assessment tool can be found in the Appendix.

1. Creativity and Innovation
2. Critical Thinking and Problem Solving

3. Communication, Collaboration, Social, and Cross-Cultural Skills
4. Information, Media, & Technological Literacy
5. Flexibility, Adaptability, Initiative, and Self-Direction
6. Productivity, Accountability, Leadership, and Responsibility

Mentors were asked in the pilot to assess their student participants in each of the domains that they felt applied to the work students had completed with them over the course of the program. As a result, between 200 and 261 eCM students were assessed for the 24 skills related to each of the six areas. Table 15 presents an overall summary of the findings for each of the six domains of 21st Century Skills. These are presented graphically in Figure 1. Table 15 presents findings for each of the 24 specific skills associated with the six areas of 21st Century Skills.

There were significant increases in participants' observed skills from the beginning (pre-) to the end (post-) of their eCM experiences ($p<.001$) for all six assessed domains of 21st Century Skills (see Table 16). Participants experienced similarly large growth across skill areas. On average, participants' initial ratings were approximately at the Progressing level while their final, post-eCM, ratings were at the approaching Demonstrates Mastery level (2.50 or higher).

Table 15. Overall 21st Century Skill Set Observation Pre-Post Findings

Skill Set	*n*	Observation Time		Pre-Post Change	*t*-stat
		Pre - *M*(*SD*)	Post - *M*(*SD*)		
Creativity & Innovation	261	1.97(.52)	2.58(.52)	+0.61	17.72***
Critical Thinking & Problem Solving	261	1.99(.47)	2.58(.51)	+0.59	18.26***
Communication, Collaboration, Social, & Cross-Cultural	261	2.05(.52)	2.64(.49)	+0.59	17.22***
Information, Media, & Technological Literacy	260	1.95(.52)	2.61(.51)	+0.66	20.07***
Flexibility, Adaptability, Initiative, & Self-Direction	261	2.02(.52)	2.67(.49)	+0.65	17.92***
Productivity, Accountability, Leadership, & Responsibility	261	1.99(.55)	2.61(.47)	+0.62	21.95***

Figure 1. 21st Century Skill Set Pre-Post Comparison with Criteria Indicators

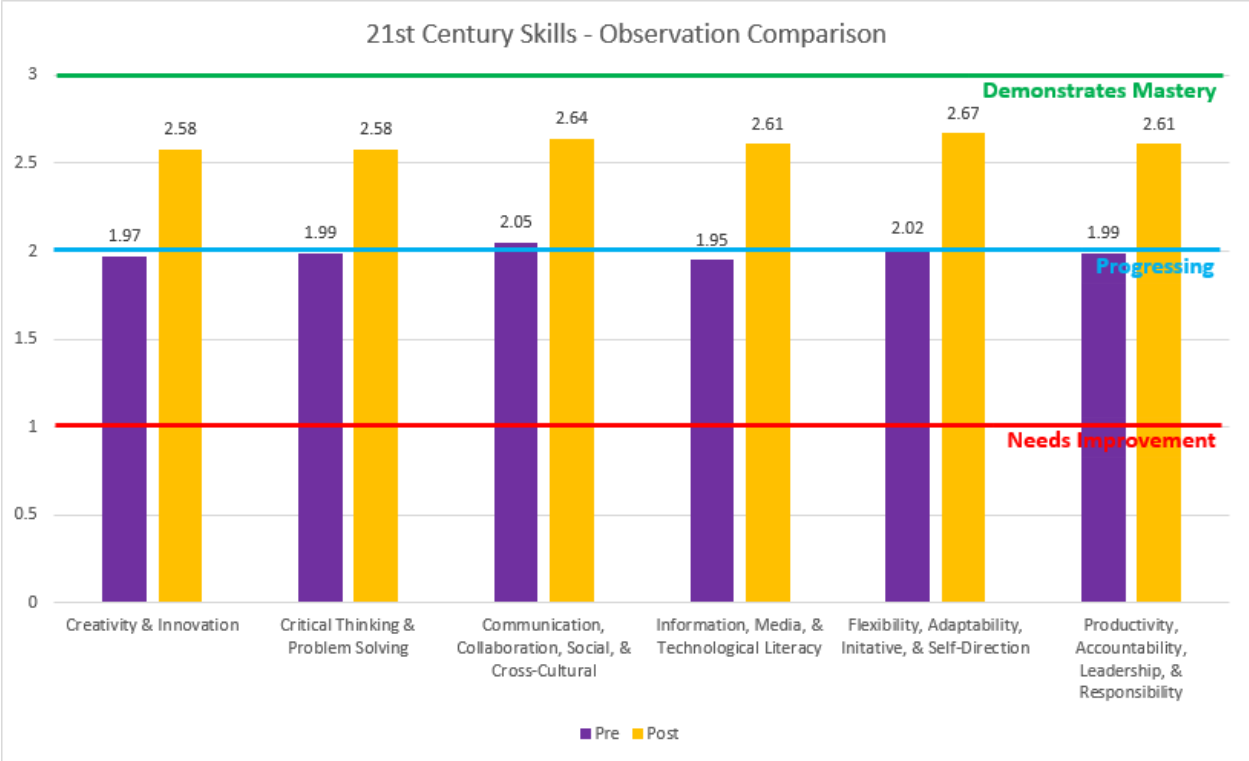


Table 16 displays findings for each of the 24 specific skills associated with the six domains of 21st Century Skills. Each of the 24 specific skills observed showed a statistically significant increase from pre- to post-ratings (p<.001). While participants improved in all 21st Century Skills over time, skills associated with the Information, Media, and Technological Literacy domain as well as Flexibility, Adaptability, Initiative, and Self-Direction domain showed the largest average increases from pre- to post- observations.

Table 16. Overall 21st Century Skill Set Pre-Post Findings

Overall Skill Set *Item (Specific Skill Observed)*	*n*	Observation Time Pre - *M*(*SD*)	Observation Time Post - *M*(*SD*)	Pre-Post Change	*t*-stat
Creativity & Innovation					
Think creatively	260	1.92(.59)	2.61(.54)	+.69	16.73***
Work creatively with others	259	2.02(.60)	2.58(.59)	+.56	13.33***
Implement innovations	254	1.98(.57)	2.56(.56)	+.58	15.09***
Critical Thinking & Problem Solving					
Reason effectively	250	2.05(.55)	2.62(.53)	+.57	13.83***
Use systems thinking	254	1.96(.55)	2.53(.61)	+.57	14.80***
Make judgments and decisions	256	1.97(.56)	2.57(.57)	+.60	14.83***

Solve problems	251	1.98(.58)	2.59(.58)	+.61	14.69***
Communication, Collaboration, Social, & Cross-Cultural					
Communicate clearly	259	1.96(.57)	2.61(.57)	+.65	15.34***
Communicate with others	260	2.11(.60)	2.68(.52)	+.57	14.94***
Interact effectively with others	258	2.09(.59)	2.63(.57)	+.54	13.32***
Information, Media, & Technological Literacy					
Access and evaluate information	248	1.94(.60)	2.63(.56)	+.69	17.55***
Use and manage information	252	1.92(.60)	2.62(.56)	+.70	17.65***
Analyze media	228	1.95(.55)	2.60(.57)	+.65	16.66***
Create media products	200	2.01(.64)	2.67(.52)	+.66	13.81***
Apply technology effectively	246	2.03(.60)	2.69(.52)	+.66	15.46***
Flexibility, Adaptability, Initiative, & Self-Direction					
Adapt to change	257	1.98(.58)	2.70(.52)	+.72	19.70***
Be flexible	256	2.02(.58)	2.71(.51)	+.69	19.83***
Manage goals and time	255	2.00(.66)	2.63(.59)	+.63	15.51***
Work independently	256	2.07(.64)	2.68(.54)	+.61	14.76***
Be a self-directed learner	261	2.03(.63)	2.64(.56)	+.61	15.10***
Productivity, Accountability, Leadership, & Responsibility					
Manage projects	256	2.02(.65)	2.63(.58)	+.61	14.52***
Produce results	244	1.99(.62)	2.64(.55)	+.65	15.49***
Guide and lead others	257	1.89(.63)	2.54(.60)	+.65	15.06***
Be responsible to others	259	2.06(.63)	2.65(.57)	+.59	14.50***

NOTE. Statistical significance levels provided in table by asterisks with *p<.05, **p<.01, ***p<.001

STEM Practices

eCM actively seeks to engage students in practices associated with STEM research and innovation. STEM practices are ways that students "do STEM" by actively engaging in STEM research and with other STEM researchers. STEM practices include, for example, the extent to which students contribute their own ideas to research projects, use laboratory equipment and research techniques, analyze data, and work with professionals in STEM outside of their school settings. In order to understand how effectively eCM is engaging students in STEM research and innovation, the questionnaire included items in which participants were asked to report on the frequency with which they engaged in various STEM practices both in eCM and in their typical school experiences in STEM.

Students were asked how often they engaged in various STEM practices while in eCM. A majority of eCM national and regional respondents indicated they engaged with most STEM practices at least once

during eCM (Tables 17 & 18). Nearly all (90% or more) reported engaging in STEM practices such as analyzing data or information and drawing conclusions (eCM - 90%; NJ&EE - 99%); and working collaboratively as part of a team (eCM - 91%; NJ&EE - 100%). A large majority (80% or more) of regional eCM participants reported engaging in multiple STEM practices during eCM, including using laboratory procedures or tools (81%); solving real world problems (81%); designing and carrying out an investigation (83%); and identifying questions or problems to investigate (86%). Similar to FY17, Between 9% and 61% of regional eCM students reported that they had not engaged in individual STEM practices at all during eCM. Table 19 and 20 report data related to STEM practices for students in their school.

Table 17. STEM Practices During eCM for National Respondents (n=72)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project	27.8%	44.4%	16.7%	9.7%	1.4%	
	20	32	12	7	1	**72**
Work with a STEM researcher on a research project topic assigned by my teacher	30.6%	31.9%	22.2%	15.3%	0.0%	
	22	23	16	11	0	**72**
Design my own research or investigation based on my own question(s)	6.9%	30.6%	34.7%	23.6%	4.2%	
	5	22	25	17	3	**72**
Present my STEM research to a panel of judges from industry or the military	27.8%	59.7%	5.6%	5.6%	1.4%	
	20	43	4	4	1	**72**
Interact with STEM researchers	16.7%	34.7%	33.3%	8.3%	6.9%	
	12	25	24	6	5	**72**
Use laboratory procedures or tools	5.6%	26.4%	30.6%	25.0%	12.5%	
	4	19	22	18	9	**72**
Identify questions or problems to investigate	4.2%	18.1%	38.9%	20.8%	18.1%	
	3	13	28	15	13	**72**
Design and carry out an investigation	2.8%	26.4%	33.3%	22.2%	15.3%	
	2	19	24	16	11	**72**

Analyze data or information and draw conclusions	1.4%	22.2%	27.8%	31.9%	16.7%	
	1	16	20	23	12	**72**
Work collaboratively as part of a team	0.0%	9.7%	15.3%	26.4%	48.6%	
	0	7	11	19	35	**72**
Build or make a computer model	47.2%	26.4%	13.9%	9.7%	2.8%	
	34	19	10	7	2	**72**
Solve real world problems	9.7%	29.2%	23.6%	16.7%	20.8%	
	7	21	17	12	15	**72**

Table 18. STEM Practices During eCM for Regional Respondents (n=686)

	Not at all	**At least once**	**Monthly**	**Weekly**	**Every day**	**Response Total**
Work with a STEM researcher or company on a real world STEM research project	55.7%	28.4%	5.1%	7.9%	2.9%	
	382	195	35	54	20	**686**
Work with a STEM researcher on a research project topic assigned by my teacher	47.8%	31.3%	7.6%	9.8%	3.5%	
	328	215	52	67	24	**686**
Design my own research or investigation based on my own question(s)	20.8%	40.8%	15.3%	16.5%	6.6%	
	143	280	105	113	45	**686**
Present my STEM research to a panel of judges from industry or the military	60.5%	30.0%	4.7%	3.9%	0.9%	
	415	206	32	27	6	**686**
Interact with STEM researchers	52.2%	28.7%	9.0%	7.0%	3.1%	
	358	197	62	48	21	**686**
Use laboratory procedures or tools	19.1%	35.0%	21.9%	19.5%	4.5%	
	131	240	150	134	31	**686**
Identify questions or problems to investigate	14.0%	34.3%	16.9%	22.7%	12.1%	
	96	235	116	156	83	**686**
Design and carry out an investigation	17.3%	36.3%	19.4%	17.6%	9.3%	

	119	249	133	121	64	**686**
Analyze data or information and draw conclusions	9.9%	31.0%	18.8%	24.2%	16.0%	
	68	213	129	166	110	**686**
Work collaboratively as part of a team	8.6%	20.1%	12.1%	24.1%	35.1%	
	59	138	83	165	241	**686**
Build or make a computer model	56.0%	26.8%	7.9%	7.1%	2.2%	
	384	184	54	49	15	**686**
Solve real world problems	19.1%	35.7%	11.7%	15.5%	18.1%	
	131	245	80	106	124	**686**

Table 19. STEM Practices During School for eCM National Respondents (n=72)

	Not at all	**At least once**	**Monthly**	**Weekly**	**Every day**	**Response Total**
Work with a STEM researcher or company on a real world STEM research project	27.8%	31.9%	16.7%	15.3%	8.3%	
	20	23	12	11	6	**72**
Work with a STEM researcher on a research project topic assigned by my teacher	31.9%	27.8%	34.7%	4.2%	1.4%	
	23	20	25	3	1	**72**
Design my own research or investigation based on my own question(s)	11.1%	41.7%	27.8%	19.4%	0.0%	
	8	30	20	14	0	**72**
Present my STEM research to a panel of judges from industry or the military	44.4%	47.2%	6.9%	1.4%	0.0%	
	32	34	5	1	0	**72**
Interact with STEM researchers	23.6%	34.7%	29.2%	5.6%	6.9%	
	17	25	21	4	5	**72**
Use laboratory procedures and tools	6.9%	30.6%	34.7%	25.0%	2.8%	
	5	22	25	18	2	**72**
Design and carry out an investigation	4.2%	31.9%	40.3%	19.4%	4.2%	
	3	23	29	14	3	**72**

Analyze data or information and draw conclusions	1.4%	25.0%	33.3%	26.4%	13.9%	
	1	18	24	19	10	**72**
Work collaboratively as part of a team	2.8%	12.5%	12.5%	31.9%	40.3%	
	2	9	9	23	29	**72**
Build or make a computer model	45.8%	29.2%	16.7%	5.6%	2.8%	
	33	21	12	4	2	**72**
Solve real world problems	12.5%	37.5%	29.2%	5.6%	15.3%	
	9	27	21	4	11	**72**

Table 20. STEM Practices During School for eCM Regional Respondents (n=687)

	Not at all	**At least once**	**Monthly**	**Weekly**	**Every day**	**Response Total**
Work with a STEM researcher or company on a real world STEM research project	64.0%	22.9%	2.5%	8.4%	2.2%	
	440	157	17	58	15	**687**
Work with a STEM researcher on a research project topic assigned by my teacher	55.0%	28.2%	6.1%	8.3%	2.3%	
	378	194	42	57	16	**687**
Design my own research or investigation based on my own question(s)	29.3%	41.8%	13.1%	10.9%	4.9%	
	201	287	90	75	34	**687**
Present my STEM research to a panel of judges from industry or the military	77.4%	16.7%	1.7%	3.1%	1.0%	
	532	115	12	21	7	**687**
Interact with STEM researchers	61.9%	24.7%	4.9%	6.7%	1.7%	
	425	170	34	46	12	**687**
Use laboratory procedures and tools	22.7%	37.7%	23.4%	12.8%	3.3%	
	156	259	161	88	23	**687**
Design and carry out an investigation	24.7%	40.2%	18.0%	13.4%	3.6%	
	170	276	124	92	25	**687**

