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ARMY EDUCATIONAL OUTREACH PROGRAM

eCYBERMISSION

2020 Annual Program Evaluation Report

Evaluation Findings

August 2021

aeop ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

AEOP Priorities

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

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

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

This report documents the evaluation of one of the AEOP elements, the eCYBERMISSION program (eCM), which is administered on behalf of the Army by the National Science Teaching Association (NSTA). The evaluation study was performed by North Carolina State 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 NSTA. Since the program's inception in 2002, over 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) typically held in the Washington, D.C. metropolitan area. In 2020, the NJ&EE was held as a virtual event due to pandemic-related travel restrictions.

A total of 14,245 students entered state competitions in FY20. The top 3 teams from each of the five regions in each grade level advanced to regional competitions for regional judging done via video conference (facilitated by Zoom). The highest score in each region for each grade determined the national finalists. The STEM in Action Grant recipient teams are selected from the regional finalist teams that submit a proposal to implement their solution in their community. Ten STEM in Action grants were awarded in 2020 to teams selected from the regional finalist teams to implement their solution in their community. Twenty National Finalist Teams with a total of 73 students along with their Team Advisors competed at the virtual NJ&EE in FY20.

The number of students participating in the eCM competition in FY20 (14,245, see Table 1) was 21% lower than in FY19, when 17,944 students registered, and a decrease of 29% compared to the FY18 when 20,004 students participated. This continues a multi-year downward trend in participation since FY17 (21,277 participants).

Table 2 summarizes demographic information for students who competed at regional competitions and for those who competed at the NJ&EE. As in previous years, eCM participants were about half (49%) female and nearly half (48%) male (in FY19, 49% were female and 48% were male; in both FY18 and FY17, 51% were female and 49% were male); 3% of participants chose not to report their gender. Less than half (40%) of overall eCM students identified themselves as White (40% in FY19; 45% in FY18; 48% in FY17) with another 24% identifying themselves as Hispanic or Latino/a (22% in FY19; 18% in FY18; 19% in FY17). Similar to previous years, 12% of participants identified themselves as Black or African American (13% in FY19; 13% in FY18; 10% in FY17) while 11% identified themselves as Asian (9% in FY19; 9% in FY18; 10% in FY17). Five percent of students identified as "other" race or ethnicity and 7% of students chose not to report their race/ethnicity. Over half of students (56%) met the AEOP definition of underserved (underserved), compared to 59% in FY19 and 53% in FY18.[1]

[1] AEOP's definition of underserved (underserved) 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).

Over half of the 73 national finalists (58%) were female (60% in FY19; 63% in FY18). Slightly more than a third (37%) of NJ&EE participants were White (40% in FY19; 30% in FY18; 47% in FY17), and 43% (38%) were Asian (38% in FY19; 52% in FY18; 30% in FY17). While White and Asian students composed the majority of the NJ&EE population, 8% were Hispanic or Latino/a (7% in FY19; 7% in FY18; 5% in FY17), and 3% were Black or African American (3% in FY19; 3% in FY18; 4% in FY17). Less than half (38%) of NJ&EE participants met the AEOP definition of underserved in FY19 (40% in FY19).

Data for eCM Team Advisors by type of school location are included in Table 3. Most team advisors came from either suburban (46%) or urban (34%) schools, while 14% came from rural schools. Small numbers came from DoDEA schools (2%), or from home school, online, frontier or tribal schools settings (<1% each).

Table 1. 2020 eCM State-Level Participation

State/DoDEA/ Territories[2]	No. of Participants	State/DoDEA/ Territories	No. of Participants
AE-E	59	**NC**	362
AK	4	**ND**	18
AL	109	**NE**	4
AP	225	**NH**	7
AR	39	**NJ**	121
AZ	408	**NM**	36
CA	568	**NV**	469
CO	134	**NY**	468
CT	27	**OH**	197
DC	66	**OK**	32
DE	4	**OR**	134
FL	4875	**PA**	179
GA	688	**PR**	18
GU	89	**RI**	0
HI	158	**SC**	517
IA	0	**SD**	0
ID	83	**TN**	295
IL	189	**TX**	821
IN	61	**UT**	197
KS	65	**VA**	393
KY	23	**VT**	116
LA	81	**WA**	60
MA	211	**WI**	97
MD	401	**WV**	24
ME	7	**WY**	0
MI	595	**INTER**	4
MN	26	**MP**	0
MO	298	**Total Participation**	14,245
MS	165		
MT	18		

[2] AE-E – Armed Forces Europe; INTER – International (locations outside of DoDEA); MP – Northern Mariana Islands

Table 2. 2020 eCM Student Profile				
Demographic Category	**Overall Participants (n=14,234)***		**eCM-NJ&EE Participants (n=73)**	
Gender	**(n=14,234)**		**(n=73)**	
Female	7,000	49.2%	42	57.5%
Male	6,860	48.2%	30	41.1%
Choose not to report	374	2.6%	1	1.4%
Race/Ethnicity	**(n=14,234)**		**(n=73)**	
Asian	1,612	11.3%	31	42.5%
Black or African American	1,745	12.3%	2	2.7%
Hispanic or Latino	3,372	23.7%	6	8.2%
Native American or Alaska Native	83	<1%	0	0%
Native Hawaiian or Other Pacific Islander	102	<1%	1	1.4%
White	5,625	39.5%	27	37.0%
Other race or ethnicity (self-reported, some more than 1 race)	699	4.9%	4	5.5%
Choose not to report	996	7.0%	2	2.7%
School Location	**(n=14,234)**		**(n=73)**	
Urban	4,906	34.5%	17	23.3%
Suburban	6,912	48.6%	42	57.5%
Rural	890	6.3%	11	15.1%
DoDEA or DODDS	410	2.9%	0	0%
Frontier/Tribal School	11	<1%	0	0%
Home School	27	<1%	0	0%
Online School	26	<1%	0	0%
Choose not to report	1,052	7.4%	3	4.1%
Grade Level	**(n=14,234)**		**(n=73)**	
6th	3,739	26.3%	18	24.7%
7th	4,128	29.0%	19	26.0%
8th	4,632	32.5%	19	26.0%
9th	1,735	12.2%	17	23.3%
Receives Free or Reduced-Price Lunch (FARMS)	**(n=14,234)**		**(n=73)**	
Yes	4,260	29.9%	11	15.1%
No	7,315	51.4%	59	80.8%
Choose not to report	2,659	18.7%	3	4.1%
English is First Language	**(n=14,234)**		**(n=73)**	
Yes	11,295	79.4%	66	90.4%
No	2,270	15.9%	6	8.2%
Choose not to report	669	4.7%	1	1.4%

One or More Parent/Guardian Graduated from College	(n=14,234)		(n=73)	
Yes	10,827	76.1%	70	95.9%
No	1,886	13.2%	3	4.1%
Choose not to report	1,521	10.7%	0	0%
Underserved Status	**(n=14,234)**		**(n=73)**	
Yes	7,911	55.6%	28	38.4%
No	4,502	31.6%	43	58.9%
Insufficient data to make determination**	1,821	12.8%	2	2.7%

*eCYBERMISSION database indicates 14,245 total participants. There were 11 participants Cvent did not include when importing participants due to various reasons (e.g., improper email address, street address, etc.). Thus, demographic data were not collected for these 11 students.

** Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for underserved status.

Table 3. 2020 eCM Team Advisor Participation by School Location

School Location Type	No. of total Participants (n=575)*	Percentage of total Participants
Team Advisors from DoDEA	13	2.3%
Team Advisors from Home School	2	<1%
Team Advisors from Online School	1	<1%
Team Advisors Rural	80	13.9%
Team Advisors Suburban	265	46.1%
Team Advisors Urban	198	34.4%
Team Advisors Frontier or Tribal School	2	<1%
Choose not to report	14	2.4%
No responses	0	0%

*eCYBERMISSION database indicates 578 total Team Advisors. There were 3 Team Advisors Cvent did not include when importing Team Advisors due to various reasons (e.g., improper email address, street address, etc.). Thus, demographic data were not collected for these 3 Team Advisors.

The total cost of the 2020 eCM program was $2,533,753. The average cost per student participant for 2020 eCM was $178 (Table 4).

Table 4. 2020 eCM Program Costs

Total Cost	$2,533,753
Total Travel*	$151,420
Participant Travel	$109,868
Total Awards	$633,974
Student Awards/Stipends	$628,574

Adult/Teacher/Mentor Awards	$5,400
Cost Per Student	$178

* Note: The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

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4 | Evaluation At-A-Glance

NC State University, in collaboration with NSTA, conducted a comprehensive evaluation of eCM. The eCM 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, Cyber Guides, 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 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, 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 the 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 questionnaires, telephone interviews with students and adults who had participated in the NJ&EE virtual event, and the program information provided by NSTA. Questionnaires were administered to students who competed at the state level, students who competed at the national (NJ&EE) level, and Team Advisors. Twelve phone interviews were conducted with eCM students who participated in the NJ&EE and ten with Team Advisors who participated in the NJ&EE. Findings are reported herein for students who competed at the state level (referred to as overall students since all participants competed at this level) and for students who competed at the NJ&EE (referred to as eCM-N students or NJ&EE students). Tables 5-9 outline the information collected in student and Team Advisor questionnaires and interviews as well as program information provided by NSTA 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. 2020 Student Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals
AEOP Goal 1	**Capturing the Student Experience:** In-school vs. In-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; 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 AEOP and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving eCM, overall satisfaction

Table 6. 2020 Team Advisor Questionnaire	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of AEOP, satisfaction with and suggestions for improving eCM, 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; efforts to expose students to AEOP, 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 AEOP and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 7. 2020 Student Interviews	
Category	**Description**
Satisfaction & Suggestions	Awareness of AEOP, motivating factors for participation, awareness of implications of research topics, satisfaction with and suggestions for improving eCM, 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. 2020 Team Advisor Interviews	
Category	**Description**
Satisfaction & Suggestions	Perceived value of eCM, benefits to participants suggestions for improving eCM
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 eCM

Table 9. 2020 Program Information Provided by NSTA	
Category	**Description**
Program	Description of eCM 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 state, national event); Participation of Army engineers and/or Army research facilities in event activities (varies by overall eCM, national event)
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

The eCM Evaluation included an 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 technological progress. Thus, it is important to consider 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.[3] 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 beginning 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 in year one. Subsequent funding was provided by AEOP. 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

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

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

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

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

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

significance are noted in the report narrative, with tables and footnotes providing results from tests for significance. Interview 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 NGSTP interview protocol is provided in Appendix F. Major trends in data and analyses are reported herein.

Study Sample

Questionnaire respondents for the FY20 eCM evaluation included 1,810 overall (state) eCM participants, 53 national students, and 187 Team Advisors. Team Advisors indicated their region on the evaluation questionnaire (Table 10).

Table 10. Team Advisor Identified Region on Evaluation Questionnaire (n=187)

eCM Region	Response Percent	Response Total
West	18.7%	35
North Central	11.8%	22
South Central	10.2%	19
North East	13.9%	26
South East	28.8%	54
Not Sure	16.6%	31

Table 11 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 margins of error for eCM-N students and for Team Advisors are outside of the acceptable range, and therefore findings for eCM-N students and Team Advisors should be interpreted with caution as they may not be generalizable to the overall population.

Table 11. 2020 eCM Questionnaire Respondents

Participant Group	Respondents (Sample)	Total Participants* (Population)	Participation Rate	Margin of Error @ 95% Confidence[4]
Overall eCM Students	1,810	14,234	12.7%	± 2.15%
eCM-N Students	53	73	72.6%	± 7.09%
Team Advisors	187	578	32.4%	± 5.89%

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

[4] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response

Because the 2020 NJ&EE was held as a virtual event, phone interviews were conducted in lieu of focus groups. Twelve students and ten Team Advisors participated in phone interviews. Interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of an 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 FY20 participants who completed the evaluation survey are provided in Table 12. Slightly more eCM participants reported being female (56%) compared to male (42%) while gender distribution was equal for eCM-NJ&EE respondents (50% female; 50% male). Similar to past years, more overall eCM and national survey participants identified with the race/ethnicity category of White (43% eCM; 45% NJ&EE) than any other category. Overall, grade level distribution was relatively equal across 7th – 9th grades (21%-33% eCM; 23%-34%). Two thirds or more of both groups (66% eCM; 85% NJ&EE) reported they did not qualify for free or reduced-price lunch (FARMS) on the evaluation survey. Few eCM (11%) and NJ&EE (7%) students reported being English Language Learners. While slightly over half of the survey participants reported attending a suburban school (52% eCM; 57% NJ&EE), approximately a quarter (24% eCM; 27% NJ&EE) indicated they were from urban schools. Very few students reported being first-generation college-going students regardless of group (10% eCM; 0% NJ&EE). Less than half of overall eCM survey participants (44%) met the AEOP definition of underserved compared to only 17% of NJ&EE participants. Demographic data for survey respondents is similar to that of the overall population of eCM participants.

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.

Table 12. 2020 eCM Student Respondent Profile				
Demographic Category	**Overall eCM Questionnaire Respondents**		**eCM-NJ&EE Questionnaire Respondents**	
Gender	**eCM n=1,166**		**eCM NJ&EE n=30**	
Female	650	55.7%	15	50.0%
Male	493	42.3%	15	50.0%
Choose not to report	23	2.0%	0	0%
Race/Ethnicity	**eCM n=1,802**		**eCM NJ&EE n=53**	
Asian	252	14.0%	18	34.0%
Black or African American	258	14.3%	1	1.9%
Hispanic or Latino	330	18.3%	5	9.4%
Native American or Alaska Native	4	<1%	0	0%
Native Hawaiian or other Pacific Islander	10	<1%	0	0%
White	782	43.4%	24	45.2%
Other race or ethnicity (specify)*	57	3.2%	3	5.7%
Choose not to report	109	6.0%	2	3.8%
Grade Level	**eCM n=1,810**		**eCM NJ&EE n=53**	
6th	65	3.6%	0	0%
7th	377	20.8%	13	24.5%
8th	493	27.2%	18	34.0%
9th	605	33.4%	12	22.6%
10th	264	14.6%	10	18.9%
Other	6	<1%	0	0%
School Location	**eCM n=1,810**		**eCM NJ&EE n=30**	
Urban	429	23.7%	8	26.7%
Rural	157	8.7%	3	10.0%
Suburban	948	52.4%	17	56.6%
DoDEA	0	0%	0	0%
Home school	0	0%	0	0%
Online school	0	0%	0	0%
I don't know	276	15.2%	0	0%
Choose not to report	0	0%	2	6.7%
Receives Free or Reduced-Price Lunch (FARMS)	**eCM n=1,810**		**eCM NJ&EE n=53**	
Yes	461	25.5%	4	7.5%
No	1,190	65.7%	45	85.0%
Choose not to report	159	8.8%	4	7.5%
English is First Language	**eCM n=1,810**		**eCM NJ&EE n=30**	
Yes	1,614	89.2%	28	93.3%
No	196	10.8%	2	6.7%

Choose not to report	0	0%	0	0%
One or More Parent/Guardian Graduated from College	**eCM n=1,810**		**eCM NJ&EE n=30**	
Yes	1,449	80.1%	30	100%
No	178	9.8%	0	0%
I don't know	126	7.0%	0	0%
Choose not to report	57	3.1%	0	0%
underserved Status	**eCM n=1,810**		**eCM NJ&EE n=53**	
Yes	794	43.9%	9	17.0%
No	707	39.0%	17	32.1%
Insufficient data to make determination**	309	17.1%	27	50.9%

* Other = African; African America, White, & Indian; Asian & White (3); Black, Asian, & White; Bengali; Biracial; Black & Latino (2); Black & White (10); Bosnian; Chinese; Hispanic & White (5); Hispanic, Asian, & Black; Indian (4); Latino (4); Latino, Asian, & Pacific Islander; Middle Eastern (6); Mixed (7); Polish.

** Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for underserved status.

Team Advisor Demographics

Adult/team advisor survey respondent demographic information is provided in Table 13. Approximately two-thirds of adults who completed the evaluation survey reportedly were female (70%) and White (62%). Three-quarters of adults reported being teachers (78%), and nearly all (96%) indicated they were eCM Team Advisors.

Table 13. 2020 eCM Adult Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Gender (n=187)		
Female	131	70.1%
Male	53	28.3%
Choose not to report	3	1.6%
Race/Ethnicity (n=187)		
Asian	28	15.0%
Black or African American	16	8.6%
Hispanic or Latino	12	6.4%
Native American or Alaska Native	1	<1%
Native Hawaiian or other Pacific Islander	2	1.1%
White	116	62.0%
Other race or ethnicity, (specify)[†]	2	1.1%
Choose not to report	10	5.3%
Occupation (n=187)		
Teacher	146	78.1%
Other school staff	3	1.6%
University educator	4	2.1%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	1	<1%
Scientist, Engineer, or Mathematics professional	17	9.1%
Other, (specify):[‡]	16	8.6%
Role in eCM (n=187)*		
Research Mentor	9	4.8%
Team advisor	179	95.7%
Teacher	50	26.7%
Other, (specify)[§]	0	4.8%

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

[†] Black & Hispanic; Mixed

[‡] Architect; Information Technology (3); JROTC Instructor; Nurse; Parent (3); Physician; Retired Intelligence Officer; Retired Teacher (2); STEM Coordinator; Teacher/Librarian (2)

5

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 21st Century Skills Assessment (Johnson & Sondergeld, 2016) evaluation is generally completed for a sample of eCM mini-grant awardees. Mentors assess each participant in a pre/post manner. The first assessment is completed in the first days of the program (pre), and the second assessment is completed at the end of the program (post). The assessment is then used to determine the growth toward mastery for each participant during their time in the eCM program. The assessment tool can be found in Appendix F. Mentors rate each participant's skills in six domains of 21st Century skills:

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

Due to COVID-19 circumstances, eCM did not complete the 21st Century Skills Assessment on participants this year. However, this assessment will continue in future programming years.

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 (Tables 14 & 15). Similar to FY19, three-quarters or more of NJ&EE and more than a third of overall eCM participants reported engaging in all STEM practices at least once during their program. Both eCM and NJ&EE students noted engaging in the following four practices most frequently (50% or more reporting weekly or every day): Working collaboratively as part of a team (eCM - 76%; NJ&EE - 92%); Analyzing data or information and draw conclusions (eCM - 67%; NJ&EE - 85%); Designing and carrying out investigations (eCM - 56%; NJ&EE - 77%); and solving real world problems (eCM - 58%; NJ&EE - 72%). Parallel items about STEM practices students engaged with during school were also asked, and those results are provided in Tables 16 and 17.

Composite scores were computed for each set of items for "Engaging in STEM Practices in eCM."[5] Response categories were converted to a scale of 1 = "Not at all" to 4 = "Every day" and averages across all items on each scale was calculated. Composite scores were used to test whether there were differences in student experiences by AEOP-defined underrepresented status (underserved) and all subgroups that make up underserved (gender, race/ethnic group, school location, FARMS, ELL, and college first generation). Additionally, differences in outcomes by participation level (national or overall eCM) were also investigated. No differences were found in terms of engaging with STEM practices in eCM by overall underserved status. However, there were differences in gender (females reporting higher; very small effect size of d=0.198), race/ethnicity (minority students reporting lower; very small effect size of d=0.166), FARMS (low-SES reporting lower; very small effect size of d=0.111), and competition level (national reporting higher; small effect size of d=0.206).[6]

Composite scores were also developed for the "Engaging in STEM Practices in School" items[7] to compare eCM STEM practice experiences to students' typical school STEM practice experiences. Students reported significantly greater engagement with STEM in eCM than in school[8] regardless of the competition level (NJ&EE - medium effect of d = 0.785; eCM overall - large effect of d = 1.34) (see Chart 1).

[5] The Cronbach's alpha reliability for these 10 items was 0.853.
[6] Independent samples t-tests – Gender: $t(1808) = 4.20$, $p < 0.001$; Race/Ethnicity: $t(1808) = 3.53$, $p < 0.001$; FARMS: $t(1808) = 2.36$, $p = 0.018$; Competition Level: $t(1808) = 4.38$, $p < 0.001$.
[7] The Cronbach's alpha reliability for these 10 items was 0.839.
[8] Dependent samples t-tests – overall eCM: $t(1809) = 16.70$, $p < 0.001$; National: $t(54) = 4.93$, $p < 0.001$.

Table 14. STEM Practices During eCM for NJ&EE Participants (n=53)

	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	20.8%	49.1%	20.8%	9.4%	
	11	26	11	5	**53**
Work with a STEM researcher on a research project topic assigned by my teacher	24.5%	47.2%	22.6%	5.7%	
	13	25	12	3	**53**
Design my own research or investigation based on my own question(s)	3.8%	30.2%	52.8%	13.2%	
	2	16	28	7	**53**
Present my STEM research to a panel of judges from industry or the military	18.9%	62.3%	15.1%	3.8%	
	10	33	8	2	**53**
Interact with STEM researchers	13.2%	35.8%	47.2%	3.8%	
	7	19	25	2	**53**
Use laboratory procedures or tools	3.8%	28.3%	56.6%	11.3%	
	2	15	30	6	**53**
Design and carry out an investigation	5.7%	17.0%	58.5%	18.9%	
	3	9	31	10	**53**
Analyze data or information and draw conclusions	1.9%	13.2%	52.8%	32.1%	
	1	7	28	17	**53**
Work collaboratively as part of a team	1.9%	5.7%	37.7%	54.7%	
	1	3	20	29	**53**
Solve real world problems	5.7%	22.6%	32.1%	39.6%	
	3	12	17	21	**53**

Table 15. STEM Practices During eCM for Overall Participants (n=1,810)