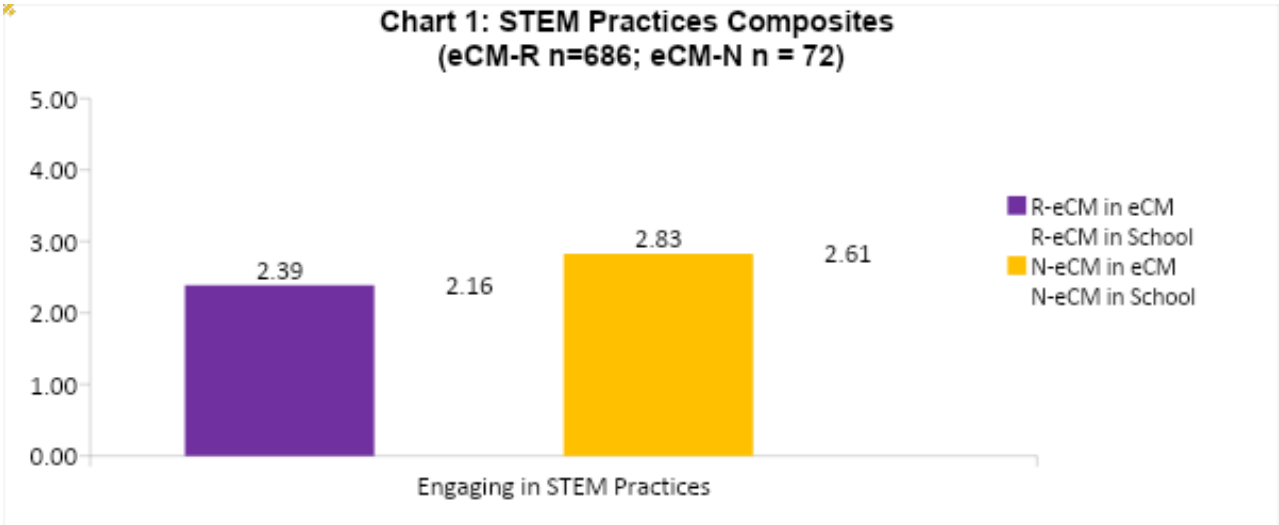
Analyze data or information and draw conclusions	14.0%	29.1%	22.1%	24.0%	10.8%	
	96	200	152	165	74	**687**
Work collaboratively as part of a team	10.6%	15.7%	17.6%	27.5%	28.5%	
	73	108	121	189	196	**687**
Build or make a computer model	60.6%	25.9%	7.7%	3.8%	2.0%	
	416	178	53	26	14	**687**
Solve real world problems	23.1%	34.5%	12.1%	14.1%	16.2%	
	159	237	83	97	111	**687**

For this set of items, a composite score was computed entitled "Engaging in STEM Practices in eCM."[4] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. The composite score was used to test whether there were differences in student experiences by completion level (national vs. regional), AEOP defined underrepresented status (U2), and all subgroups that make up U2 (gender, race/ethnic group, school location, FARMS, ELL, and college first generation). Significant group differences were found in terms of Engaging with STEM Practices in eCM for competition level, overall U2 status, FARMS, race/ethnicity, school location, and first generation for college. National competition level students reported significantly higher engagement in STEM practices in eCM than Regional level students[5] (small effect size of d = 0.324). Non-U2 students reported significantly higher levels as compared to U2 students[6] (small effect of d = 0.267 standard deviations). Non-minority students reported significantly higher levels as compared to minority students[7] (small effect of d = 0.269 standard deviations). Low-SES students reported significantly lower levels as compared to non-free/reduced lunch students[8] (small effect size of d = 0.2.99). Students attending schools in the suburbs reported significantly higher levels compared to urban/rural/frontier school students[9] (small effect size of d = 0.213). Students who had at least one parent attend college reported significantly higher levels compared to students who did not have a parent attend college[10] (small effect size of d = 0.2.38). No differences were found by gender or ELL status.

To evaluate how eCM STEM Practice experiences compared to their typical school STEM Practice experiences, students were asked how often they engaged in the same activities in school (Tables 18 and

[4] The Cronbach's alpha reliability for these 11 items was 0.896.
[5] Two-tailed independent samples t-test: $t(411) = 2.71$, $p = .007$.
[6] Two-tailed independent samples t-test: $t(386) = 2.64$, $p < 0.001$.
[7] Two-tailed independent samples t-test: $t(386) = 2.64$, $p = 0.009$.
[8] Two-tailed independent samples t-test: $t(365) = 2.86$, $p = .005$.
[9] Two-tailed independent samples t-test: $t(366) = 2.04$, $p = .042$.
[10] Two-tailed independent samples t-test: $t(381) = 2.32$, $p = .021$.

19). Regardless of competition level, students reported significantly greater Engagement with STEM in eCM than in school[11] (NJ&EE - high effect of d = 0.864 standard deviations; Regional - high effect of d = 0.817 standard deviations) (see Chart 1).



STEM Knowledge and Skills

To measure to what extent students build STEM knowledge and skills while engaging in in eCM activities, the questionnaire asked participants to report on gains in knowledge and specific skills related to STEM. A large majority (nearly 80% or more) of eCM and NJ&EE students indicated they experienced some degree of STEM knowledge gain as a result of participating in eCM (Tables 21 and 22). A consistent pattern was identified across items, with NJ&EE students reported greater gains than regional students. For example, more than half of the NJ&EE questionnaire respondents reported large gains across the STEM knowledge items, and only 17%-26% of overall eCM respondents indicated the same level of gains. STEM knowledge items with the greatest group differences (40% points or more) in student-reported large gains were in depth knowledge of a STEM topic (eCM - 17%; NJ&EE - 60%); knowledge of research processes, ethics, and rules for conduct in STEM (eCM - 22%; NJ&EE - 64%); and knowledge of research conducted in a STEM topic or field (eCM - 21%; NJ&EE - 63%).

Table 21. eCM--NJ&EE Participant Reports of Impact on STEM Knowledge (n=72)

	No gain	Small gain	Medium gain	Large gain	Response Total

[11] Two-tailed dependent samples t-tests - Regional: $t(71) = 3.64$, $p < 0.001$; National: $t(685) = 10.71$, $p < 0.001$.

In depth knowledge of a STEM topic(s)	0.0%	2.8%	37.5%	59.7%	
	0	2	27	43	**72**
Knowledge of research conducted in a STEM topic or field	0.0%	2.8%	34.7%	62.5%	
	0	2	25	45	**72**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	5.6%	30.6%	63.9%	
	0	4	22	46	**72**
Knowledge of how scientists and engineers work on real problems in STEM	0.0%	4.2%	36.1%	59.7%	
	0	3	26	43	**72**
Knowledge of what everyday research work is like in STEM	2.8%	2.8%	38.9%	55.6%	
	2	2	28	40	**72**

Table 22. eCM-Overall Participant Reports of Impact on STEM Knowledge (n=686)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
In depth knowledge of a STEM topic(s)	18.2%	27.3%	37.5%	17.1%	
	125	187	257	117	**686**
Knowledge of research conducted in a STEM topic or field	16.9%	25.8%	36.2%	21.1%	
	116	177	248	145	**686**
Knowledge of research processes, ethics, and rules for conduct in STEM	17.8%	25.5%	34.3%	22.4%	
	122	175	235	154	**686**
Knowledge of how scientists and engineers work on real problems in STEM	18.2%	22.9%	33.1%	25.8%	
	125	157	227	177	**686**
Knowledge of what everyday research work is like in STEM	21.7%	25.5%	30.2%	22.6%	
	149	175	207	155	**686**

STEM Knowledge student questionnaire items were combined into a composite variable[12] to assess differences between subgroups of students. Students competing at the NJ&EE level reported significantly higher STEM Knowledge gains than regional level students[13] (medium effect size of d = 0.659). Many significant differences in STEM Knowledge gains were found by demographics. Significant differences in STEM Knowledge were found by overall U2 status[14] (small effect size of d = 0.310) with non-U2 students reporting higher gains than U2 students. STEM Knowledge differences were found by race/ethnicity[15] (small effect size of d = 0.451) with non-minority students reporting significantly higher gains than minority students. For FARMS, Low-SES students reported significantly lower STEM Knowledge gains compared to regular-SES students[16] (small effect size of d = 0.439). Females reported significantly lower STEM Knowledge gains compared to males[17] (small effect size of d = 0.202). In termes of college first generation students, those with a parent who had attended college reported significantly higher STEM Knowledge gains compared to students who did not have a parent attend college[18] (small effect size of d = 0.413). No differences in STEM Knowledge were found by ELL status or school location.

The impact of eCM on student STEM competencies are summarized in Tables 23 and 24. Regardless of competition level, more than half of the responding participants reported medium or large gains on all STEM competency items with the exception of regional eCM students with regards to using computer models of objects or systems to test cause and effect relationships (only 38% reported medium or large gains). Across items, NJ&EE students reported higher gains than regional students. Items with the largest group differences in reported medium or large gains (35% points or more) are the following: defending an argument that conveys how an explanation best describes an observation (eCM - 54%; NJ&EE - 92%); using computer models of objects or systems to test cause and effect relationships (eCM - 38%; NJ&EE - 74%); and supporting an argument that conveys how an explanation best describes an observation (eCM - 61%; NJ&EE - 96%).

A composite score was calculated for gains in STEM Competencies.[19] This composite was used to test if the eCM program had differential impacts depending on student group membership. Students competing at the NJ&EE reported significantly higher gains in their STEM competencies compared to regional students[20] (large effect size of d = 0.585). There was no overall U2 difference for STEM Competencies. However, there were significant differences by college first generation status and FARMS. Students who had a parent attend college reported significantly higher gains in STEM Competencies than

[12] The Cronbach's alpha reliability for these 5 items was 0.924.
[13] Two-tailed independent samples t-test: $t(756) = 9.06$, $p < .0001$.
[14] Two-tailed independent samples t-test: $t(411) = 3.14$, $p = .002$.
[15] Two-tailed independent samples t-test: $t(386) = 4.43$, $p < .001$.
[16] Two-tailed independent samples t-test: $t(365) = 4.20$, $p < .001$.
[17] Two-tailed independent samples t-test: $t(411) = 205$, $p = .041$.
[18] Two-tailed independent samples t-test: $t(381) = 4.03$, $p < .001$.
[19] The STEM Competencies composite (11 items) has a Cronbach's alpha reliability of 0.936.
[20] Two-tailed independent samples t-test: $t(756) = 8.04$, $p < .001$.

students who did not have a parent who attended college[21] (small effect size of d = 0.270). Low-SES students reported significantly lower gains in STEM competencies than regular SES students[22] (small effect size of d = 0.322). No significant differences were found in terms of STEM Competencies depending on gender, ELL status, race/ethnicity, or school location.

Table 23. eCM-NJ&EE Participant Gains in their STEM Competencies – Science and Engineering Practices (n=72)

	No gain	Small gain	Medium gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	4.2%	8.3%	40.3%	47.2%	
	3	6	29	34	**72**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	1.4%	8.3%	36.1%	54.2%	
	1	6	26	39	**72**
Making a model of an object or system showing its parts and how they work	4.2%	8.3%	26.4%	61.1%	
	3	6	19	44	**72**
Carrying out procedures for an experiment and recording data accurately	2.8%	6.9%	27.8%	62.5%	
	2	5	20	45	**72**
Using computer models of objects or systems to test cause and effect relationships	11.1%	15.3%	33.3%	40.3%	
	8	11	24	29	**72**
Organizing data in charts or graphs to find patterns and relationships	6.9%	11.1%	22.2%	59.7%	
	5	8	16	43	**72**
Considering different interpretations of data when deciding how the data answer a question	4.2%	12.5%	36.1%	47.2%	
	3	9	26	34	**72**

[21] Two-tailed independent samples t-test: $t(365) = 2.58$, $p = .010$.
[22] Two-tailed independent samples t-test: $t(381) = 3.14$, $p = .002$.

Supporting an explanation for an observation with data from experiments	1.4%	2.8%	40.3%	55.6%	
	1	2	29	40	**72**
Defending an argument that conveys how an explanation best describes an observation	1.4%	6.9%	34.7%	56.9%	
	1	5	25	41	**72**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	4.2%	11.1%	23.6%	61.1%	
	3	8	17	44	**72**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	2.8%	6.9%	30.6%	59.7%	
	2	5	22	43	**72**

Table 24. eCM Overall Participant Gains in their STEM Competencies – Science and Engineering Practices (n=686)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
Asking a question that can be answered with one or more scientific experiments	13.7%	28.0%	37.6%	20.7%	
	94	192	258	142	**686**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	12.4%	23.6%	38.8%	25.2%	
	85	162	266	173	**686**
Making a model of an object or system showing its parts and how they work	20.4%	23.5%	31.5%	24.6%	
	140	161	216	169	**686**
Carrying out procedures for an experiment and recording data accurately	13.4%	22.9%	35.4%	28.3%	
	92	157	243	194	**686**
Using computer models of objects or systems to test cause and effect relationships	36.7%	25.2%	23.9%	14.1%	
	252	173	164	97	**686**
Organizing data in charts or graphs to find patterns and relationships	14.3%	28.4%	31.9%	25.4%	
	98	195	219	174	**686**

Considering different interpretations of data when deciding how the data answer a question	16.3%	28.7%	35.7%	19.2%	
	112	197	245	132	**686**
Supporting an explanation for an observation with data from experiments	15.3%	24.1%	33.5%	27.1%	
	105	165	230	186	**686**
Defending an argument that conveys how an explanation best describes an observation	19.2%	26.8%	30.8%	23.2%	
	132	184	211	159	**686**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	20.1%	27.0%	33.4%	19.5%	
	138	185	229	134	**686**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	14.9%	24.3%	33.2%	27.6%	
	102	167	228	189	**686**

Students were also asked about the impact of eCM on their 21st Century Skills. Regardless of competition level, students reported substantial gains for items assessing their perceived knowledge, skills, and habits that are considered critical for success in the 21st century workplace. Similar to FY17, nearly 90% or more of NJ&EE participants reported medium or large gains on all 21st Century Skills items (Table 25). Again, fewer regional eCM respondents reported medium or large gains (between 62% and 73%) across 21st Century Skills items (Table 26). Since reported gains were quite high for both groups, there was less of a gap between group responses (average 20% point difference). Items with the largest difference (20% points or more) in reported medium or large gains were working well with students from all backgrounds (eCM - 68%; NJ&EE - 93%); viewing failure as an opportunity to learn (eCM - 62%; NJ&EE - 85%); and sticking with a task until it is finished (eCM - 69%; NJ&EE - 90%).

Table 25. eCM-NJ&EE Participant Reports of Impacts on 21st Century Skills (n=72)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
Sticking with a task until it is finished	4.2%	5.6%	33.3%	56.9%	
	3	4	24	41	**72**

Making changes when things do not go as planned	1.4%	6.9%	29.2%	62.5%	
	1	5	21	45	**72**
Working well with students from all backgrounds	1.4%	5.6%	34.7%	58.3%	
	1	4	25	42	**72**
Including others' perspectives when making decisions	2.8%	6.9%	26.4%	63.9%	
	2	5	19	46	**72**
Communicating effectively with others	1.4%	9.7%	31.9%	56.9%	
	1	7	23	41	**72**
Viewing failure as an opportunity to learn	8.3%	6.9%	27.8%	56.9%	
	6	5	20	41	**72**

Table 26. eCM Overall Participant Reports of Impacts on 21st Century Skills (n=686)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
Sticking with a task until it is finished	11.8%	19.2%	32.4%	36.6%	
	81	132	222	251	**686**
Making changes when things do not go as planned	9.6%	17.3%	34.4%	38.6%	
	66	119	236	265	**686**
Working well with students from all backgrounds	13.3%	18.5%	34.3%	34.0%	
	91	127	235	233	**686**
Including others' perspectives when making decisions	10.1%	19.0%	34.7%	36.3%	
	69	130	238	249	**686**
Communicating effectively with others	10.3%	18.2%	31.9%	39.5%	
	71	125	219	271	**686**
Viewing failure as an opportunity to learn	16.6%	21.0%	27.3%	35.1%	
	114	144	187	241	**686**

A 21st Century composite variable[23] was computed to test for differences between student subgroups. Significant differences were found by competition level[24] (NJ&EE greater gains; small effect size of d =

[23] The 21st Century Skills composite (6 items) had a Cronbach's alpha reliability of .912.
[24] Two-tailed independent samples t-test: $t(756) = 5.10$, $p < .001$.