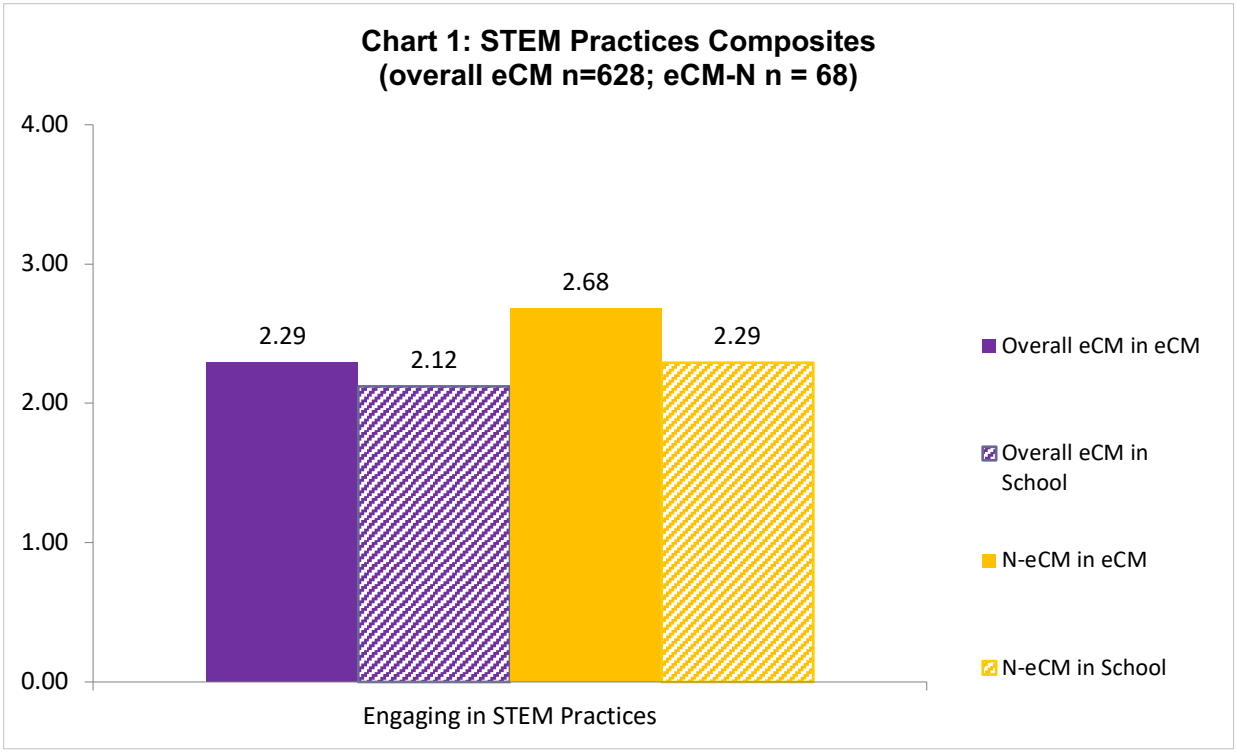
	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	57.7%	28.7%	10.1%	3.5%	
	1,045	520	182	63	**1,810**
Work with a STEM researcher on a research project topic assigned by my teacher	49.2%	30.7%	15.4%	4.7%	
	890	556	279	85	**1,810**
Design my own research or investigation based on my own question(s)	15.2%	36.6%	32.3%	15.8%	
	276	663	585	286	**1,810**
Present my STEM research to a panel of judges from industry or the military	63.3%	27.1%	6.3%	3.3%	
	1,146	490	114	60	**1,810**
Interact with STEM researchers	53.1%	30.9%	10.8%	5.1%	
	961	560	196	93	**1,810**
Use laboratory procedures and tools	17.6%	37.6%	30.1%	14.8%	
	318	680	544	268	**1,810**
Design and carry out an investigation	11.3%	32.4%	34.4%	21.9%	
	205	586	623	396	**1,810**
Analyze data or information and draw conclusions	6.2%	26.5%	40.1%	27.2%	
	113	480	725	492	**1,810**
Work collaboratively as part of a team	5.2%	18.5%	32.2%	44.1%	
	95	334	582	799	**1,810**
Solve real world problems	11.0%	30.7%	28.0%	30.3%	
	200	556	506	548	**1,810**

Table 16. STEM Practices During School for eCM NJ&EE Participants (n=53)

	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	49.1%	37.7%	11.3%	1.9%	
	26	20	6	1	**53**
Work with a STEM researcher on a research project topic assigned by my teacher	45.3%	43.4%	9.4%	1.9%	
	24	23	5	1	**53**
Design my own research or investigation based on my own question(s)	13.2%	49.1%	32.1%	5.7%	
	7	26	17	3	**53**
Present my STEM research to a panel of judges from industry or the military	60.4%	34.0%	5.7%	0.0%	
	32	18	3	0	**53**
Interact with STEM researchers	35.8%	41.5%	20.8%	1.9%	
	19	22	11	1	**53**
Use laboratory procedures and tools	13.2%	30.2%	47.2%	9.4%	
	7	16	25	5	**53**
Design and carry out an investigation	9.4%	37.7%	47.2%	5.7%	
	5	20	25	3	**53**
Analyze data or information and draw conclusions	1.9%	15.1%	58.5%	24.5%	
	1	8	31	13	**53**
Work collaboratively as part of a team	0.0%	5.7%	49.1%	45.3%	
	0	3	26	24	**53**
Solve real world problems	11.3%	47.2%	22.6%	18.9%	
	6	25	12	10	**53**

Table 17. STEM Practices During School for eCM Overall Participants (n=1,810)

	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	61.1%	28.3%	8.4%	2.2%	
	1,106	513	152	39	**1,810**
Work with a STEM researcher on a research project topic assigned by my teacher	50.1%	34.4%	12.7%	2.9%	
	906	622	230	52	**1,810**
Design my own research or investigation based on my own question(s)	23.0%	44.9%	25.2%	6.9%	
	417	812	456	125	**1,810**
Present my STEM research to a panel of judges from industry or the military	72.3%	22.3%	3.7%	1.8%	
	1,308	403	67	32	**1,810**
Interact with STEM researchers	56.6%	32.3%	7.8%	3.3%	
	1,024	585	141	60	**1,810**
Use laboratory procedures and tools	16.2%	42.0%	33.8%	8.0%	
	294	761	611	144	**1,810**
Design and carry out an investigation	15.2%	42.7%	33.1%	9.0%	
	276	772	600	162	**1,810**
Analyze data or information and draw conclusions	7.3%	30.3%	44.9%	17.5%	
	132	548	813	317	**1,810**
Work collaboratively as part of a team	4.9%	19.7%	44.5%	30.9%	
	88	357	806	559	**1,810**
Solve real world problems	15.1%	37.1%	28.3%	19.6%	
	273	671	512	354	**1,810**



STEM Knowledge and Skills

Students were asked to report on their gains in knowledge and STEM skills as a result of participating in eCM (Tables 18 and 19). More than 85% of overall eCM and all NJ&EE students indicated they experienced at least small gains in their STEM knowledge as a result of participating in eCM. More students in NJ&EE agreed the program had medium to large impacts across STEM knowledge and skills items compared to overall eCM students, approximately 60% of whom reported medium to large gains.

Table 18. eCM--NJ&EE Participant Reports of Impact on STEM Knowledge (n=53)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	0.0%	13.2%	35.8%	50.9%	
	0	7	19	27	**53**
Knowledge of research processes, ethics, and rules for conduct in STEM	0.0%	15.1%	30.2%	54.7%	
	0	8	16	29	**53**
Knowledge of how scientists and engineers work on real problems in STEM	1.9%	11.3%	24.5%	62.3%	
	1	6	13	33	**53**
Knowledge of what everyday research work is like in STEM	1.9%	17.0%	28.3%	52.8%	
	1	9	15	28	**53**

Table 19. Overall eCM Participant Reports of Impact on STEM Knowledge (n=1,810)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	8.3%	28.1%	45.6%	18.0%	
	151	508	825	326	**1,810**
Knowledge of research processes, ethics, and rules for conduct in STEM	9.4%	26.9%	38.2%	25.5%	
	170	487	692	461	**1,810**
Knowledge of how scientists and engineers work on real problems in STEM	11.8%	26.7%	34.9%	26.5%	
	214	484	632	480	**1,810**
Knowledge of what everyday research work is like in STEM	13.7%	26.1%	33.0%	27.2%	
	248	472	597	493	**1,810**

To evaluate differences in STEM knowledge gains by subgroup, survey items were combined into a composite variable.[9] Significant differences in STEM knowledge gains were found by overall underserved status (underserved reporting lower; very small effect size of $d = 0.134$), race/ethnicity (minority students reporting lower; very small effect size of $d = 0.143$), FARMS (low-SES students reporting lower; very small effect size of $d = 0.098$), and competition level (national reporting higher; small effect size of $d = 0.268$).[10]

[9] The Cronbach's alpha reliability for these 4 items was 0.864.

[10] Independent samples *t*-tests – underserved Status: $t(1508) = 2.60$, $p = 0.009$; Race/Ethnicity: $t(1861) = 3.08$, $p = 0.002$; FARMS: $t(1861) = 2.12$, $p = 0.031$; Competition Level: $t(1861) = 5.78$, $p < 0.001$.

Tables 20 and 21 summarize the impact of eCM on students' STEM competency gains. More than half of the survey participants reported medium or large gains across STEM competency items. Participants in NJ&EE (72%-91%) reported greater gains in STEM competencies compared to their overall eCM peers (58%-75%) across all items. Items with the largest group differences in reported medium or large gains (20% points or more) were: Identifying the limitations of the methods and tools used for collecting data (eCM - 62%; NJ&EE - 91%); Defining a problem than can be solved by developing a new or improved product or process (eCM - 66%; NJ&EE - 89%); Considering multiple interpretations of data to decide if something works as intended (eCM – 58%; NJ&EE - 79%); and Supporting an explanation with my STEM knowledge or data from experiments (eCM - 62%; NJ&EE - 83%).

Composite scores were calculated for gains in STEM competencies[11] and used to assess for differential impacts on STEM competencies depending on student group membership. Significant STEM competency differences were not found by overall underserved status. However, significant differences in STEM competencies gains were found by gender (females reporting higher; small effect size of d = 0.210), race/ethnicity (minority students reporting lower; very small effect size of d = 0.115), FARMS (low-SES students reporting lower; very small effect size of d = 0.103), and competition level (national reporting higher; small effect size of d = 0.223).[12]

Table 20 eCM-NJ&EE Participant Gains in their STEM Competencies – Science and Engineering Practices (n=53)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	0.0%	11.3%	26.4%	62.3%	
	0	6	14	33	**53**
Creating a hypothesis or question that can be tested in an experiment	5.7%	17.0%	34.0%	43.4%	
	3	9	18	23	**53**
Using my knowledge and creativity to suggest a solution to a problem	0.0%	20.8%	28.3%	50.9%	
	0	11	15	27	**53**
Making a model to show how something works	7.5%	20.8%	22.6%	49.1%	
	4	11	12	26	**53**
	1.9%	11.3%	37.7%	49.1%	

[11] The STEM Competencies composite (13 items) has a Cronbach's alpha reliability of 0.937.
[12] Independent samples t-tests – Gender: $t(1861) = 4.54$, $p < 0.001$; Race/Ethnicity: $t(1861) = 2.47$, $p = 0.014$; FARMS: $t(1861) = 2.22$, $p = 0.027$; Competition Level: $t(1861) = 4.81$, $p < 0.001$.

Designing procedures or steps for an experiment that work	1	6	20	26	**53**
Identifying the limitations of the methods and tools used for collecting data	0.0%	9.4%	35.8%	54.7%	
	0	5	19	29	**53**
Carrying out an experiment and recording data accurately	1.9%	11.3%	32.1%	54.7%	
	1	6	17	29	**53**
Creating charts or graphs to display data and find patterns	1.9%	30.2%	26.4%	41.5%	
	1	16	14	22	**53**
Considering multiple interpretations of data to decide if something works as intended	3.8%	17.0%	35.8%	43.4%	
	2	9	19	23	**53**
Supporting an explanation with my STEM knowledge or data from experiments	1.9%	15.1%	32.1%	50.9%	
	1	8	17	27	**53**
Identifying the strengths and limitations of data or arguments presented in technical or scientific texts	1.9%	22.6%	28.3%	47.2%	
	1	12	15	25	**53**
Presenting an argument that uses data and/or findings from an experiment	3.8%	15.1%	22.6%	58.5%	
	2	8	12	31	**53**
Defending an argument based upon findings from an experiment or other data	3.8%	17.0%	30.2%	49.1%	
	2	9	16	26	**53**

Table 21. Overall eCM Participant Gains in their STEM Competencies – Science and Engineering Practices (n=1,810)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	8.2%	26.1%	41.4%	24.3%	
	149	472	750	439	**1,810**
Creating a hypothesis or question that can be tested in an experiment	6.9%	21.5%	39.4%	32.2%	
	124	390	714	582	**1,810**
Using my knowledge and creativity to suggest a solution to a problem	5.9%	19.4%	36.7%	38.0%	
	107	351	664	688	**1,810**
Making a model to show how something works	14.3%	24.1%	32.7%	28.8%	
	259	437	592	522	**1,810**
Designing procedures or steps for an experiment that work	7.7%	25.0%	37.9%	29.4%	
	140	452	686	532	**1,810**
Identifying the limitations of the methods and tools used for collecting data	9.9%	28.2%	38.3%	23.5%	
	179	511	694	426	**1,810**
Carrying out an experiment and recording data accurately	7.7%	21.9%	39.1%	31.3%	
	139	396	708	567	**1,810**
Creating charts or graphs to display data and find patterns	13.7%	28.0%	32.8%	25.5%	
	248	507	593	462	**1,810**
Considering multiple interpretations of data to decide if something works as intended	11.4%	30.9%	35.0%	22.7%	
	206	559	634	411	**1,810**
Supporting an explanation with my STEM knowledge or data from experiments	10.2%	27.4%	39.0%	23.4%	
	184	496	706	424	**1,810**
Identifying the strengths and limitations of data or arguments presented in scientific or technical texts	11.4%	29.8%	37.5%	21.4%	
	206	539	678	387	**1,810**
Presenting an argument that uses data and/or findings from an experiment	11.4%	27.1%	36.0%	25.5%	
	206	491	652	461	**1,810**

Defending an argument based upon findings from an experiment or other data	13.8%	26.0%	34.9%	25.4%	
	249	471	631	459	**1,810**

Students responded to survey items about the impact of eCM on their 21st Century skills (Tables 22 & 23). Overall eCM participants reported lower gains (39% to 79% medium/large gains) compared to NJ&EE participants (45% to 87% medium/large gains). Items with large proportions of both competition levels reporting as medium/large gains were: Working creatively with others (NJ&EE – 87%, eCM – 79%); Using my creative ideas to make a product (NJ&EE – 83%, eCM – 75%); Communicating clearly with others (NJ&EE – 83%, eCM – 71%); and Solving problems (NJ&EE – 85%, eCM – 75%).

For overall eCM survey participants, a 21st Century skills composite variable[13] was computed to test for differences between student subgroups. No differences in 21st Century skills were not found by overall underserved status. However, significant differences in 21st Century skills gains were found by gender (females reporting higher; very small effect size of $d = 0.182$) and competition level (national reporting higher; very small effect size of $d = 0.109$).[14]

[13] The 21st Century Skills composite (23 items) had a Cronbach's alpha reliability of .964.
[14] Independent samples *t*-tests – Gender: $t(1861) = 3.92$, $p < 0.001$; Competition Level: $t(1861) = 2.35$, $p = 0.019$.