0.371). College first generation status was the only demographic variable with significant differences[25] (first generation students lower gains; very small effect size of d = 0.226). Statistical differences were not found between groups in terms of 21st Century Skills by overall U2 status, gender, race/ethnicity, school location, FARMS, or ELL status.

STEM Identity and Confidence

A series of items intended to measure the impact of eCM on students' STEM identities were also asked on the student questionnaire. Because students are unlikely to pursue STEM if they do not see themselves as capable of succeeding in STEM[26], deepening students' STEM knowledge and skills is important for increasing the likelihood that they will pursue STEM education and/or careers. The impact of eCM on participants' STEM identities varied greatly by competition level (Tables 27 and 28). Nearly all NJ&EE students (more than 90%) indicated at least some gain as a result of eCM, and regional eCM students reported an average of slightly more than two-thirds (68%) for the same. While approximately three-quarters or more of NJ&EE students reported medium to large gains in their STEM identity and confidence, regional eCM students selected response options that were spread across the answer continuum (no gain – large gain). For example, items with large gaps (45% points or more) in medium to large gain responses between groups were desire to build relationships with mentors who work in STEM (eCM - 38%; NJ&EE - 88%); interest in a new STEM topic (eCM - 43%; NJ&EE - 89%); and connecting a STEM topic or field to personal values (eCM - 43%; NJ&EE - 88%).

Table 27. eCM-NJ&EE Participant Reports on Impacts on STEM Identity (n=72)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	4.2%	6.9%	31.9%	56.9%	
	3	5	23	41	**72**
Deciding on a path to pursue a STEM career	6.9%	20.8%	34.7%	37.5%	
	5	15	25	27	**72**
Sense of accomplishing something in STEM	1.4%	5.6%	25.0%	68.1%	
	1	4	18	49	**72**

[25] Two-tailed independent samples t-test: $t(381) = 2.21$, $p = .028$.

[26] 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.

Feeling prepared for more challenging STEM activities	0.0%	9.7%	22.2%	68.1%	
	0	7	16	49	**72**
Thinking creatively about a STEM project or activity	1.4%	5.6%	29.2%	63.9%	
	1	4	21	46	**72**
Desire to build relationships with mentors who work in STEM	2.8%	9.7%	31.9%	55.6%	
	2	7	23	40	**72**
Connecting a STEM topic or field to my personal values	4.2%	8.3%	33.3%	54.2%	
	3	6	24	39	**72**

Table 28. eCM Overall Participant Reports on Impacts on STEM Identity (n=686)

	No gain	**Small gain**	**Medium gain**	**Large gain**	**Response Total**
Interest in a new STEM topic	34.5%	22.6%	26.2%	16.6%	
	237	155	180	114	**686**
Deciding on a path to pursue a STEM career	41.3%	26.4%	20.8%	11.5%	
	283	181	143	79	**686**
Sense of accomplishing something in STEM	24.3%	25.2%	28.0%	22.4%	
	167	173	192	154	**686**
Feeling prepared for more challenging STEM activities	23.2%	23.0%	32.1%	21.7%	
	159	158	220	149	**686**
Thinking creatively about a STEM project or activity	23.3%	24.3%	27.4%	24.9%	
	160	167	188	171	**686**
Desire to build relationships with mentors who work in STEM	37.6%	24.5%	23.5%	14.4%	
	258	168	161	99	**686**
Connecting a STEM topic or field to my personal values	33.7%	23.8%	24.5%	18.1%	
	231	163	168	124	**686**

STEM Identity items[27] were used to generate a composite score to assess whether the eCM program had differential impacts on subgroups of students. Students competing at the NJ&EE reported significantly higher STEM Identity gains than regional students[28] (large effect size of d = 0.719). Overall U2 status differences were not found in terms of STEM Identity. There were, however, significant differences found by FARMS and college first generation status. Low-SES students reported less gains than regular SES students[29] (small effect size of d = 259). Students who had a parent attend college reported greater gains than students who did not have a parent attdne college[30] (small effect size of d = 0.306). No significant differences were found by gender, race/ethnicity, school location, or ELL status for gains in STEM Identity.

[27] The Cronbach's alpha reliability for these 7 STEM Identity items was 0.943.
[28] Two-tailed independent samples t-test: $t(756) = 9.89$, $p < .001$.
[29] Two-tailed independent samples t-test: $t(365) = 2.47$, $p = .014$.
[30] Two-tailed independent samples t-test: $t(381) = 2.99$, $p = .003$.

6 | Priority #2 Findings

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

Mentor Strategies and Support

Team Advisors and other adults play a critical role in the eCM program. Adults/Team Advisors provide one-on-one support to students, chaperone students, advise students on educational and career paths, may provide opportunities for students to use laboratory space and/or equipment, and generally serve as STEM role models for eCM students. Adults were asked whether or not they used a number of strategies when working with students. These strategies comprised five main areas of effective team advising: [31]

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.

Adults were asked about their use of multiple strategies related to effective team advising. Tables 29-33 display eCM adult responses and show that the majority of adults reported using various effective mentoring strategies in their team advising.

A majority of eCM adults reported using used multiple strategies to establish the relevance of learning activities to students (Table 29). For example, nearly all adults (90% or more) reported giving students

[31] 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.

real-life problems to investigate or solve (90%); helping students understand how STEM can help them improve their own community (90%); and asking students to relate real-life events or activities to topics covered in eCM (91%). Selecting readings or activities that relate to students' backgrounds (60%) was the strategy used least often.

Table 29. Team Advisors Using Strategies to Establish the Relevance of Learning Activities (n=274)

	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 eCM experience	88.7%	11.3%	
	243	31	**274**
Giving students real-life problems to investigate or solve	90.1%	9.9%	
	247	27	**274**
Selecting readings or activities that relate to students' backgrounds	60.2%	39.8%	
	165	109	**274**
Encouraging students to suggest new readings, activities, or projects	85.0%	15.0%	
	233	41	**274**
Helping students become aware of the role(s) that STEM plays in their everyday lives	89.8%	10.2%	
	246	28	**274**
Helping students understand how STEM can help them improve their own community	90.1%	9.9%	
	247	27	**274**
Asking students to relate real-life events or activities to topics covered in eCYBERMISSION	91.2%	8.8%	
	250	24	**274**

More than half of eCM adult questionnaire respondents reported using all of the strategies to support the diverse needs of learners (Table 30). Using a variety of teaching and/or mentoring activities to meet the needs of all students (94%); and interacting with students and other personnel the same way regardless of their background (91%) were strategies used by nearly all adults. Highlighting under-representation of women and racial/ethnic minority populations in STEM and/or their contributions in STEM (54%) was the strategy used by the least number of eCM adults.

Table 30. Team Advisors Using Strategies to Support the Diverse Needs of Learners (n=274)

	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 eCM experience	77.0%	23.0%	
	211	63	**274**
Interact with students and other personnel the same way regardless of their background	90.9%	9.1%	
	249	25	**274**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	93.8%	6.2%	
	257	17	**274**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	71.5%	28.5%	
	196	78	**274**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	75.5%	24.5%	
	207	67	**274**
Directing students to other individuals or programs for additional support as needed	82.1%	17.9%	
	225	49	**274**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	54.0%	46.0%	
	148	126	**274**

Almost two-thirds or more of eCM adults reported using all strategies to support participant development of collaboration and interpersonal skills (Table 31). Two strategies reportedly used most often were having participants listen to the ideas of others with an open mind (96%); and having participants give and receive constructive feedback with others (91%). The least-used strategy for developing collaboration and interpersonal skills was having participants tell other people about their backgrounds and interests (63%).

Table 31. Team Advisors Using Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n=274)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having participant(s) tell other people about their backgrounds and interests	62.8%	37.2%	
	172	102	**274**
Having participant(s) explain difficult ideas to others	87.6%	12.4%	
	240	34	**274**
Having participant(s) listen to the ideas of others with an open mind	95.6%	4.4%	
	262	12	**274**
Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	86.5%	13.5%	
	237	37	**274**
Having participant(s) give and receive constructive feedback with others	90.9%	9.1%	
	249	25	**274**

Table 32 summarizes adult responses about use of strategies to support participant engagement in authentic STEM activities. Use of these strategies was widespread, with nearly three-quarters of eCM adults indicating they used each strategy. Strategies with the greatest use were allowing participants to work independently to improve their self-management abilities (96%); providing participants with constructive feedback to improve their STEM competencies (94%); and supervising participants while they practice STEM research skills (91%).

Table 32. Team Advisors Using Strategies to Support Participant Engagement in Authentic STEM Activities (n=274)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	72.6%	27.4%	
	199	75	**274**

Having participant(s) search for and review technical research to support their work	88.0%	12.0%	
	241	33	**274**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	79.9%	20.1%	
	219	55	**274**
Supervising participant(s) while they practice STEM research skills	90.5%	9.5%	
	248	26	**274**
Providing participant(s) with constructive feedback to improve their STEM competencies	94.2%	5.8%	
	258	16	**274**
Allowing participant(s) to work independently to improve their self-management abilities	95.6%	4.4%	
	262	12	**274**

Advising strategies used to support students' STEM educational and career pathways was the final group of items eCM adults were asked to respond to (Table 33). As in FY17, responses these strategies were used by fewer eCM adults than any of the other previous strategy sets. Only half of the items had 50% or more eCM adults reporting use. The two most frequently used strategies for supporting students' STEM educational and career pathways were providing guidance about educational pathways that will prepare participants for a STEM career (72%); and asking participants about their educational and/or career goals (71%).

While one goal of AEOP is to increase participants' awareness of DoD STEM career opportunities, only 37% of adult respondents indicated they discussed STEM career opportunities within the DoD or other government agencies with students. Similarly, another AEOP goal is to increase participants' awareness of AEOP opportunities, and again, only 37% of adults reported recommending other AEOPs that align with student goals. Although these are less than desirable responses, they represent slight increases from FY17.

Table 33. Team Advisors Using Strategies to Support Participant STEM Educational and Career Pathways (n=274)

	Yes - I used this strategy	**No - I did not use this strategy**	**Response Total**

Asking participant(s) about their educational and/or career goals	71.2%	28.8%	
	195	79	**274**
Recommending extracurricular programs that align with participants' goals	56.6%	43.4%	
	155	119	**274**
Recommending Army Educational Outreach Programs that align with participants' goals	37.2%	62.8%	
	102	172	**274**
Providing guidance about educational pathways that will prepare participant(s) for a STEM career	71.5%	28.5%	
	196	78	**274**
Discussing STEM career opportunities within the DoD or other government agencies	36.9%	63.1%	
	101	173	**274**
Discussing STEM career opportunities in private industry or academia	57.3%	42.7%	
	157	117	**274**
Discussing the economic, political, ethical, and/or social context of a STEM career	55.8%	44.2%	
	153	121	**274**
Recommending student and professional organizations in STEM to my student(s)	45.6%	54.4%	
	125	149	**274**
Helping participant(s) build a professional network in a STEM field	32.5%	67.5%	
	89	185	**274**
Helping participant(s) with their resume, application, personal statement, and/or interview preparations	33.2%	66.8%	
	91	183	**274**

Given the responses discussed above, it is not surprising that eCM advisors reported discussing very few AEOP programs explicitly with their students during the program other than eCM (89%) (Table 34). While very few team advisors reported discussing specific AEOPs with students (4%-13%), 36% indicated they discussed AEOP programs in general. Aside from eCM, the most commonly discussed AEOP with students was JSHS (13%).

Table 34. Team Advisors' Responses to AEOP Programs that were Explicitly Discussed with Participants (n=274)

	Yes - I discussed this program with my student(s)	No - I did not discuss this	Response Total

		program with my student(s)	
UNITE	6.9%	93.1%	
	19	255	**274**
Junior Science & Humanities Symposium (JSHS)	12.8%	87.2%	
	35	239	**274**
Science & Engineering Apprenticeship Program (SEAP)	8.8%	91.2%	
	24	250	**274**
Research & Engineering Apprenticeship Program (REAP)	8.8%	91.2%	
	24	250	**274**
High School Apprenticeship Program (HSAP)	7.7%	92.3%	
	21	253	**274**
College Qualified Leaders (CQL)	5.5%	94.5%	
	15	259	**274**
GEMS Near Peer Mentor Program	6.6%	93.4%	
	18	256	**274**
Undergraduate Research Apprenticeship Program (URAP)	6.2%	93.8%	
	17	257	**274**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	8.8%	91.2%	
	24	250	**274**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	4.4%	95.6%	
	12	262	**274**
I discussed AEOP with participant(s) but did not discuss any specific program	35.8%	64.2%	
	98	176	**274**
eCYBERMISSION	89.4%	10.6%	
	245	29	**274**

Program Features and Feedback/Satisfaction

Student satisfaction with eCM program features was assessed through a series of questionnaire items (Tables 35 and 36). As has been the dominant pattern, NJ&EE participants reported greater overall satisfaction compared to regional participants. Areas in which both national and regional participants reported being somewhat or very much satisfied were the submission process (eCM - 53%; NJ&EE - 90%); applying or registering for the program (eCM - 53%; NJ&EE - 88%); the eCM website (eCM - 62%; NJ&EE - 86%); and educational materials used during program activities (eCM - 56%; NJ&EE - 82%). Large numbers of both national and regional participants indicated not experiencing eCM features related to Cyber Guides, including live chat (eCM - 53%; NJ&EE - 35%); discussion forum (eCM - 41%; NJ&EE - 35%); and feedback (eCM - 42%; NJ&EE - 28%). Similarly large numbers of national and regional students indicated not experiencing eCM features related to Mission Control Communications, includinlg phone response time (eCM - 50%; NJ&EE - 38%) and email response time (eCM - 47%; NJ&EE - 33%).

Table 35. Student Satisfaction with eCM-N Program Features (n=72)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	5.6%	2.8%	4.2%	37.5%	50.0%	
	4	2	3	27	36	**72**
Submission process	1.4%	2.8%	5.6%	30.6%	59.7%	
	1	2	4	22	43	**72**
Value of Cyber Guide live chat	34.7%	4.2%	15.3%	20.8%	25.0%	
	25	3	11	15	18	**72**
Variety of STEM Mission Challenges available	11.1%	2.8%	8.3%	22.2%	55.6%	
	8	2	6	16	40	**72**
Value of Cyber Guides feedback	27.8%	4.2%	6.9%	20.8%	40.3%	
	20	3	5	15	29	**72**
Value of Cyber Guides discussion form	34.7%	4.2%	8.3%	23.6%	29.2%	
	25	3	6	17	21	**72**

Educational materials (e.g., online resources, etc.) used during program activities	9.7%	0.0%	8.3%	25.0%	56.9%	
	7	0	6	18	41	**72**
eCybermission website	2.8%	1.4%	9.7%	33.3%	52.8%	
	2	1	7	24	38	**72**
Mission control (phone) response time	37.5%	2.8%	8.3%	18.1%	33.3%	
	27	2	6	13	24	**72**
Mission control (email) response time	33.3%	1.4%	5.6%	22.2%	37.5%	
	24	1	4	16	27	**72**

Table 36. Student Satisfaction with eCM-R Program Features (n=686)

	Did not experience	**Not at all**	**A little**	**Somewhat**	**Very much**	**Response Total**
Applying or registering for the program	10.2%	12.5%	24.2%	28.6%	24.5%	
	70	86	166	196	168	**686**
Submission process	8.5%	14.6%	24.5%	27.3%	25.2%	
	58	100	168	187	173	**686**
Value of Cyber Guide live chat	53.1%	13.8%	13.0%	10.2%	9.9%	
	364	95	89	70	68	**686**
Variety of STEM Mission Challenges available	22.9%	13.1%	19.8%	22.9%	21.3%	
	157	90	136	157	146	**686**
Value of Cyber Guides feedback	41.5%	13.1%	17.1%	16.2%	12.1%	
	285	90	117	111	83	**686**
Value of Cyber Guides discussion form	41.3%	14.3%	17.3%	15.3%	11.8%	
	283	98	119	105	81	**686**
Educational materials (e.g., online resources, etc.) used during program activities	14.9%	9.5%	20.0%	24.9%	30.8%	
	102	65	137	171	211	**686**

eCybermission website	7.3%	11.4%	19.7%	26.2%	35.4%	
	50	78	135	180	243	**686**
Mission control (phone) response time	50.1%	13.8%	12.7%	11.8%	11.5%	
	344	95	87	81	79	**686**
Mission control (email) response time	47.1%	12.7%	14.3%	13.3%	12.7%	
	323	87	98	91	87	**686**

In order to understand more about students' satisfaction with their overall eCM experience, students who competed at the regional level and those who competed at the national level were asked to respond to an open-ended item on the questionnaire asking about their satisfaction with eCM. A sample of 100 regional student responses and was analyzed in addition to the 63 NJ&EE student responses received. Of the 100 eCM-R student responses, over three-quarters (81%) had something positive to say about the program, and all students competing at the NJ&EE had positive comments about the program. Many responses were simple affirmations of the student's experience in the program. For example, students said, "I love eCybermission," and "It was my first year and I plan to enter every year I can. Loved it!" Regional student participants who provided more specific responses wrote about the teamwork, real-world problem solving, and learning they experienced during eCM. Students competing at the NJ&EE focused on the opportunity to meet people, their learning about STEM and about STEM careers, and the real-world problem-solving skills they gained. For example,

> "I believe eCYBERMISSION was a great experience, not only helping me learn about STEM, but also making me a better team player, as well as helping me solve real world problems. I know more about the world around me, and can hopefully one day use my newfound knowledge to make something important." (eCM-R Student)
>
> "Overall, I thought that eCYBERMISSION was a great experience and benefited me in many ways. For example, I feel that eCYBERMISSION has taught me lessons such as to stick with something and persevere." (eCM-R Student)
>
> "I personally thought that the overall experiment and project was an amazing experience. I learned about other people's projects through the website and thought that they were very intriguing. I also thought that there were many opportunities to kids who don't have access to STEM or interacting with STEM researchers. I ended up learning how to stay organized and stay ahead more efficiently. Since my team's project was about eliminating algal growth from cavern pools, I got to learn about caves and even got to visit one. eCYBERMISSION helped me to learn something new and interact with others in many different ways. I definitely loved the experience and would most likely do it again." (eCM-R Student)

> "I love eCYBER because it helps me solve REAL problems in my community, helps me feel like I am giving back, and gets me into stem fields more than any science class at school ever would. I think it is incredible." (eCM-N Student)

> "I loved eCYBER so much! I made so many new friends that I will be able to stay in contact with! I was able to help others in the process! I loved the workout we did!" (eCM-N Student)

Of the 81 regional students who offered positive comments, 21 also offered caveats. These caveats were focused on the workload, stress, clarity of expectations, and the choices of project topics. The 5 NJ&EE participants who offered caveats focused on elements associated with the event, such as the schedule, the amount of freedom they had, and the stress of competition. For example,

> "My overall satisfaction with my eCYBERMISSION experience was ok. It wasn't boring but it also wasn't a lot of fun. It was stressful and confusing but, also really cool to build and model some things. I also really enjoyed the fact that we got to choose who we wanted in our team." (eCM-R Student)

> "This was a good way to involve students in STEM, and I did enjoy this project. I do wish it had been slightly clearer on the specifics of what we needed to do, but overall it was quite educational." (eCM-R Student)

> "eCYBERMISSION was very interesting and enjoyable. My favorite parts would probably be the ARMY labs since they were unique yet fun. The whole experience was good, but the schedule was very packed and I often got tired in the middle of the day. Also, I had an online school course I signed up for during summer, but I had no time to work on it. Additionally, my team and I would sleep very late in order to prepare for the judging and would have to wake up really early. It was also somewhat inconvenient to have our team advisor be with us at all times. However, the experience was fun, regardless of the tight schedule." (eCM-N Student)

A small number of regional students (4%) offered no opinion about their satisfaction with eCM and 14% had no positive comments about the program. Those who provided reasons for dissatisfaction with the program cited a lack of learning, the length of the program, their lack of interest, and a desire for career information outside of the Army.

Students were also asked in an open-ended questionnaire item to list three ways in which eCM could be improved. Of the 100 regional student responses sampled, the most often-mentioned improvements were:

- provide better or clearer instructions, questions, and/or deadlines (28%)
- provide more topics or options for projects (26%)
- provide more ideas and/or examples of projects (25%)

- allow more time or shorten the project requirements (23%)
- improve the website (21%) by making it easier to navigate, allowing more than one person at a time to edit the mission folder, autosaving work, improving the typeface and design, and making the submission process more user-friendly
- provide more support or resources for student research (15%) such as live chats and lists of scientists for students to contact

Other improvements mentioned by less than 10% of students included:

- making eCM more interesting or fun
- providing more flexibility in group sizes (larger groups, greater team diversity, options for individual participation, and options for teams of 2)
- providing more publicity and/or more participants
- providing more interactive/hands-on activities
- avoiding changes in submission dates
- providing opportunities to apply solutions in reality or providing more competition opportunities
- improving communication
- providing better information for mentors or team advisors
- shortening the questionnaire

The 68 NJ&EE students who offered suggestions for improvements focused on elements of the NJ&EE events. The most frequently mentioned improvement, mentioned in 44% of comments, was to provide more free time and/or more student freedom at the NJ&EE event. Other improvements suggested for the NJ&EE event included improvements to food (18%), more or longer field trips (13%), shorter days and/or more time to sleep (12%), more social activities or interaction with other teams (10%), and more hands-on and/or interactive activities (7%).

NJ&EE students participating in focus groups also offered several suggestions for improvements. These suggestions included:

- providing more information about careers and other AEOPs outside of the NJ&EE event
- providing more outreach and/or appointing student ambassadors for eCM
- providing more time with other teams during the NJ&EE event,
- providing a list of allowable materials for projects
- including the STEM-in-Action grant teams with other teams for activities
- allowing students to choose workshops to attend
- providing more opportunities to see other teams' projects
- providing more free time and/or student freedom
- allowing more time for field trips
- starting the day later

- improving the food options and/or providing snacks

For example, NJ&EE students said:

> "I think if the AEOP had some kind of group or something of students – middle school and high school students – and basically the job of these middle/high school students would be advertisement in their schools, I think that would be useful in terms of a lot of students would be able to go to AEOP programs" (eCM-N Student)
>
> "Whenever we have free time, which isn't a lot of time, everyone clusters in teams. The interactions you do have with other teams [is] nice. I feel like you could do more outside of your team." (eCM-N Student)
>
> "My team kind of struggled with the curfew. We felt it was a little early, especially since we didn't have free time during the day…we couldn't even practice our speech or anything." (eCM-N Student)

Team advisors reported the similar patterns of satisfaction with eCM program features as student participants (Table 37). More than three-quarters of eCM adults reported being somewhat or very much satisfied with the application or registration process (90%); submission process (93%); eCM website (90%); education materials (79%); and the variety of STEM Mission Challenges available (83%). Additionally, nearly a quarter or more of eCM team advisors indicated they did not experience Cyber Guide features (live chat – 59%, discussion forum – 53%, feedback – 43%) or Mission Control communications (phone – 49%, email – 21%). Additionally, while more than half of advisors reported being somewhat or very much satisfied with NSTA communications (59%), more than a third (35%) indicated this was something they did not experience.

Table 37. Team Advisor Satisfaction with eCM Program Features (n=274)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	2.6%	0.7%	6.9%	25.5%	64.2%	
	7	2	19	70	176	**274**
Communication with National Science Teachers Association (NSTA)	35.4%	0.0%	5.8%	16.4%	42.3%	
	97	0	16	45	116	**274**

Submission process	1.5%	1.8%	4.0%	24.5%	68.2%	
	4	5	11	67	187	**274**
Value of Cyber Guide live chat	58.8%	1.1%	7.7%	13.1%	19.3%	
	161	3	21	36	53	**274**
The variety of STEM Mission Challenges available	8.8%	1.5%	6.9%	23.4%	59.5%	
	24	4	19	64	163	**274**
Value of Cyber Guides' feedback	43.4%	0.4%	7.3%	14.2%	34.7%	
	119	1	20	39	95	**274**
Value of Cyber Guides discussion forum	53.3%	0.7%	9.9%	10.9%	25.2%	
	146	2	27	30	69	**274**
eCYBERMISSION website	1.5%	0.7%	7.7%	27.7%	62.4%	
	4	2	21	76	171	**274**
Educational materials	12.0%	1.1%	7.7%	26.6%	52.6%	
	33	3	21	73	144	**274**
Mission control (phone) response time	48.5%	1.1%	3.6%	5.1%	41.6%	
	133	3	10	14	114	**274**
Mission control (email) response time	21.2%	0.4%	2.2%	10.6%	65.7%	
	58	1	6	29	180	**274**

Like the student questionnaire, the adult questionnaire included open-ended items asking participants to share their opinions about the program. Adults were asked to comment on their overall satisfaction with the program. Of the 100 adult responses sampled, nearly all (96%) had positive comments about the program, focusing on the opportunity for student teams to work independently and to solve real-world problems in their own communities. For example,

> "eCYBERMISSION continues to be the highlight of science for my 6th - 9th graders. They show tremendous growth during the experience and from year to year as they grow through the program. It is the single best way I've found to develop independent workers." (eCM Team Advisor)

> "I like eCybermission. It allows me to introduce 6th grade science students, just entering middle school, to the process of identifying a relevant real-world problem to them, picking a group and dividing up the work, working together to solve their problem." (eCM Team Advisor)

> "I found eCybermission to be a unique experience that incorporated experimental design, creative problem solving, collaboration skills with others to solve community problems, science lab skills, data gathering analysis, [and] how to bring it all together." (eCM Team Advisor)

> "I use it as part of my curriculum and it has also guided the structure of our school science fair. It is a LOT of work for students and teachers alike, but it provides real world experience of the ups and down of science as a career. Worth every minute!" (eCM Team Advisor)

Only 4 adult participants had nothing positive to say about the program, indicating that they had received inadequate information and preparation, and experienced difficulties in working with students in teams. Another 17 team advisors made positive comments but provided caveats as well, noting that they felt there was not enough information provided for advisors new to the program, citing mismatches between eCM and NGSS and/or science fair requirements, inadequate time to complete projects, student difficulties with the project and/or lack of student motivation, the website design, and logistical issues such as time and limited computer access. For example,

> "Overall very satisfied. Would be perfect if lessons were updated to be NGSS/5E aligned. Also, better organization of website - too often had to look in two or three places and found different rubrics for the same thing." (eCM Team Advisor)

> "The eCYBERMISSION process was poorly executed from our end. We received minimal training and little guidance on expectations. As an advisor, I was not provided with clear information to guide my students. The process was cumbersome." (eCM Team Advisor)

> "This was an extremely stressful program for me as working with groups of 4 is nearly impossible." (eCM Team Advisor)

> "eCybermission was a definite challenge for my students and me, as well. It was difficult completing work since I only see these students 1 1/2 hours per week or less. I am also in a different building then their main classrooms so spending time together [was difficult]." (eCM Team Advisor)

Adults were asked in another open-ended questionnaire item to list the three most important strengths of eCM. Of the 100 team advisor responses sampled, nearly half focused on the real-world problems addressed in eCM (46%) and student teamwork (45%). Over a third of adult respondents (35%) noted the usefulness of program materials and resources, and over a quarter (28%) emphasized the research and design skills students gain during eCM. Other benefits noted included students' development of time management skills and perseverance during a long-term project (18%), the ability for students to choose their own projects and develop independent work skills (17%), the opportunity to have their projects judged and/or to be awarded prizes (17%), the critical thinking and problem-solving skills

students gain (16%), and the increased interest and/or motivation for STEM they noted in their students (15%).

Adult focus group participants at the NJ&EE also noted the emphasis on real-world research and problem-solving as a strength of eCM, and included in their comments the benefits of exposing students to STEM research in middle school, the feedback students receive on projects, and the benefits of changing girls' perspectives on STEM careers. Team advisors also noted that they have benefited from eCM in terms of their relationships with students, the opportunity to network, and transformation of their teaching practice. For example,

> "I have a group of students who …were published as seventh graders…I've had students who have worked with professors from MIT…I had kids earn scholarship money…The doors and opportunities that these students have gained because of this are invaluable. This is what true education should be like. I wish everyone knew about [eCM]." (eCM Team Advisor)
>
> "This competition starts early enough to where it's actually at a pivotal point for kids…You get the kids in the very beginning…I know that the boys do benefit from this equally, but I've seen so many girls changing the way that they are looking at STEM fields because of eCYBERMISSION.". (eCM Team Advisor)
>
> "[eCM] changed my career completely. I'm a biology teacher. I have a degree in biology, teaching middle school science….I started advising eCYBERMISSION and became an engineering teacher, and now, everything's different. Completely different." (eCM Team Advisor)
>
> "[eCM] really does change your relationships with the students in the classroom, but it empowers you as a teacher, because when you see how you're making a difference in those kids' lives with [eCM], it makes you feel good about teaching." (eCM Team Advisor)

Adults were also asked to respond to an open-ended item asking them to describe three ways eCM could be improved for future participants. Of the 100 adult responses sampled, the most frequently mentioned improvements (88%) focused on resources, including suggestions for:

- More live student supports (23%) such as live chats during class times, webinars, meeting with mentors, and other interactive supports
- Sample mission folders and/or examples of successful projects (23%)
- More specific information, clearer questions, and/or better topics (18%)
- Supports for generating project ideas (8%)
- Adjusting the project difficulty and/or level of language for younger students (8%)
- Updating the curriculum to ensure accuracy and/or align with NGSS (8%)
- Directory of expert mentors and/or assistance with forming partnerships (7%)

- More team advisor training and/or resources (5%) such as better mentoring, mentoring within the same time zone, workshops, support for new team advisors, career information
- Providing student orientation materials such as video or PowerPoint overviews (3%)

Three quarters (75%) of responses included improvements for various program features. These comments included suggestions for:

- More varied group sizes and/or allowing mixed grade levels in groups (12%)
- More time/longer program/earlier start date (11%)
- Providing a timeline and/or providing more incremental deadlines (11%)
- Providing more or earlier feedback on projects (7%)
- Better communication (7%), including contacting parents directly for student SSNs, providing information directly to students, and including information in emails on the website
- More outreach/more AEOP information/more career information (5%)
- Supply materials and/or not limiting grants to new participants (4%)
- Accommodating transient populations of students with flexibility of submission of participant names (4%)
- Accommodating student populations without regular computer access (2%)
- Providing more local or regional forums for competition (2%)
- Special accommodations for special needs students (1%)
- Including non-U.S. citizens (1%)

Slightly less than half (42%) of the adult responses sampled focused on website improvements, including suggestions for:

- General improvements in website (19%)
- Improving mission folder submission features (17%) such as allowing upload of Google Docs, videos, and graphics, and generally facilitating the ease of submission
- Simplifying the design and reducing the amount of information provided on the website (6%)

Adults participating in the focus group at NJ&EE also suggested various program improvements. These improvements included providing more outreach or publicity for eCM, altering the timing of NJ&EE in relation to other events such as JSS, providing ways to integrate eCM into classroom curriculum, and using program alumni as ambassadors. For example,

> “In my state, nobody even knows about this competition. If it wasn’t for the team last year, nobody, absolutely nobody knows.” (eCM Team Advisor)

> ““There’s a lot for teachers to balance in the classroom between this wonderful [eCM] experience where they’re actually like scientists…and getting through what you’re supposed to…It’s so hard for a teacher to take that on… I know some states have it woven into their

curricula…It would be great to have this somehow interwoven into middle school curricula. Maybe targeting middle schools…where they can go in and actually have some kind of outreach for that." (eCM Team Advisor)

"I think that by highlighting the past alumni of eCYBERMISSION's accomplishments, the national champions, some of the other teams that have gone on to do other great things, I think actually putting that up even on the website would definitely give other kids encouragement that 'if they could do it, I could do it, too.'" (eCM Team Advisor)

Next Generation STEM Teaching Project (NGSTP) Evaluation Findings

In recognition of the critical role that teachers play in developing students' STEM literacy and STEM-specific skills, the U.S. Army Research, Development, & Engineering Command (RDECOM) partnered with NSTA to pilot a professional learning experience for teachers beginning in the 2017-2018 school year and extending across three consecutive years. The goal of NGSTP is to provide in-service teachers with a robust understanding of the Next Generation Science Standards (NGSS) in the context of real-world research through mentoring by Army S&Es. The learning experience has three vital and intertwined components:

- Face to face training and follow-up webinars providing teachers with knowledge and resources about incorporating NGSS-aligned three-dimensional instruction in their classrooms.
- Pairing teachers with Army S&Es to act as mentors in developing and delivering curricular content.
- Grants of up to $2,600 per year to purchase supplies for classroom activities related to the curriculum teachers developed during their professional learning experience.