Table 22. eCM-NJ&EE Participant Reports of Impacts on 21st Century Skills (n=53)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	3.8%	18.9%	35.8%	41.5%	
	2	10	19	22	**53**
Working creatively with others	0.0%	13.2%	28.3%	58.5%	
	0	7	15	31	**53**
Using my creative ideas to make a product	1.9%	15.1%	32.1%	50.9%	
	1	8	17	27	**53**
Thinking about how systems work and how parts interact with each other	7.5%	17.0%	26.4%	49.1%	
	4	9	14	26	**53**
Evaluating others' evidence, arguments, and beliefs	9.4%	11.3%	34.0%	45.3%	
	5	6	18	24	**53**
Solving problems	0.0%	15.1%	37.7%	47.2%	
	0	8	20	25	**53**
Communicating clearly (written and oral) with others	3.8%	13.2%	35.8%	47.2%	
	2	7	19	25	**53**
Collaborating with others effectively and respectfully in diverse teams	3.8%	15.1%	28.3%	52.8%	
	2	8	15	28	**53**
Interacting effectively with others in a respectful and professional manner	3.8%	15.1%	37.7%	43.4%	
	2	8	20	23	**53**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	5.7%	20.8%	37.7%	35.8%	
	3	11	20	19	**53**
Using and managing data accurately, creatively, and ethically	3.8%	15.1%	26.4%	54.7%	
	2	8	14	29	**53**
Analyzing media (news) - understanding points of view in the media	11.3%	32.1%	18.9%	37.7%	
	6	17	10	20	**53**
	26.4%	28.3%	17.0%	28.3%	

Creating media products like videos, blogs, social media	14	15	9	15	**53**
Use technology as a tool to research, organize, evaluate, and communicate information	3.8%	24.5%	28.3%	43.4%	
	2	13	15	23	**53**
Adapting to change when things do not go as planned	1.9%	22.6%	34.0%	41.5%	
	1	12	18	22	**53**
Incorporating feedback on my work effectively	1.9%	22.6%	35.8%	39.6%	
	1	12	19	21	**53**
Setting goals and utilizing time wisely	5.7%	18.9%	35.8%	39.6%	
	3	10	19	21	**53**
Working independently and completing tasks on time	3.8%	13.2%	45.3%	37.7%	
	2	7	24	20	**53**
Taking initiative and doing work without being told to	3.8%	26.4%	24.5%	45.3%	
	2	14	13	24	**53**
Prioritizing, planning, and managing projects to achieve completion	3.8%	18.9%	30.2%	47.2%	
	2	10	16	25	**53**
Producing results - sticking with a task until it is finished	3.8%	18.9%	28.3%	49.1%	
	2	10	15	26	**53**
Leading and guiding others in a team or group	5.7%	15.1%	26.4%	52.8%	
	3	8	14	28	**53**
Being responsible to others - thinking about the larger community	0.0%	18.9%	30.2%	50.9%	
	0	10	16	27	**53**

Table 23. Overall eCM Participant Reports of Impacts on 21st Century Skills (n=1,810)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	7.7%	18.3%	34.4%	39.6%	
	139	332	623	716	**1,810**
Working creatively with others	6.2%	15.0%	34.6%	44.2%	
	112	272	626	800	**1,810**
Using my creative ideas to make a product	8.5%	17.0%	35.2%	39.3%	
	154	308	637	711	**1,810**
Thinking about how systems work and how parts interact with each other	10.4%	22.9%	36.7%	29.9%	
	189	415	664	542	**1,810**
Evaluating others' evidence, arguments, and beliefs	7.9%	21.8%	38.8%	31.5%	
	143	394	703	570	**1,810**
Solving problems	5.7%	19.7%	37.0%	37.7%	
	103	356	669	682	**1,810**
Communicating clearly (written and oral) with others	7.7%	21.4%	34.8%	36.1%	
	140	387	629	654	**1,810**
Collaborating with others effectively and respectfully in diverse teams	6.6%	18.7%	36.4%	38.3%	
	120	339	658	693	**1,810**
Interacting effectively with others in a respectful and professional manner	6.9%	19.5%	37.4%	36.2%	
	124	353	677	656	**1,810**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	7.2%	23.6%	41.3%	27.8%	
	131	428	747	504	**1,810**
Using and managing data accurately, creatively, and ethically	7.3%	22.9%	38.6%	31.2%	
	132	414	699	565	**1,810**
Analyzing media (news) - understanding points of view in the media	16.0%	29.9%	32.4%	21.7%	
	290	542	586	392	**1,810**
	34.9%	26.4%	22.5%	16.2%	

Creating media products like videos, blogs, social media	631	478	407	294	**1,810**
Use technology as a tool to research, organize, evaluate, and communicate information	7.7%	23.9%	34.4%	34.0%	
	140	432	622	616	**1,810**
Adapting to change when things do not go as planned	7.7%	20.2%	35.9%	36.2%	
	140	365	650	655	**1,810**
Incorporating feedback on my work effectively	7.6%	25.5%	38.6%	28.4%	
	137	461	698	514	**1,810**
Setting goals and utilizing time wisely	8.2%	21.3%	37.3%	33.2%	
	148	386	675	601	**1,810**
Working independently and completing tasks on time	9.2%	22.9%	33.6%	34.3%	
	167	415	608	620	**1,810**
Taking initiative and doing work without being told to	8.8%	22.3%	34.4%	34.4%	
	160	404	623	623	**1,810**
Prioritizing, planning, and managing projects to achieve completion	8.2%	20.1%	39.5%	32.2%	
	149	363	715	583	**1,810**
Producing results - sticking with a task until it is finished	7.9%	21.2%	35.9%	35.0%	
	143	383	650	634	**1,810**
Leading and guiding others in a team or group	10.1%	19.0%	35.1%	35.8%	
	183	343	636	648	**1,810**
Being responsible to others - thinking about the larger community	6.7%	19.1%	34.4%	39.9%	
	121	345	622	722	**1,810**

STEM Identity and Confidence

Both overall eCM and NJ&EE students were asked a series of survey questions to assess the impact of eCM on their STEM identities. Because students are unlikely to pursue STEM if they do not see themselves as capable of succeeding in STEM[15], 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 was greater for NJ&EE participants (64%-85% medium/large impact) compared to overall eCM participants (39%-65% medium/large impact) (Tables 24 and 25). Three items with the greatest eCM impact (medium/large) for both competition levels were: Sense of accomplishment from their work in the program (overall eCM - 65%; NJ&EE - 85%); Better prepared for more challenging STEM activities (overall eCM - 59%; NJ&EE - 77%); and Confidence to try out new ideas or procedures on their own in a STEM project (overall eCM - 55%; NJ&EE - 81%).

Table 24. eCM-NJ&EE Participant Reports on Impacts on STEM Identity (n=53)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	7.5%	18.9%	34.0%	39.6%	
	4	10	18	21	**53**
Interest in pursuing a STEM career	15.1%	20.8%	28.3%	35.8%	
	8	11	15	19	**53**
Sense of accomplishment from my work in the program	1.9%	13.2%	20.8%	64.2%	
	1	7	11	34	**53**
Better prepared for more challenging STEM activities	1.9%	20.8%	28.3%	49.1%	
	1	11	15	26	**53**
Confidence to try out new ideas or procedures on my own in a STEM project	7.5%	11.3%	30.2%	50.9%	
	4	6	16	27	**53**
Desire to build relationships with mentors who work in STEM	7.5%	24.5%	35.8%	32.1%	
	4	13	19	17	**53**

[15] 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.