Teachers participating in NGSTP develop curricular materials based upon their workshop and metnroing experiences that they then deliver in their own classrooms (as part of a science class or as part of eCM activities). The expectation is that the program will strengthen teachers' content knowledge and teaching capacities by providing them with a structured learning opportunity and mentoring from content experts to develop curricular materials. Ultimately, the program aims to achieve the following outcomes:

1. Increase teacher awareness of and interest in STEM and STEM careers
2. Increase teacher understanding of and ability to facilitate three-dimensional learning (as described in the NGSS) with their students
3. Increase students' awareness and interest in STEM content and STEM careers in the DoD using authentic real-world content developed by their teachers.

The program is national in scope, and in its first year (2017-2018 school year) of operation the NGSTP program administrator worked with NSTA to recruit teachers participating in eCM. In the program's first year of operation, 8 teachers participated in NGSTP (7 females and 1 male). These teachers were from states across the U.S., including New Jersey, Pennsylvania, Massachussetts, Missouri, West Vriginia, Wisconsin, and Wyoming.

Because of the small population size, the evaluation relied on interviews with 7 participating teachers. Teachers participating in the phone interviews were all female. All of the participatns were science teachers. One of the teachers taught 9th grade honors biology and environmental science, 3 taught 8th

grade (physical science, integrated science, and STEM electives), 1 taught 7th grade, 1 taught 6th and 7th grades, and 1 taught 6th, 7th, and 8th grades.

The evaluation of NGSTP is organized according to the program outcomes outlined above, and also includes a discussion of strengths and successes of the program and participants' suggestions for program improvements.

Outcome #1: Increase teacher awareness and interest in STEM and STEM careers

Teachers participating in interviews were dedicated science teachers with an already strong awareness of and interest in STEM. They appreciated the opportunity to work with Army S&Es and were often able to connect what they learned from their mentors to the lesson plans they created, and sometimes were even able to connect the Army S&Es directly with students (discussed in Outcome #3 below). Teachers who worked with Army S&Es appreciated the opportunities to collaborate with research professionals, and especially the support in content they were able to provide. For example, participating teachers said:

> "I ended up talking to two [Army mentors] on the phone and then three [by] email. We've kept up because they wanted to know how the project went for the kids. They were great. They were the reason for a couple of the adjustments that we made when we were deciding on exactly how we wanted to do the project. They gave me some great ideas to give the kids so they could get the results that they hoped for." (NGSTP Participant)

> [Partnering with the Army scientists was useful] because they were microbiologists and we were working with fungus. That's just not something that I do every day." (NGSTP Participant)

> "Anytime that you can interact with someone who's a scientist or an engineer, that's always a valuable experience for yourself as a teacher, so you can see how it's done, and for the students." (NGSTP Participant)

> "[NGSTP] puts me within touch with a scientist who can help me think through my ideas and make certain I have my science correct when I state things to kids." (NGSTP Participant)

One teacher reported that she was able to share the skills she gained from her mentor at a professional development even in her school, thereby expanding the connection to Army STEM careers to her teaching colleagues:

> "When I went into a professional day last week, we were doing something and I taught my colleagues about different things that [the Army mentor] had taught [me and my students] about different tricks of lab skills and stuff… it was incredibly impactful." (NGSTP Participant)

Three of the teachers were less enthusiastic about their interactions with mentors, one due to mentor non-response and the other 2 due to logistical difficulties with connecting with the mentors. For example,

> "I was given the guy's name in January. I had already written my lesson plan. I sent him a copy of the lesson plan to ask if he could help with technicalities. Did he think I was doing it right? Was this a good plan? I never got any kind of response back at all. Nothing, zippo, zero, zilch." (NGSTP Participant)

> "The project was actually pretty well established and we were ready to teach it by the time we were given the engineers' names… The engineer was wonderful. He contacted me but [I did not work with him]...I think my students did reach out to him." (NGSTP Participant)

> "[My lack of contact with the Army mentor] was due partly to [the timing of the program]. There also was the possible government shutdown thing. Then they were like, 'Well, you know, maybe, maybe not.' Then they said, 'Yeah, go ahead and meet with them.' By the time that happened, I was already so deep into science fair and trying to be the science fair coordinator [that I didn't have time]." (NGSTP Participant)

Outcome #2: Increase teacher understanding of and ability to facilitate three-dimensional learning with their students

NGSTP teachers appreciated the opportunity to take a deep dive into NGSS and three-dimensional learning during workshops. Teachers reported that they gained new information about NGSS and how to incorporate that information into their classroom practice. Teachers particularly pointed out the value of learning about practices related to NGSS and then being able to immediately implement those practices in their classrooms.

> "The thing that probably impacted me the most was the phenomenon approach to introducing the lessons and then having the students come up with guiding questions. I have, since the training…developed four phenomenon-based lessons from that training." (NGSTP Participant)

> "[The training] was very specific in how you can incorporate the standards. How you can incorporate the 3D modeling and everything into the classroom, which is just much more tangible to what we are doing. I did find it very valuable." (NGSTP Participant)

> "The training made me realize that I had no clue really what the next gen approach was [until]… I had that two-day training and really focused on the storyline approach and how the kids were supposed to come up with ideas for the investigations and the whole point of the phenomenon tying it together. I've read that they needed to understand the big picture before, but I didn't get it until I put it together with the training…It wasn't just going to the training, it was the fact that

I then had to implement it immediately afterwards to teach the lesson before the end of the eCYBERMISSION competition. The fact I had to immediately put it into practice for my kids, made me have to sit there and really figure out how I was going to do a storyline." (NGSTP Participant)

Two of the participating teachers also emphasized the value of opportunities to work with other teachers when developing their lesson plans, suggesting that the communities of professional practice formed in NGSTP may enhance teacher learning about and implementation of NGSS practices. For example,

"[At the train the trainer workshop], the three of us could bounce ideas off each other. The one woman, I knew what I wanted to do, but she knew a piece of equipment that I could buy that would do what I wanted to do, [and] we helped her with identifying what her goals and objectives would be." (NGSTP Participant)

"I liked that they got us with other teachers of similar grade and a similar place in our teaching so that we could go through the professional development together. That was probably the best part for me." (NGSTP Participant)

Outcome #3: Increase students' awareness and interest in STEM content and STEM careers in the DoD using authentic real-world content developed by their teachers

The lesson plans participants created and delivered to students as part of NGSTP were focused on providing real-world connections, many of which were a result of experience with their Army S&E mentors. For example,

"[In my lesson], I wanted to focus on DNA analysis. Because obviously, DNA is something that is just growing in leaps and bounds in everyday society in so many different ways…It's still very basic the way that you teach it with DNA modeling. If we're lucky, I get to put a couple of beads together to make a model of it…[Because of NGSTP] I was able to, bring into the classroom actual gel electrophoresis and teach [students] lab skills - do a DNA fingerprinting lab in which they actually got to run the gel electrophoresis and determine who the father of the baby whale was…It wrapped one basic lesson about DNA into so many different areas." (NGSTP Participant)

"As part of the program Ispoke with the [an Army] professional engineer. He helped me out with [teaching] sound as far as making sure [students] understood that it was a pressure wave...He helped me out with understanding fiber optics because I had to teach myself fiber optics…I had to learn about lasers as well, so that was helpful to talk with him." (NGSTP Participant)

Some of the participating teachers reported that they were able to connect their Army mentors directly with students, thereby creating a direct connection to Army STEM careers for their students. For example,

> [The Army mentor] helped me with the lesson plans three different times with my bio classes. With my environmental science classes, [students and the mentor had] a great informal question and answer, just about science, the Army, life, and so many different things. [Later], the kids face-timed him to ask him a couple of questions because I went on with the lab, with the DNA…I took pictures of the kids incorporating some of the little tricks that he had taught them about pipetting." (NGSTP Participant)

Program Strengths and Successes

When interview participants were asked to comment upon the strengths of their NGSTP experience, all 7 commented on the value of the face-to-face professional development experience. Participants spoke on topics such as their learning about NGSS practices, the clarity of the instruction they received, and the practical skills they gained in creating lesson plans and implementing new practices in the classroom. Other benefits mentioned were benefits to their students' eCM teams, the funding they received, the connection with scientists, and the resume-building value of the train-the-trainer workshop. For example,

> "[A benefit was] understanding what it meant to incorporate all three areas [of three dimensional learning] into…a lesson plan. I never really thought about the 'grab' factor of teaching a subject content from the backwards way.. I've gone on the [NSTA] website so many times to pick out some of the lesson plans, feedback, and little things that I never even really even knew was there." (NGSTP Participant)

> " [A benefit was] the ability to go to the conference, and …to be able to buy new materials, because I wouldn't have been able to do the electromagnetic spectrum lab without being able to purchase new materials." (NGSTP Participant)

> "I think that [the instructors] were just really clear. Everything was step by step. It was sequential. They took you from the beginning, just a basic introduction, until we were ready to make our own lesson plan…I liked how they had us work through different hands-on activities so we could see exactly what they were talking about. It wasn't vague." (NGSTP Participant)

> "Here in our district, we don't really focus as much on this phenomenon-based learning. I do project-based learning…I kind of thought of an anchoring phenomenon as it had to be this extraordinary thing. It had to be something that was unexplainable, that would be far-reaching. It seemed very difficult to plan lessons that way, but after going to the class, they really

explained that it could be this regular thing, like water running on the floor, which is what I started with." (NGSTP Participant)

"The funding support was good, the ability to talk with a scientist so that I had someone else other than just the other teachers that I work with in the building." (NGSTP Participant)

"[The training] was fabulous. I think that it helped to make the eCYBERMISSION group's submission more robust, which was great. I did like going to the NGSS train-the-trainer. That's a really great thing for me to be able to, honestly, put on a resume. It looks great." (NGSTP Participant)

Teachers all had positive things to say about their experiences, and participants shared some notable success stories, including their enthusiasm about disseminating their new knowledge in their own practice settings, the unique opportunity of attending a NSTA conference and the training, particularly for those from schools that lack resources to support these types of professional development opportunities. For example,

"I'm very, very thankful that I was able to participate in [NGSTP]. I would love to do this again if there is another opportunity. I have taught the other science teachers. I brought back and shared with them what I learned. We're trying to integrate…since we're supposed to be doing the same thing.[NGSTP] was very beneficial." (NGSTP Participant)

"That was my first NSTA conference. I would have never been able to do that without this program. My school district does not have the funds to send us to a conference, especially that far away…[and] my district would not have been able to pay the $600 fee for me to participate in the train-the-trainer NGSS Professional Development. To have that opportunity, my principal and assistant superintendent were just thrilled. It was very beneficial." (NGSTP Participant)

"It's a great program. I'm a small-school teacher, [so] I don't have very many options available to me. This is a great way to give me some professional development, to get me to thinking about what I'm doing in the classroom. It put me within touch with a scientist who can help me think through my ideas and make certain I have my science correct when I state things to kids. Then the last piece is the money to assist the kids and their projects and their thinking and everything else…it's a wonderful program." (NGSTP Participant)

"I think the whole program of eCYBERMISSION has been wonderful, and I think [NGSTP] is a great thing for teachers to see that different way of structuring lessons." (NGSTP Participant)

Suggestions for Program Improvement

Although all teachers had positive things to say about their NGSTP experience, most offered suggestions when asked about ways the program could be improved for the future. Teachers' suggestions for improvement included the following:

- Clarifying the funding structure and altering the timing of funding to eliminate the need for reimbursements
- Provide earlier connections with Army S&Es
- Adjust the timing (earlier) to better fit with eCM schedules
- Provide a template for the lesson plan
- Provide more clarity about expectations and deadlines
- Form distinct cohorts of teachers (one suggestion was to use Google Hangout to allow teachers to get to know each other)
- Provide more support and emphasis on NGSS science and engineering practices
- Provide more follow-up after workshop
- Have workshops at regional NSTA events to reach more teachers
- Eliminate the requirement for comparative lesson plans (teachers may not have lesson plans for eCM since it's student led), and instead use student pre-and post- assessments to show student growth
- Connect students directly with S&Es

In participants' words:

> "[An improvement is] the reimbursement piece. You had to use your own money or your district's money to do that. Money is tight in schools anyway. My principal…wasn't willing to put money out there. He didn't have enough information about the program to be super-confident that that money was going to come back into the building." (NGSTP Participant)

> "I think that because it was a pilot year, there was a lot of confusion with particularly getting the scientists involved. The other piece was, the funding of the lesson was a little bit not clear to start, because at the start, we were supposed to turn in a budget. I had done a whole budget but then we were supposed to receive the money and then be able to use it, but that switched and it didn't switch until after January. The timing made it so difficult because then we were told to purchase things and then get reimbursed, so I think just more clarity on how that piece works so that you can fit in timewise." (NGSTP Participant)

> "I would have loved to have been able to do it earlier in the school year because I get my eCYBERMISSION kids teamed up and they already had their problem that they wanted to investigate by the time I did this. I wasted time and spun some wheels there, trying to figure out how I could…fit the timing of eCYBERMISSION, the timing of what I was suppose to teach and

when so that I could still stay with my other science teachers in the department, [and] also have it related to what my kids were investigating for eCYBERMISSION. I pulled it off, but that was harder than it really needed to be." (NGSTP Participant)

"[In eCM, students are] solving real problems. It's not always going to connect to a lesson plan. You're dealing with a group of three or four students. It's not like you're going to teach that lesson to your entire course section. That lesson only really pertains to those four students. I pulled those four students after school and did that lesson with them. It's not like when you're working with a small group after school, that you're going to type up a formal lesson plan, [so coming up with a comparative lesson plan was difficult]." (NGSTP Participant)

"In terms of the program, if you're dealing with a group of teachers who have very limited experience with science and engineering practice and crosscutting concepts, you really need to spend some time with those and developing the teacher's concept of that." (NGSTP Participant)

"A two-day workshop, it can get you started, but more professional development would be needed in order to really get a teacher to the final stages, where they can implement it with some level of comfort in their classroom." (NGSTP Participant)

"I do feel strongly about the idea that if this is a cohort, that people need to know each other, because in my opinion, I functioned in a vacuum. I really didn't feel like I had any input from…the program, and certainly not the mentor…. I think the more that you can get people to share with each other and just foster relationships with each other, it's going to make it a better and stronger program." (NGSTP Participant)

In summary, the NGSTP program had a successful inaugural year in 2017-2018. Although there are several ways participants felt the program could be improved in the future, all of the teachers interviewed all reported benefiting from the program. The professional development workshop was viewed positively, and many of the teachers interviewed reported having "aha" moments about ways to implement NGSS three-dimensional learning in their classrooms. When teachers were able to connect with Army S&E mentors, these were fruitful relationships that exposed teachers to Army STEM professionals and to leverage content experts as resources for curriculum development. Teachers all reported being able to implement their learning in their own practice settings, and valued the real-life aspects that they were able to infuse into lessons. In some cases, students were able to connect directly with Army S&Es, providing direct connections to Army STEM professionals.

7 | Priority #3 Findings

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

How Participants Found Out About AEOP

In order to determine what recruitment methods are most effective, students were asked to indicate all of the ways they learned about eCM. Table 38 shows that a majority of students (87%) reported learning about eCM from their teachers. A third of students also indicated they learned about eCM from someone who works a the school they attend (35%).

Table 38. How eCM Students Learned about eCM (n=21,148)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	1.61%	341
AEOP on Facebook, Twitter, Instagram, or other social media	1.27%	269
School or university newsletter, email, or website	0.07%	15
Past participant of program	12.35%	2,611
Friend	8.00%	1,691
Family Member	3.10%	655
Someone who works at the school or university I attend	34.50%	7,297
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.38%	81
Community group or program	1.61%	341
Teacher	87.29%	18,461
Print Advertising	0.21%	44
eCM Website	4.87%	1,029
Choose Not to Report	4.30%	910

Students in the NJ&EE focus groups reported learning about eCM through teachers, parents, friends or past participants, or online. Some focus group participants indicated that they had participated in eCM as a school requirement. For example:

> "I learned about it my seventh grade year. [The] seventh grade honors class was also required to take eCYBERMISSION." (e-CM-N Student)

> "One of my best friend's moms heard about it from one of her friends." (e-CM-N Student)

> I was just researching on the Internet and then I stumbled across eCYBERMISSION. I started following it a little more closely. After reading the rules and stuff, it got me interested. I just formed a team." (e-CM-N Student)

Table 39 shows combined national and regional eCM participant motivational factors. The three top factors were external motivators: teacher encouragement to participate (59%), academic requirement or school grade (19%), and opportunity to have fun with friends (17%). Two internal educational factors also received more than 10% of student support: interest in STEM (13%) and desire to learn something new or interesting (12%).

Students participating in focus group also reported a variety of motivations for participating. While some students were motivated to participate by their teachers or course requirements, others reported participating because they enjoy the experience, for the learning opportunities, and to make connections. For example:

> "In seventh grade…our teacher made us do it. The year after, we all decided to do it again because we enjoyed it. (eCM-N Student)

> "My friends told me about it. I just thought it would be a fun thing to do over the year. I never participated in this type of competition before. [I] thought it would be fun to research different things and then build something on my own." (eCM-N Student)

> "We wanted to do it so we could make good connections and learn how to use the scientific method better." (eCM-N Student)

In regards to the factors that motivated students to participate in eCM, there were 36 national students who responded to the question at registration and 143 regional students. Again, this is a very small sample compared to the overall eCM population. For both national competition and regional participants, the primary motivation was "desire to learn something new or interesting" followed by an interest to "serve the community or country".

Table 39. Factors Motivating Students to Participate in eCM (n=22,358)

Choice	Response Percent	Response Total
My teacher encouraged me to participate	58.69%	13,122
Academic requirement or school grade	18.88%	4,222
Opportunity to have some fun with my friends	16.55%	3,701
Interest in STEM	13.19%	2,950
Desire to learn something new or interesting	11.87%	2,655
Building college application or résumé	6.36%	1,422
Exploring how school learning applies to real life	6.09%	1,361
Earning awards and recognition	6.01%	1,343
Exploring education and/or career goals	5.03%	1,125
Serving the community or country	3.99%	893
Interest in expanding my laboratory or research skills	3.69%	824
Interest in STEM careers with the Army	1.77%	396
Having fun	0.42%	93
Learning in ways that are not possible in school	0.13%	30
Seeing how school learning applies to real life	0.13%	29
Desire to expand laboratory or research skills	0.12%	27
Exploring a unique work environment	0.11%	25
Opportunity to use advanced laboratory technology	0.10%	23
Earning stipends or awards for doing STEM	0.07%	15
Recommendations of past participants	0.04%	9
Networking opportunities	0.03%	7
The mentor(s)	0.03%	6
Choose not to report	10.31%	2,306

Previous Program Participation and Future Interest

eCM participants reported on their previous participation in AEOP programs as part of the registration process (Table 40). The most frequently reported program for past participation was eCM (25%) followed by Camp Invention at 3% and Gains in the Education of Mathematics and Science (GEMS) at 2%.

Additionally, 1% reported previous participation in Junior Solar Spring (JSS), and 25% reported participation in some other, non-AEOP STEM program.

Table 40. Previous Program Participation (n=19,552)

Choice	Response Percent	Response Total
Camp Invention	2.52%	492
eCYBERMISSION	25.18%	4,924
Junior Solar Sprint (JSS)	1.00%	195
Gains in the Education of Mathematics and Science (GEMS)	1.73%	338
UNITE	0.00 %	0
Junior Science & Humanities Symposium (JSHS)	0.00 %	0
Science & Engineering Apprenticeship Program (SEAP)	0.00 %	0
Research & Engineering Apprenticeship Program (REAP)	0.00 %	0
High School Apprenticeship Program (HSAP)	0.00 %	0
College Qualified Leaders (CQL)	0.00 %	0
Undergraduate Research Apprenticeship Program (URAP)	0.00 %	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.00 %	0
I've never participated in any AEOP programs	52.77%	10,317
Other STEM Program	24.56 %	4,801

Student interest level in participating in future AEOP programs was assessed by the questionnaire (Tables 41 and 42). Regardless of competition level, if students had heard of the AEOP programs, few reported not being at all interested (15% or less) in future participation. NJ&EE participants (38%-89%) reported

substantially more interest in future AEOP participation compared to regional eCM participants (11%-38%). With the exception of eCM, NJ&EE students (4%-40%) also indicated less often that they had never heard of an AEOP program compared to regional participants (54%-67%). Students in the NJ&EE focus groups indicated that the alumni panel, their mentors, and promotional items such as notepads informed them about AEOPs.

Table 41. eCM-NJ&EE Participant Interest in Future AEOP Programs (n=72)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
Camp Invention	40.3%	2.8%	19.4%	20.8%	16.7%	
	29	2	14	15	12	**72**
eCYBERMISSION	0.0%	8.3%	2.8%	12.5%	76.4%	
	0	6	2	9	55	**72**
Junior Solar Sprint (JSS)	22.2%	11.1%	22.2%	27.8%	16.7%	
	16	8	16	20	12	**72**
Gains in the Education of Mathematics and Science (GEMS)	4.2%	4.2%	15.3%	30.6%	45.8%	
	3	3	11	22	33	**72**
UNITE	29.2%	13.9%	12.5%	30.6%	13.9%	
	21	10	9	22	10	**72**
Junior Science & Humanities Symposium (JSHS)	15.3%	2.8%	27.8%	20.8%	33.3%	
	11	2	20	15	24	**72**
Science & Engineering Apprenticeship Program (SEAP)	20.8%	6.9%	19.4%	27.8%	25.0%	
	15	5	14	20	18	**72**
Research & Engineering Apprenticeship Program (REAP)	9.7%	5.6%	19.4%	34.7%	30.6%	
	7	4	14	25	22	**72**
High School Apprenticeship Program (HSAP)	15.3%	6.9%	20.8%	30.6%	26.4%	
	11	5	15	22	19	**72**

College Qualified Leaders (CQL)	23.6%	8.3%	18.1%	27.8%	22.2%	
	17	6	13	20	16	**72**
GEMS Near Peer Mentor Program	13.9%	8.3%	20.8%	31.9%	25.0%	
	10	6	15	23	18	**72**
Undergraduate Research Apprenticeship Program (URAP)	29.2%	6.9%	12.5%	29.2%	22.2%	
	21	5	9	21	16	**72**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	30.6%	6.9%	11.1%	27.8%	23.6%	
	22	5	8	20	17	**72**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	33.3%	12.5%	16.7%	23.6%	13.9%	
	24	9	12	17	10	**72**

Table 42. eCM Overall Participant Interest in Future AEOP Programs (n=686)

	I've never heard of this program	Not at all	A little	Somewhat	Very much	Response Total
Camp Invention	59.2%	14.4%	13.6%	8.0%	4.8%	
	406	99	93	55	33	**686**
eCYBERMISSION	8.3%	28.1%	25.4%	17.2%	21.0%	
	57	193	174	118	144	**686**
Junior Solar Sprint (JSS)	57.9%	15.9%	14.6%	6.4%	5.2%	
	397	109	100	44	36	**686**
Gains in the Education of Mathematics and Science (GEMS)	60.2%	14.0%	11.8%	7.0%	7.0%	
	413	96	81	48	48	**686**
UNITE	66.9%	13.0%	9.6%	6.1%	4.4%	
	459	89	66	42	30	**686**
Junior Science & Humanities Symposium (JSHS)	63.7%	13.3%	11.4%	7.0%	4.7%	
	437	91	78	48	32	**686**

Science & Engineering Apprenticeship Program (SEAP)	59.5%	13.4%	12.7%	8.0%	6.4%	
	408	92	87	55	44	**686**
Research & Engineering Apprenticeship Program (REAP)	59.9%	15.2%	12.1%	7.6%	5.2%	
	411	104	83	52	36	**686**
High School Apprenticeship Program (HSAP)	59.8%	13.1%	12.5%	8.3%	6.3%	
	410	90	86	57	43	**686**
College Qualified Leaders (CQL)	61.5%	11.2%	11.5%	8.7%	7.0%	
	422	77	79	60	48	**686**
GEMS Near Peer Mentor Program	64.6%	13.0%	11.1%	6.4%	5.0%	
	443	89	76	44	34	**686**
Undergraduate Research Apprenticeship Program (URAP)	63.0%	14.3%	10.2%	6.6%	6.0%	
	432	98	70	45	41	**686**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	54.2%	12.8%	14.9%	9.0%	9.0%	
	372	88	102	62	62	**686**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	61.2%	12.7%	11.5%	7.9%	6.7%	
	420	87	79	54	46	**686**

Awareness of STEM Careers and DoD STEM Careers and Research

An AEOP goal is to increase both the number and diversity of students who pursue STEM careers. Thus, the student questionnaire asked how many STEM jobs/careers in general (Tables 43 and 44) as well as DoD STEM jobs/careers (Tables 45 and 46) students learned about during their eCM experience. All NJ&EE students and 70% of regional participants reported hearing about at least one STEM job/career through eCM. However, NJ&EE participants indicated they had learned about more STEM jobs/careers than regional participants, with 64% of national students reporting learning about 5 or more and only 17% of regional students indicating the same.

Table 43. Number of STEM Jobs/Careers National Students Learned About During eCM (n=72)

Choice	Response Percent	Response Total
None	0.00 %	0
1	1.39 %	1

2	8.33 %	6
3	13.89 %	10
4	12.50 %	9
5 or more	63.89 %	46

Table 44. Number of STEM Jobs/Careers Regional Students Learned About During eCM (n=686)

Choice	Response Percent	Response Total
None	30.17 %	207
1	12.83 %	88
2	20.26 %	139
3	15.01 %	103
4	4.81 %	33
5 or more	16.91 %	116

NJ&EE students reported learning about more DoD jobs/careers than regional participants. Nearly all NJ&EE (93%) and only 38% of regional students indicated learning about one or more DoD STEM job/career. When comparing the number of students who had learned about 5 or more DoD STEM jobs/careers, 47% of NJ&EE students reported affirmatively and only 6% of regional students indicated they had as well.

Table 45. Number of DoD STEM Jobs/Careers National Students Learned About During eCM (n=72)

Choice	Response Percent	Response Total
None	6.94 %	5
1	1.39 %	1
2	5.56 %	4
3	20.83 %	15
4	18.06 %	13
5 or more	47.22 %	34

Table 46. Number of DoD STEM Jobs/Careers Regional Students Learned About During eCM (n=686)

Choice	Response Percent	Response Total
None	61.95 %	425

1	9.62 %	66
2	11.52 %	79
3	7.73 %	53
4	2.77 %	19
5 or more	6.41 %	44

Students at the NJ&EE participating in focus groups were also asked about whether and how they had learned about STEM career opportunities in the DoD during eCM. Students cited the workshops and presentations at the NJ&EE as sources of information, along with research they conducted during their projects, and talking with mentors. Some students volunteered that they had developed an interest in pursuing a STEM career in the DoD as a result of these experiences. For example:

> "Prior to doing eCYBERMISSION, I never thought about [a career in STEM with the Army or DoD]. After hearing the presentations and all of the benefits, I think it would actually be a smart choice…I'm definitely considering it. (eCM-N Student)

> "We also had to contact experts [as part of our project]…We learned about all these different jobs relating to a certain subject and how specific they are." (eCM-N Student)

> "Before eCYBERMISSION, I was sure that I wanted to be some kind of engineer, but I wasn't sure that I could do this with the Army, because I thought the Army wasn't about STEM. Through this program I learned that STEM is a very important part of the Army." (eCM-N Student)

Since attitudes about the importance of DoD research are an important prerequisite to continued student interest in the field and to potential DoD STEM involvement in the future, students were asked their opinions of what DoD researchers do and the value of DoD research more broadly. Student opinions were favorable, with most students agreeing or strongly agreeing with all items (Table 47 and 48). However, NJ&EE students expressed greater agreement (90% or more) than regional students (approximately 50%) across items. It is important to note that approximately a third of all regional students indicated "neither agree nor disagree" with all items compared to less than 10% of national students. Similar to FY17, the two statements with the highest agreement among students were that DoD researchers solve real-world problems (eCM - 56%; NJ&EE - 93%); and DoD research is important to society (eCM - 56%; NJ&EE - 93%).

Table 47. eCM-NJ&EE Participant Opinions about DoD Researchers and Research (n=72)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total

DoD researchers advance science and engineering fields	0.0%	1.4%	8.3%	37.5%	52.8%	
	0	1	6	27	38	**72**
DoD researchers develop new, cutting edge technologies	0.0%	0.0%	8.3%	27.8%	63.9%	
	0	0	6	20	46	**72**
DoD researchers solve real-world problems	0.0%	1.4%	5.6%	27.8%	65.3%	
	0	1	4	20	47	**72**
DoD research is important to society	0.0%	0.0%	6.9%	25.0%	68.1%	
	0	0	5	18	49	**72**

Table 48. eCM Overall Participant Opinions about DoD Researchers and Research (n=686)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	8.5%	5.2%	38.8%	32.7%	14.9%	
	58	36	266	224	102	**686**
DoD researchers develop new, cutting edge technologies	8.2%	6.0%	34.1%	34.1%	17.6%	
	56	41	234	234	121	**686**
DoD researchers solve real-world problems	7.6%	4.2%	32.1%	32.4%	23.8%	
	52	29	220	222	163	**686**
DoD research is important to society	7.4%	4.4%	32.5%	33.8%	21.9%	
	51	30	223	232	150	**686**

Interest and Future Engagement in STEM

A key goal of the AEOP is to develop a STEM-literate citizenry. As such, students need to be engaged both in and out of school with high-quality STEM activities. The questionnaire asked students to reflect on the likelihood that they would engage in STEM activities outside of required school courses as a result of their eCM experience. Between 30% and 45% of regional students (Table 49) reported "about the same likelihood before and after eCM" to engage in the activities listed. However, on average, 30% reported that they were "more likely" to engage in these activities. It is noteworthy that the regional respondent results are 5 percentage points higher than in FY17 for these items. Comparatively, an average of two-thirds of NJ&EE students reported they were "more likely" to engage in all STEM activities listed (Table 50). A 30% point average gap existed between national and regional respondents' reports of likelihood to engage. Some of the stronger examples of this discrepancy in student responses include the following (students "more likely" or "much more likely"): help with a community service project related to STEM (eCM - 35%, NJ&EE - 79%); talk with friends or family about STEM (eCM - 31%, NJ&EE - 68%); participate in a STEM camp, club, or competition (eCM - 28%, NJ&EE - 72%).