Table 25. Overall eCM Participant Reports on Impacts on STEM Identity (n=1,810)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	22.5%	29.4%	28.3%	19.8%	
	407	532	513	358	**1,810**
Interest in pursuing a STEM career	31.5%	29.7%	23.4%	15.4%	
	570	538	424	278	**1,810**
Sense of accomplishment from my work in the program	11.2%	24.0%	34.7%	30.1%	
	202	435	628	545	**1,810**
Feeling prepared for more challenging STEM activities	15.1%	25.9%	33.9%	25.1%	
	274	468	614	454	**1,810**
Confidence to try out new ideas or procedures on my own in a STEM project	16.7%	28.5%	32.0%	22.7%	
	303	516	580	411	**1,810**
Desire to build relationships with mentors who work in STEM	28.1%	28.8%	25.8%	17.3%	
	509	521	467	313	**1,810**

A composite score for STEM Identity items[16] was computed to assess for differential eCM program impact on subgroups of students. No differences in STEM Identity were found by overall underserved Status. Significant STEM identity differences were found by race/ethnicity (minority students reporting lower; very small effect size of $d = 0.109$) and competition level (national reporting higher; small effect size of $d = 0.240$).[17]

[16] The Cronbach's alpha reliability for these 6 STEM Identity items was 0.906.

[17] Independent samples *t*-tests – Gender: $t(1861) = 4.54$, $p < 0.001$; Race/Ethnicity: $t(1861) = 2.47$, $p = 0.014$; FARMS: $t(1861) = 2.22$, $p = 0.027$; Competition Level: $t(1861) = 4.81$, $p < 0.001$.

6

6 | Priority #2 Findings

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

Team Advisor 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 comprise five main areas of effective team advising:[18]

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

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

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

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

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

Adults were asked about their use of multiple strategies related to effective team advising. Tables 26-30 display eCM adult responses and show that the majority of adults reported using various effective mentoring strategies in their team advising.

Approximately two-thirds or more of eCM adults reported using all strategies associated with establishing the relevance of learning activities (Table 26). Strategies with 90% or more of Team Advisors reporting using were: Becoming familiar with student backgrounds and interests at the beginning of eCM (94%); Asking students to relate real-life events or activities to topics covered in eCM (95%); and Helping students understand how STEM can help them improve their communities (96%).

Table 26. Team Advisors Using Strategies to Establish the Relevance of Learning Activities (n=187)

	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	93.6%	6.4%	
	175	12	**187**
Giving students real-life problems to investigate or solve	89.3%	10.7%	
	167	20	**187**
Selecting readings or activities that relate to students' backgrounds	61.5%	38.5%	
	115	72	**187**
Encouraging students to suggest new readings, activities, or projects	85.6%	14.4%	
	160	27	**187**
Helping students become aware of the role(s) that STEM plays in their everyday lives	88.8%	11.2%	
	166	21	**187**
Helping students understand how STEM can help them improve their own community	96.3%	3.7%	
	180	7	**187**
Asking students to relate real-life events or activities to topics covered in eCYBERMISSION	95.2%	4.8%	
	178	9	**187**

More than half of eCM Team Advisors indicated using all strategies to support the diverse needs of learners (Table 27). Strategies used by more than 90% of adult respondents were: Interacting with students and other personnel the same way regardless of their background (92%); and Using a variety of teaching and/or mentoring activities to meet the needs of all students (94%). Similar to FY19, the strategy of Highlighting under-representation of women and racial/ethnic minority populations in STEM and/or their contributions in STEM (57%) was reportedly used least by eCM Team Advisors.

Table 27. Team Advisors Using Strategies to Support the Diverse Needs of Learners (n=187)

	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	75.9%	24.1%	
	142	45	**187**
Interact with students and other personnel the same way regardless of their background	90.4%	9.6%	
	169	18	**187**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	93.6%	6.4%	
	175	12	**187**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	73.3%	26.7%	
	137	50	**187**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	74.3%	25.7%	
	139	48	**187**
Directing students to other individuals or programs for additional support as needed	82.4%	17.6%	
	154	33	**187**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	57.2%	42.8%	
	107	80	**187**

Similar to FY19, two-thirds or more of eCM Team Advisors reported using all strategies to support participants' development of collaboration and interpersonal skills (Table 28). Three strategies reportedly used by more than 90% were: Having participants listen to the ideas of others with an open mind (95%); Having participants give and receive constructive feedback with others (94%); and Having participants exchange ideas with others whose backgrounds/viewpoints are different from their own (92%). The least implemented strategy was having participants tell other people about their backgrounds/interests (68%).

Table 28. Team Advisors Using Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n=187)

	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	67.9%	32.1%	
	127	60	**187**
Having participant(s) explain difficult ideas to others	85.0%	15.0%	
	159	28	**187**
Having participant(s) listen to the ideas of others with an open mind	94.7%	5.3%	
	177	10	**187**
Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	92.0%	8.0%	
	172	15	**187**
Having participant(s) give and receive constructive feedback with others	93.6%	6.4%	
	175	12	**187**

As within past years, three-quarters or more of eCM Team Advisors reported implementing all strategies to support participants' engagement in authentic STEM activities (Table 29). More than 90% of Team Advisors reported using three strategies: Supervising participants while they practice STEM research skills (96%); Providing participants with constructive feedback to improve STEM competencies (96%); and Allowing participants to work independently to improve their self-management abilities (98%).

Table 29. Team Advisors Using Strategies to Support Participant Engagement in Authentic STEM Activities (n=187)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	76.5%	23.5%	
	143	44	**187**
Having participant(s) search for and review technical research to support their work	88.8%	11.2%	
	166	21	**187**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	81.3%	18.7%	
	152	35	**187**
Supervising participant(s) while they practice STEM research skills	95.7%	4.3%	
	179	8	**187**
Providing participant(s) with constructive feedback to improve their STEM competencies	95.7%	4.3%	
	179	8	**187**
Allowing participant(s) to work independently to improve their self-management abilities	97.9%	2.1%	
	183	4	**187**

Table 30 shows the final set of strategies Team Advisors were asked about related to supporting students' STEM educational and career pathways. Similar to past years, these strategies were reportedly used less frequently than any other previous strategy set. For approximately two-thirds of the items, 50% or more eCM adults reported implementation. 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 (73%); and Asking participants about their educational and/or career goals (70%).

One goal of AEOP is to increase participants' awareness of DoD STEM career opportunities. However, adult survey responses show that only around a third of adults (36%) reported discussing STEM career opportunities within the DoD or other government agencies with students. Another AEOP goal is to increase participants' awareness of AEOP opportunities, yet only a third (34%) of adults reported recommending other AEOP that align with student goals. While these responses are less than desirable, they represent slight increases from FY19.

Table 30. Team Advisors Using Strategies to Support Participant STEM Educational and Career Pathways (n=187)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking participant(s) about their educational and/or career goals	72.7%	27.3%	
	136	51	**187**
Recommending extracurricular programs that align with participants' goals	56.1%	43.9%	
	105	82	**187**
Recommending Army Educational Outreach Programs that align with participants' goals	33.7%	66.3%	
	63	124	**187**
Providing guidance about educational pathways that will prepare participant(s) for a STEM career	70.1%	29.9%	
	131	56	**187**
Discussing STEM career opportunities within the DoD or other government agencies	35.8%	64.2%	
	67	120	**187**
Discussing STEM career opportunities in private industry or academia	64.7%	35.3%	
	121	66	**187**
Discussing the economic, political, ethical, and/or social context of a STEM career	55.6%	44.4%	
	104	83	**187**
Recommending student and professional organizations in STEM to my student(s)	51.3%	48.7%	
	96	91	**187**
Helping participant(s) build a professional network in a STEM field	36.4%	63.6%	
	68	119	**187**
Helping participant(s) with their resume, application, personal statement, and/or interview preparations	35.8%	64.2%	
	67	120	**187**

NJ&EE student participants were also asked about the use of multiple teaching and mentoring strategies by their Team Advisors during their program (Table 31). The most frequently reported strategies include: Working on a team project or activity (96%); Learning or practicing a variety of STEM skills (93%); and Giving feedback to improve in STEM (93%). According to NJ&EE student participants, Team Advisors were less likely to recommend AEOP that align with student interests (42%) or discuss DoD STEM careers (42%).