Table 49. eCM-NJ&EE Impact on Participants' Intent to Engage in STEM Out of School (n=72)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	4.2%	1.4%	48.6%	23.6%	22.2%	
	3	1	35	17	16	**72**
Tinker (play) with a mechanical or electrical device	1.4%	0.0%	30.6%	40.3%	27.8%	
	1	0	22	29	20	**72**
Work on solving mathematical or scientific puzzles	0.0%	2.8%	43.1%	37.5%	16.7%	
	0	2	31	27	12	**72**
Use a computer to design or program something	0.0%	2.8%	34.7%	38.9%	23.6%	
	0	2	25	28	17	**72**
Talk with friends or family about STEM	0.0%	2.8%	34.7%	31.9%	30.6%	
	0	2	25	23	22	**72**
Mentor or teach other students about STEM	0.0%	5.6%	26.4%	38.9%	29.2%	
	0	4	19	28	21	**72**
Help with a community service project related to STEM	0.0%	1.4%	25.0%	36.1%	37.5%	

	0	1	18	26	27	**72**
Participate in a STEM camp, club, or competition	0.0%	2.8%	18.1%	37.5%	41.7%	
	0	2	13	27	30	**72**
Take an elective (not required) STEM class	0.0%	1.4%	26.4%	31.9%	40.3%	
	0	1	19	23	29	**72**
Work on a STEM project or experiment in a university or professional setting	0.0%	1.4%	27.8%	26.4%	44.4%	
	0	1	20	19	32	**72**

Table 50. eCM Overall Impact on Participants' Intent to Engage in STEM Out of School (n=686)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	22.3%	12.8%	44.8%	13.1%	7.0%	
	153	88	307	90	48	**686**
Tinker (play) with a mechanical or electrical device	13.7%	12.2%	35.3%	25.2%	13.6%	
	94	84	242	173	93	**686**
Work on solving mathematical or scientific puzzles	16.9%	11.4%	40.4%	20.8%	10.5%	
	116	78	277	143	72	**686**
Use a computer to design or program something	14.3%	12.1%	39.5%	20.7%	13.4%	
	98	83	271	142	92	**686**
Talk with friends or family about STEM	18.1%	15.9%	34.7%	19.0%	12.4%	
	124	109	238	130	85	**686**
Mentor or teach other students about STEM	20.7%	16.3%	36.2%	17.2%	9.6%	
	142	112	248	118	66	**686**
Help with a community service project related to STEM	16.9%	13.4%	35.0%	22.3%	12.4%	
	116	92	240	153	85	**686**
Participate in a STEM camp, club, or competition	22.3%	15.6%	34.4%	16.3%	11.4%	
	153	107	236	112	78	**686**

Take an elective (not required) STEM class	20.3%	16.5%	31.2%	18.7%	13.4%	
	139	113	214	128	92	**686**
Work on a STEM project or experiment in a university or professional setting	20.4%	14.9%	33.2%	17.9%	13.6%	
	140	102	228	123	93	**686**

Items comprising students' engagement in STEM outside of required school courses were used to produce a composite score[32] to compare subgroups of students. Statistical group differences were found by competition level[33] (NJ&EE higher - medium effect size of d = 0.623). Differences were also found by overall U2 status[34] (U2 lower - small effect size of d = 0.308); race/ethnicity [35] (minority students lower - small effect size of d = 0.401); FARMS[36] (low-SES lower - small effect size of d = 0.463); and first generation status[37] (first generation students lower - small effect size of d = 0.481). There were no significant differences by gender, school location, and ELL status for engagement in STEM outside of required school courses.

Students were asked about their education aspirations after participating in eCM (Tables 51 and 52). Regardless of competition level, the vast majority of students expected to, at minimum, complete a Bachelor's degree (eCM - 87%, NJ&EE - 99%). In terms of more advanced post-secondary work, more NJ&EE students (67%) reported a desire to get more education after college than regional students (42%).

Table 51. Participant Education Aspirations After eCM-NJ&EE (n=72)

Choice	Response Percent	Response Total
Graduate from high school	0.00 %	0
Go to a trade or vocational school	1.39 %	1
Go to college for a little while	0.00 %	0
Finish college (get a Bachelor's degree)	31.94 %	23
Get more education after college	66.67 %	48

Table 52. Participant Education Aspirations After eCM Overall (n=686)

Choice	Response Percent	Response Total

[32] These 10 items for Future STEM Engagement had a Cronbach's alpha reliability of 0.943.
[33] Two-tailed independent samples t-test: $t(756) = 8.57$, $p < .001$.
[34] Two-tailed independent samples t-test: $t(411) = 3.12$, $p = .002$.
[35] Two-tailed independent samples t-test: $t(386) = 3.94$, $p < .001$.
[36] Two-tailed independent samples t-test: $t(365) = 4.42$, $p < .001$.
[37] Two-tailed independent samples t-test: $t(381) = 4.69$, $p < .001$.

Graduate from high school	5.10 %	35
Go to a trade or vocational school	1.46 %	10
Go to college for a little while	5.98 %	41
Finish college (get a Bachelor's degree)	45.92 %	315
Get more education after college	41.55 %	285

Resources

eCM participating adults were asked which resources were most valuable for exposing students to AEOPs (Table 53). Similarly to FY17, a majority of eCM adult questionnaire respondents indicated that participating in eCM (63%) and the eCM website (66%) were "very much" useful. However, most adult participants (51%-86%) indicated they did not experience the other resources listed.

Table 53. Usefulness of Resources for Exposing Students to AEOPs (n=274)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
eCybermission website	5.8%	1.5%	6.2%	20.8%	65.7%	
	16	4	17	57	180	**274**
Army Educational Outreach Program (AEOP) website	51.8%	2.6%	8.0%	14.6%	23.0%	
	142	7	22	40	63	**274**
AEOP on Facebook, Twitter, Pinterest or other social media	75.9%	2.9%	4.7%	8.4%	8.0%	
	208	8	13	23	22	**274**
AEOP brochure	71.9%	2.2%	5.8%	9.1%	10.9%	
	197	6	16	25	30	**274**
It Starts Here! Magazine	86.1%	2.9%	3.6%	3.3%	4.0%	

	236	8	10	9	11	**274**
eCybermission Program administrator	51.1%	2.2%	5.5%	10.6%	30.7%	
	140	6	15	29	84	**274**
Invited speakers or "career" events	75.2%	2.2%	2.9%	6.6%	13.1%	
	206	6	8	18	36	**274**
Participation in eCYBERMISSION	10.9%	0.4%	6.2%	19.7%	62.8%	
	30	1	17	54	172	**274**

Table 54 summarizes results from eCM adult survey participants reporting how useful the same resources were for exposing students to DoD STEM careers. A similar pattern of resource usefulness was found, but the responses were not as strongly favorable. Again, adults were most likely to rate participation in eCM (50%) and the eCM website as "very much" useful for exposing students to DoD STEM careers. More than half of adults (60%-79%) indicated not having experienced all of the remaining AEOP resources.

Table 54. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=274)

	Did not experience	**Not at all**	**A little**	**Somewhat**	**Very much**	**Response Total**
eCYBERMISSION website	16.8%	2.2%	11.3%	18.2%	51.5%	
	46	6	31	50	141	**274**
Army Educational Outreach Program (AEOP) website	59.5%	2.9%	6.9%	9.5%	21.2%	
	163	8	19	26	58	**274**
AEOP on Facebook, Twitter, Pinterest or other social media	78.8%	4.7%	4.4%	5.1%	6.9%	
	216	13	12	14	19	**274**
AEOP brochure	77.0%	3.3%	4.0%	5.8%	9.9%	

	211	9	11	16	27	**274**
eCYBERMISSION Program administrator or site coordinator	60.6%	3.3%	6.2%	8.4%	21.5%	
	166	9	17	23	59	**274**
Invited speakers or "career" events	76.3%	3.6%	2.2%	6.2%	11.7%	
	209	10	6	17	32	**274**
Participation in eCYBERMISSION	25.2%	1.8%	8.4%	14.6%	50.0%	
	69	5	23	40	137	**274**

Overall Impact

Tables 55 and 56 summarize participant responses to questions about their opinion of the overall impact of eCM. While NJ&EE students reported higher impacts on all items compared to regional students, both groups indicated they experienced impact as a result of eCM. Two aspects for which more than half of all students agreed that eCM had an impact were more confidence in their STEM knowledge, skills, and abilities (eCM - 65%, NJ&EE - 96%); and a greater appreciation of Army or DoD STEM research (eCM - 52%, NJ&EE - 94%). Although students reported that eCM impacted their STEM skills positively, in terms of eCM's impact on their future interest in other AEOP programs or DoD STEM positions, there was a substantial difference by group with NJ&EE reporting much higher impacted interest than regional students: more interested in participating in other AEOPs (eCM - 39%, NJ&EE - 95%); more interested in pursuing a STEM career with the Army or DoD (eCM - 34%, NJ&EE - 81%).

Overall eCM Impact survey items were combined into a composite variable[38] to assess differences between student subgroups. With the exception of gender, there were significant differences by all other subgroups. National students reported significantly higher levels in comparison to regional students[39] (large effect size of d = 0.803). Differences on overall eCM Impact were not found by U2 status. However, ELL students reported significantly higher levels than non-ELL students[40] (small effect size of d = 0.211).

Table 55. Participant Opinion of eCM-NJ&EE Impacts (n=72)

	Disagree - This did not happen	**Disagree - This happened but not because**	**Agree - eCybermission somewhat made me feel this way**	**Agree - eCybermission was primary reason**	**Response Total**

[38] The Cronbach's alpha reliability for these 10 Overall eCM Impact items was 0.940.
[39] Two-tailed independent samples t-test: $t(756) = 11.04$, $p < .001$.
[40] Two-tailed independent samples t-test: $t(403) = 2.12$, $p = .035$.

		of eCybermission			
I am more confident in my STEM knowledge, skills, and abilities	0.0%	4.2%	48.6%	47.2%	
	0	3	35	34	**72**
I am more interested in participating in STEM activities outside of school requirements	2.8%	6.9%	45.8%	44.4%	
	2	5	33	32	**72**
I am more aware of other AEOPs	1.4%	2.8%	31.9%	63.9%	
	1	2	23	46	**72**
I am more interested in participating in other AEOPs	2.8%	2.8%	30.6%	63.9%	
	2	2	22	46	**72**
I am more interested in taking STEM classes in school	2.8%	20.8%	34.7%	41.7%	
	2	15	25	30	**72**
I am more interested in earning a STEM degree	6.9%	20.8%	25.0%	47.2%	
	5	15	18	34	**72**
I am more interested in pursuing a career in STEM	6.9%	20.8%	31.9%	40.3%	
	5	15	23	29	**72**
I am more aware of Army or DoD STEM research and careers	4.2%	0.0%	30.6%	65.3%	
	3	0	22	47	**72**
I have a greater appreciation of Army or DoD STEM research	2.8%	2.8%	31.9%	62.5%	
	2	2	23	45	**72**
I am more interested in pursuing a STEM career with the Army or DoD	12.5%	6.9%	36.1%	44.4%	
	9	5	26	32	**72**

Table 56. Participant Opinion of eCM Overall Impacts (n=686)

	Disagree - This did not happen	Disagree - This happened but not because of eCybermission	Agree - eCybermission somewhat made me feel this way	Agree - eCybermission was primary reason	Response Total

I am more confident in my STEM knowledge, skills, and abilities	18.7%	16.5%	50.1%	14.7%	
	128	113	344	101	**686**
I am more interested in participating in STEM activities outside of school requirements	28.6%	24.2%	34.8%	12.4%	
	196	166	239	85	**686**
I am more aware of other AEOPs	38.8%	15.0%	34.4%	11.8%	
	266	103	236	81	**686**
I am more interested in participating in other AEOPs	43.6%	17.5%	27.8%	11.1%	
	299	120	191	76	**686**
I am more interested in taking STEM classes in school	27.8%	24.1%	35.0%	13.1%	
	191	165	240	90	**686**
I am more interested in earning a STEM degree	34.4%	23.8%	30.9%	10.9%	
	236	163	212	75	**686**
I am more interested in pursuing a career in STEM	35.9%	25.1%	28.6%	10.5%	
	246	172	196	72	**686**
I am more aware of Army or DoD STEM research and careers	36.2%	16.5%	32.4%	15.0%	
	248	113	222	103	**686**
I have a greater appreciation of Army or DoD STEM research	30.2%	17.5%	35.3%	17.1%	
	207	120	242	117	**686**
I am more interested in pursuing a STEM career with the Army or DoD	45.9%	20.0%	24.1%	10.1%	
	315	137	165	69	**686**

In order to further understand the impact of eCM, an open-ended item on the questionnaire asked students to list the three most important ways they benefited from participating. In a sample of 100 responses from e-CM regional students, the most often cited benefit, mentioned by more than half (52%) of students) was teamwork. About a third of students cited STEM learning (34%) and the opportunity to solve real-world problems (33%). Other benefits included research skills (19%), organization and time management (14%), career information (14%), social benefits such as time with friends and meeting new people (14%), communication and/or writing skills (13%), and increased interest in STEM (8%). The 68 NJ&EE students who responded cited similar benefits, although they were less likely to emphasize teamwork (22%), and more likely to emphasize career information (29%) than

were regional students. Other benefits cited by NJ&EE students included STEM learning (28%), real-world problem solving (22%), networking (21%), Army/DoD and/or AEOP information (15%), public speaking (13%), research skills (8%), and confidence (8%).

NJ&EE students participating in focus groups mentioned similar benefits of participating in eCM. For example:

> "I learned a lot about mainly teamwork and also real-world applications, like how we can use what we're learning and put it into a problem and solve the problem." (eCM-N Student)
>
> "I learned a lot about STEM careers. In school, we usually just learn about STEM, but not as much [about] careers.". (eCM-N Student)
>
> "[The biggest benefit of eCM was] probably being able to create a mission folder and a portfolio of all our achievements…There was also how our projects are real science, how they directly relate to the community, and how we're actually being able to make a difference." (eCM-N Student)
>
> "We get to apply real-world skills in creating our mission folder and working out all the teamwork and collaboration…Also, I loved being able to connect with more people outs of the small town that I'm from. Being able to learn about other people and more STEM pathways [is a benefit of eCM]." (eCM-N Student)

8 | Findings and Recommendations

Summary of Findings

The FY18 evaluation of eCM collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the Table 57.

Table 57. 2018 eCM Evaluation Findings

Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
Participation in eCM decreased slightly in FY18 as compared to previous years. The demographics of students participating in the NJ&EE in terms of race/ethnicity are not representative of the demographics of students competing at regional levels.	In FY18, eCM regional sites registered 20,004 students, which represents a slight (6%) decrease from FY17 (21,277), and a 3% decrease from the 20,607 students who participated in FY16.
	Overall, 52% of students engaged in regional eCM were from underserved groups. As in previous years, both males and females are relatively equally represented at the regional level (51% were female and 49% were male).
	Slightly less than half (45%) of regional students identified themselves as White, 18% identified themselves as Hispanic or Latino/a, 13% identified themselves as Black or African American 9% as Asian, and 8% of students chose not to report their race/ethnicity.
	NJ&EE participants included a much smaller percentage (32%) of underserved students compared to the regional level (52%). Over half of NJ&EE participants (52%) were Asian, while 33% were White, 4% were Hispanic or Latino/a, and 3% were Black or African American.
eCM student participants reported engaging in STEM practices more frequently in eCM than in their typical school experiences, although students competing at the NJ&EE reported significantly more frequent engagement than students competing at the regional level, and there were differences in engagement by U2 status, and between several subgroups.	A majority of eCM national and regional respondents indicated they engaged with most STEM practices at least once during eCM. Nearly all (90%-100%) eCM and NJ&EE students reported engaging in STEM practices such as analyzing data or information and drawing conclusions and working collaboratively as part of a team. A majority (60% -86%) of eCM and NJ&EE participants reported engaging in several other STEM practices during eCM, including using laboratory procedures or tools; solving real world problems; designing and carrying out an investigation; and identifying questions or problems to investigate.
	Regardless of competition level, students reported significantly greater Engagement with STEM in eCM than in school (high effect size for both NJ&EE and regional students)
	There were differences in engagement in STEM across several subgroups: ● National competition level students reported significantly higher engagement in STEM practices in eCM than Regional level students (small effect size) ● Non-U2 students reported significantly higher levels of engagement in STEM as compared to U2 students (small effect size)

	• Non-minority students reported significantly higher levels compared to minority students (small effect size) • Low-SES students reported significantly lower levels of engagement in STEM practices compared to non-free/reduced lunch students (small effect size). • Students attending schools in the suburbs reported significantly higher levels compared to urban/rural/frontier school students (small effect size) • Students who had at least one parent attend college reported significantly higher levels compared to students who did not have a parent attend college (small effect size).
eCM student participants reported gains in their STEM knowledge as a result of participating in eCM, although students competing at the NJ&EE reported significantly greater gains than students competing at the regional level, and there were differences in gains were differences in gains by U2 status, and between several subgroups .	A large majority (nearly 80% or more) of eCM and NJ&EE students indicated they experienced some degree of STEM knowledge gain as a result of participating in eCM.
	Differences in gains in STEM knowledge were identified across various subgroups: • Students competing at the NJ&EE level reported significantly higher STEM Knowledge gains than Regional level students (medium effect size) • Non-U2 students reported significantly higher gains than U2 students (small effect size) • Non-minority students reported larger gains than minority students (small effect size) • Low-SES students reported significantly lower STEM Knowledge gains compared to regular-SES students (small effect size) • No differences in STEM Knowledge were found by gender or ESL status. • Students with a parent who had attended college reported significantly higher STEM Knowledge gains compared to students who did not have a parent attend college (small effect size)
eCM student participants reported gains in their STEM competencies, although students competing at the NJ&EE reported significantly greater gains than students competing at the regional	A majority of eCM and NJ&EE student participants (53% - 98%) reported at least small gains on all STEM competency (science and engineering practices) items.

level, and there were differences in gains by first generation college status, and SES status.	Although there were no differences in students' gains in STEM competencies by U2 status, the following group differences were identified: ● Students competing at the NJ&EE reported significantly higher gains in STEM Competencies compared to regional students (large effect size) ● Students who had a parent attend college reported significantly higher gains in STEM Competencies than students who did not have a parent who attended college (small effect size) ● Low-SES students reported significantly lower gains in STEM competencies than regular SES students (small effect size).
Student participants reported that eCM had positive impacts on their 21st Century Skills, although students competing at the NJ&EE reported significantly larger gains than students competing at the regional level, and there were differences in gains by first generation college status. Mentors reported that they observed gains in students' 21st Century Skills over the course of their eCM participation.	Most eCM students (92% - 99% NJ&EE; 83% - 90%) reported at least small gains in all items assessing the knowledge, skills, and habits that are considered critical for success in the 21st century workplace.
	Although there was no significant difference by U2 status, significant differences by subgroup were identified for students' gains in 21st Century skills: ● NJ&EE students reported significantly greater gains in their 21st Century skills than regional students (small effect size) ● Students who had a parent attend college reported significantly greater gains in their 21st Century Skills (small effect size).
	Students whose schools were participating in the eCM Mini-Grant experienced significant growth in assessed 21st Century skills from the beginning (pre-) to the end (post-) of their eCM experiences for all six assessed domains. On average, participants' initial ratings were at the Progressing level while their final, post-eCM, ratings were at the approaching Demonstrates Mastery level.
Students reported gains in their STEM identities as a result of participating in eCM, although students competing at the NJE&E reported significantly larger gains than students competing at the regional level, and there were differences in gains by	Most eCM students (59% - 93%) reported at least small gains in items related to their STEM identities, including their interest in STEM and feelings of self-efficacy regarding STEM, however the impact of eCM on participants' STEM identities varied greatly by competition level. Nearly all NJ&EE students (more than 90%) indicated at least some gain as a result of eCM, and regional eCM students reported an average of slightly more than two-thirds (68%) for the same.
	Although there was no significant difference by U2 status, significant differences in STEM Identity gains were identified for some subgroups:

first generation college status and SES status.	• Students competing at the NJ&EE reported significantly higher STEM Identity gains than regional students (large effect size) • Students who did not have a parent who attended college reported significantly lower gains in STEM Identity (small effect size) • Low-SES students reported significantly lower gains in STEM identity (small effect size)
Priority #2: *Support and empower educators with unique Army research and technology resources*	
Team advisors used a range of mentoring strategies with students.	A majority of mentors reported using strategies to establish the relevance of learning activities (85% - 91%), support the diverse needs of students as learners (54% - 94%), support students' development of collaboration and interpersonal skills (63% - 96%), and support students' engagement in authentic STEM activities (73% - 96%). Most mentors also used strategies to support students' STEM educational and career pathways (33% - 72%); as compared to other areas of mentoring, fewer mentors reported using several of these strategies, including discussing STEM career opportunities within the DoD or other government agencies, recommending student and professional organizations in STEM to students, helping participants build a professional network in a STEM field, and helping participants with their resume, application, personal statement, and/or interview preparations.
Very few eCM team advisors discussed any AEOP other than eCM with students.	While fewer than 15% of team advisors reported discussing any AEOP other than eCM with students (4%-13%), over a third (36%) indicated they discussed AEOP programs in general.
eCM students reported being satisfied with program features that they had experienced, although students competing at the NJE&E reported higher levels of satisfaction than students competing at the regional level. Students also offered various suggestions for program improvement.	Very few NJ&EE participants (4% or fewer) reported being dissatisfied with any feature of eCM about which they were asked, and most had experienced each of the features and were at least somewhat satisfied with each feature they had experienced. More regional students had not experienced various program features (9%-50%), and were more likely (10%-15%) to express being "not at all" satisfied with features. Areas in which majorities of both national and regional participants reported being somewhat or very much satisfied were the submission process, applying or registering for the program, the eCM website, and educational materials used during program activities.

	Regional eCM students' suggestions for improvement focused on eCM content or resources, including providing better or clearer instructions, questions, and/or deadlines; providing more topics or options for projects; providing more ideas and/or examples of projects; allowing more time or shortening the project requirements; improving the website; and providing more support or resources for student research.
	NJ&EE students' suggestions for improvement focused on elements of the NJ&EE event, including providing more freedom and/or free time for students, improving the quality and/or choice of food, providing more and/or longer field trips, shorter program days and/or more time to sleep, more time to socialize with other teams, and more hands-on/interactive activities.
eCM team advisors reported being satisfied with program features that they had experienced. Mentors also offered various suggestions for program improvements.	Very few team advisors (2% or less) expressed dissatisfaction with any program features. More than half of team advisors reported not experiencing Cyber Guide live chats and Cyber Guide discussion forums. Large majorities of mentors were at least somewhat satisfied with all program features they had experienced.
	Team advisors cited a number of strengths of eCM, including its focus on real-world problems, the opportunity for students to work in teams, the usefulness of program materials and resources, and the opportunity for students to develop research skills.
	Team advisors suggested improvements focused on eCM resources, program features, and website improvements. Improvements suggested for resources included providing more student live supports; providing more sample mission folders and/or examples of successful projects; and providing more specific information, more choices of topics, and/or clearer questions. Improvements related to program features included allowing more varied group sizes and/or mixing grade levels within groups; allowing more time for students to complete projects; and providing a timeline or incremental deadlines. Suggested improvements for the website included general improvements and improving features related to mission folder submission. Other qualitative findings included a perceived need for increased publicity for the program and suggestions for using students and alumni as eCM ambassadors.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	

Students were motivated to participate in eCM primarily by the learning and service opportunities.	Students most frequently identified the desire to learn something new or interesting (eCM - 41%, NJ&EE - 56%) and serving the community or country (eCM - 12%, NJ&EE - 36%) as motivators for participating.
eCM participants were likely to express interest in participating in eCM again, however the majority of students at the regional level had not heard of other AEOPs.	A large majority of students (92%) competing at the NJ&EE were at least a little interested in competing in eCM again, and 64% of students at the regional level were interested in participating again in the future.
	Findings suggest that students are exposed to other AEOPs at NJ&EE. Most NJ&EE students reported that they had heard of all other AEOPs, and over half (54% - 92%) expressed having some interest in participating in each of the programs in the future. As compared with FY17, NJ&EE students' awareness of JSS increased (38% had not heard of it in FY17; 22% in FY18). More than half of all regional students reported not having heard of any AEOP other than eCM, and fewer (11%-38%) expressed interest in future participation in other AEOPs as compared to NJ&EE students (38%-89%).
	Adults reported that participating in eCM (89%) and the eCM website (93%) were the most useful resources for exposing students to AEOPs, however most adult respondents had not experienced any of the other resources listed, such as the AEOP website, AEOP social media, and the AEOP brochure.
eCM students at all competition levels learned about STEM careers generally, however students competing at the NJ&EE level were much more likely to be familiar with DoD STEM jobs or careers.	All NJ&EE students and 70% of regional participants reported hearing about at least one STEM job/career through eCM. However, NJ&EE students reported learning about more DoD jobs/careers than regional participants. Nearly all NJ&EE (93%) and only 38% of regional students indicated learning about one or more DoD STEM job/career.
	Adults rated participation in eCM (73%) and the eCM website (81%) as the most useful resources for exposing students to DoD STEM careers. More than half of adults had not having experienced any of the other AEOP resources.
	NJ&EE students in focus groups cited the workshops and presentations at the NJ&EE as sources of information about DoD STEM careers, along with research they conducted during their projects, and talking with mentors.

eCM students expressed positive opinions about DoD research and researchers, although regional students were less likely to have an opinion when asked about these topics.	Most students at both the regional and national levels of competition agreed with various statements about DoD research and researchers, although NJ&EE students expressed greater agreement (90% or more) than regional students (approximately 50%) across items.. Approximately a third of all regional students indicated "neither agree nor disagree" with items related to DoD research and researchers compared to less than 10% of NJ&EE students.
Most eCM students competing at the NJ&EE level reported that they were more likely to engage in various STEM activities in the future after participating in eCM, although regional students reported substantially less increase in the likelihood of future STEM engagement, and there were significant differences by U2 status, race/ethnicity, first generation college status, and SES status.	An average of two-thirds (67%) of NJ&EE students reported they were more likely to engage in all STEM activities about which they were asked. A 30% point average gap existed between national and regional respondents' reports of likelihood to engage in activities such as helping with a community service project related to STEM, talking with friends or family about STEM, and participating in a STEM camp, club, or competition. It is noteworthy, however, that the regional respondent reports are 5 percentage points higher than FY17 regional findings for these items.
	There were differences in likelihood of future engagement in STEM across subgroups: ● Students competing at the NJ&EE were significantly more likely to report an increase in likelihood of future STEM engagement than were regional participants (medium effect size) ● U2 students were significantly less likely to report an increase in likelihood of future STEM engagement (small effect size) ● Minority students were significantly less likely to report an increase in likelihood of future STEM engagement (small effect size) ● Students who did not have a parent who attended college were significantly less likely to report an increase in likelihood of future STEM engagement (small effect size) ● Low SES students were significantly less likely to report an increase in likelihood of future STEM engagement (small effect size).
Most eCM students planned to at least complete a Bachelor's degree.	Regardless of competition level, the vast majority of students (eCM - 87%, NJ&EE - 99%) expected to, at minimum, complete a Bachelor's degree. More than half of NJ&EE students (67%) reported aspirations to get more education after college while fewer than half of regional

	students (42%) indicated that they intended to pursue post-Baccalaureate education.
eCM had positive impacts for students at all levels of competition, however NJ&EE students reported significantly higher levels of impact, and there were significant differences in impact by subgroups.	More than half of students at both the regional and NJ&EE levels of competition reported that eCM impacted their STEM knowledge, skills, and abilities (eCM - 65%, NJ&EE - 96%) and gave them a greater appreciation of Army or DoD STEM research (eCM - 52%, NJ&EE - 94%). in terms of eCM's impact on their future interest in other AEOP programs or DoD STEM positions, there was a substantial difference by group with NJ&EE reporting much higher impacts than regional students in their interest in participating in other AEOPs (eCM - 39%, NJ&EE - 95%); more interested in pursuing a STEM career with the Army or DoD (eCM - 34%, NJ&EE - 81%).
	Although there was no significant difference in overall program impact by U2 status, significant differences across some subgroups were identified: ● Students competing at the NJ&EE reported significantly higher levels of overall impact in comparison to regional students (large effect size). Minority students reported significantly lower levels of overall impact compared to non-minority students (very small effect size) ● Low-SES students reported significantly lower levels of overall impact compared to regular-SES students (very small effect size) ● ESL students reported significantly higher levels of overall impact than non-ESL students (very small effect size).
	Both students at the regional and national competition levels cited benefits of participating in eCM. Regional students were most likely to identify teamwork, STEM learning, and the opportunity to solve real-world problems as benefits. National students were most likely to identify career information, STEM learning, teamwork, the opportunity to solve real-world problems, and the opportunity to network as benefits of participating in eCM.

Responsiveness to FY17 Evaluation Recommendations

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

In this report, we will highlight recommendations made in FY17 to programs and summarize efforts and outcomes reflected in the FY18 APR toward these areas.

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

FY17 Recommendation: Despite NSTA's continued efforts in outreach to the Team Advisors and subsequently students through emails and the eCM website, the results of the survey indicate that, as in FY16 (53% regional; 23% NJ&EE) and few participants use the CyberGuide live chat (22% regional; 38% NJ&EE). NSTA should continue to work to market to participants the value of the use of these important resources to increase the usage.

eCM FY18 Efforts and Outcomes: Was not discussed in the FY18 APR under responsiveness to FY17 evaluation, so unclear what efforts and outcomes eCM engaged in to address this recommendation.

FY17 Recommendation: In FY17, more than a third of regional eCM participants (31%) reported on the evaluation survey they had not learned about any DoD/STEM jobs/careers. Conversely, 68% of NJ&EE participants reported learning about five or more DoD/STEM careers. NSTA should continue to work with regional sites to infuse the learning and connections of the program to the DoD and relevant STEM careers within and outside of the DoD.

eCM FY18 Efforts and Outcomes: Was not discussed in the FY18 APR under responsiveness to FY17 evaluation, so unclear what efforts and outcomes eCM engaged in to address this recommendation.

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

FY17 Recommendation: Students continue to report having little knowledge of other programs in the AEOP. This is an area of concern due to the overarching goal of creating an AEOP pipeline and retention of participants in additional AEOPs. Over a third (38%) of NJ&EE students had never heard of JSS, indicating two things: 1) eCM is likely their first program in the AEOP pipeline, and 2) eCM may not be

marketing this program as frequently as other opportunities. Few Team Advisor/Adults (9%) reported discussing any other AEOPs with students besides eCM, a decrease from 25% in FY16. Most regional participants (60-71%) had not heard of other individual AEOPs. As stated in FY16, the evaluation results suggest that more should be done to make the connection and to inform students of future opportunities in AEOP. In addition, since Team Advisors are an important source of student information, additional efforts should be made to educate Team Advisors about the AEOP and programs for which their students are eligible.

eCM FY18 Efforts and Outcomes: Was not discussed in the FY18 APR under responsiveness to FY17 evaluation, so unclear what efforts and outcomes eCM engaged in to address this recommendation.

Recommendations for FY19 Program Improvement/Growth

Evaluation findings indicate that FY17 was another successful year for the eCM program. A notable success for the year was the engagement of underserved students at the regional level, which was 53%. Overall, 80% or more of participants in eCM reported growth in STEM knowledge and 21st Century Skills as a result of participation in the program. While these successes are commendable, there are some areas that remain with potential for growth and/or improvement.

The evaluation team therefore offers the following recommendations for FY18 and beyond:

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

The NJ&EE demographics continue to not be reflective of the overall population of participants in eCM. Only 32% of NJ&EE students were from underserved backgrounds, compared to 53% of the overall participant group. It is recommended that NSTA utilize scaffolding strategies and supports to enable more participants from underserved groups to grow their skills and knowledge so that they have increased opportunities for success. A targeted campaign to reach out to past participants from underserved groups that includes additional mentoring through the process is one potential strategy to engage students in future years who have experienced the program and provide additional supports to increase their chance of having a more effective project and presentation for eCM.

The overall participation in eCM has continued on a downward trend. In FY18, participation decreased by 6%. It is recommended that eCM employ strategies to reach new participants, as well as supports for previous participants to engage again. Through multiple years of participation, it is likely that students will grow their knowledge, skills, and experience with competition programs and this in and of itself may

increase their chances of success in the future. Therefore, reaching out to underserved groups of past participants may be a strategy that may help with both of these areas for future growth.

In FY18, participants at regional and national levels again reported significantly different experiences in eCM. At the national level, students reported being more engaged in STEM practices. Further, students from underserved backgrounds reported less engagement in STEM practices in eCM than for other students. This trend was also similar for students from suburban schools. Therefore, in the continuous improvement process, eCM should think about resources and strategies that may work to level the playing field for students from various backgrounds, as well as finding ways to make regional experiences more similar in context and quality as NJ&EE experiences. Though some of this may be attributed to NJ&EE students coming from more affluent areas and more supportive backgrounds prior to NJ&EE, it is clear that the week-long activities at NJ&EE are something that regional students could benefit from if there were some way to package opportunitites online or through the local mentor.

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

Few Team Advisors (less than 15%) are discussing specific AEOP opportunities other than eCM with participants. This is an incredible missed opportunity, as students in eCM are eligible for a number of other AEOP programs in the future, including apprenticeships and programs such as JSHS and Unite.

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

As in FY17, eCM students overall continue to report having little knowledge of other programs in the AEOP besides eCM (more than 50%). Additionally, only 38% of eCM regional participants reported learning about DoD STEM careers. It is understood that the level of influence over the many regional sites is less than what is available at the NJ&EE. However, it is recommended that eCM work with the consortium to utilize current and develop other additional resources that teachers/Team Advisors can use as tools to communicate with students about future AEOP opportunities and DoD STEM careers overall.