Table 31. NJ&EE Student Reports of Teaching and Mentoring Strategies used by Team Advisors (n=53)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	69.8%	30.2%	
	37	16	**53**
Helped me understand how I can use STEM to improve my community	90.6%	9.4%	
	48	5	**53**
Used a variety of strategies to help me learn	90.6%	9.4%	
	48	5	**53**
Gave me extra support when I needed it	90.6%	9.4%	
	48	5	**53**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	90.6%	9.4%	
	48	5	**53**
Allowed me to work on a team project or activity	96.2%	3.8%	
	51	2	**53**
Helped me learn or practice a variety of STEM skills	92.5%	7.5%	
	49	4	**53**
Gave me feedback to help me improve in STEM	92.5%	7.5%	
	49	4	**53**
Talked to me about the education I need for a STEM career	56.6%	43.4%	
	30	23	**53**
Recommended Army Educational Outreach Programs (AEOP) that match my interests	41.5%	58.5%	
	22	31	**53**
Discussed STEM careers with the Department of Defense (DoD) or government	41.5%	58.5%	
	22	31	**53**

eCM student participants were also asked about the use of various teaching and mentoring strategies by their Team Advisors during their program (Table 32). The most commonly reported strategies include: Working on a team project or activity (90%); Teaching students how to use STEM to improve the community (82%); Providing feedback to improve in STEM (79%); and Giving extra support when needed (79%). eCM student responses suggest their Team Advisors were less likely to: Talk about education needed for STEM careers (44%); Recommend AEOP that align with student interests (30%); or Discuss DoD STEM careers (30%).

Table 32. eCM Student Reports of Teaching and Mentoring Strategies used by Team Advisors (n=1,810)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	70.5%	29.5%	
	1,276	534	**1,810**
Helped me understand how I can use STEM to improve my community	82.3%	17.7%	
	1,489	321	**1,810**
Used a variety of strategies to help me learn	77.8%	22.2%	
	1,409	401	**1,810**
Gave me extra support when I needed it	79.4%	20.6%	
	1,437	373	**1,810**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	73.0%	27.0%	
	1,321	489	**1,810**
Allowed me to work on a team project or activity	89.6%	10.4%	
	1,622	188	**1,810**
Helped me learn or practice a variety of STEM skills	74.5%	25.5%	
	1,349	461	**1,810**
Gave me feedback to help me improve in STEM	79.5%	20.5%	
	1,439	371	**1,810**
Talked to me about the education I need for a STEM career	43.6%	56.4%	
	790	1,020	**1,810**

Recommended Army Educational Outreach Programs that match my interests	30.2%	69.8%	
	546	1,264	**1,810**
Discussed STEM careers with the DoD or government	29.6%	70.4%	
	536	1,274	**1,810**

Although approximately 90% of eCM Team Advisors reported discussing eCM with their students, very few explicitly discussed any other AEOP (2% - 12%) with students (Table 33). However, nearly a third (31%) of Team Advisors said they discussed AEOP in general with their students, but without referencing any particular programs.

Table 33. Team Advisors' Responses to AEOP that were Explicitly Discussed with Participants (n=187)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Junior Solar Sprint (JSS)	9.1%	90.9%	
	17	170	**187**
Unite	2.7%	97.3%	
	5	182	**187**
Junior Science & Humanities Symposium (JSHS)	11.8%	88.2%	
	22	165	**187**
Science & Engineering Apprenticeship Program (SEAP)	5.9%	94.1%	
	11	176	**187**
Research & Engineering Apprenticeship Program (REAP)	6.4%	93.6%	
	12	175	**187**
High School Apprenticeship Program (HSAP)	6.4%	93.6%	
	12	175	**187**
GEMS Program	9.1%	90.9%	
	17	170	**187**
College Qualified Leaders (CQL)	2.1%	97.9%	
	4	183	**187**
GEMS Near Peer Mentor Program	3.7%	96.3%	
	7	180	**187**
	2.1%	97.9%	

Undergraduate Research Apprenticeship	4	183	**187**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	8.0%	92.0%	
	15	172	**187**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	1.6%	98.4%	
	3	184	**187**
I discussed AEOP with participant(s) but did not discuss any specific program	31.0%	69.0%	
	58	129	**187**
eCYBERMISSION	89.8%	10.2%	
	168	19	**187**

Program Features and Feedback/Satisfaction

Student responses on their satisfaction with eCM program features are presented in Tables 34 and 35. Overall, NJ&EE participants (40%-96%) reported higher levels of satisfaction compared to overall eCM participants (27%-84%). Program aspects that at least 75% of both national and overall eCM participants were somewhat or very much satisfied with included: Submission process (overall eCM - 80%; NJ&EE - 96%); Applying or registering for the program (overall eCM - 79%; NJ&EE - 94%); eCM website (overall eCM - 84%; NJ&EE - 89%); and educational materials (overall eCM - 77%; NJ&EE - 87%). More than a third of participants (38%-53%) at both the regional and national levels indicated not experiencing eCM features related to Cyber Guides (overall eCM - 48%; NJ&EE - 38%); Mission Control (phone) response time (overall eCM - 40%; NJ&EE - 53%); and Mission Control (email) response time (overall eCM - 46%; NJ&EE - 42%).

Table 34. NJ&EE Student Satisfaction with Program Features (n=53)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	3.8%	1.9%	32.1%	62.3%	
	2	1	17	33	**53**
Submission process	1.9%	1.9%	34.0%	62.3%	
	1	1	18	33	**53**
Value of Cyber Guide Live Chat	28.3%	7.5%	26.4%	37.7%	
	15	4	14	20	**53**
Variety of STEM Mission Challenges available	7.5%	7.5%	34.0%	50.9%	
	4	4	18	27	**53**

Value of Team Talk feedback	34.0%	5.7%	20.8%	39.6%	
	18	3	11	21	**53**
Value of Cyber Guides Discussion Forum	37.7%	7.5%	26.4%	28.3%	
	20	4	14	15	**53**
Educational materials (e.g., online resources, etc.) used during program activities	5.7%	7.5%	37.7%	49.1%	
	3	4	20	26	**53**
eCYBERMISSION website	7.5%	3.8%	34.0%	54.7%	
	4	2	18	29	**53**
Mission Control (phone) response time	52.8%	7.5%	17.0%	22.6%	
	28	4	9	12	**53**
Mission Control (email) response time	41.5%	1.9%	30.2%	26.4%	
	22	1	16	14	**53**

Table 35. Overall eCM Student Satisfaction with Program Features (n=1,810)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Applying or registering for the program	9.2%	11.4%	47.5%	31.8%	
	167	207	860	576	**1,810**
Submission process	7.2%	12.8%	46.1%	33.9%	
	131	232	834	613	**1,810**
Value of Cyber Guide live chat	61.8%	11.3%	17.0%	9.9%	
	1,118	205	307	180	**1,810**
Variety of STEM Mission Challenges available	28.3%	12.2%	37.9%	21.6%	
	513	220	686	391	**1,810**
Value of Team Talk feedback	44.5%	9.6%	28.0%	18.0%	
	805	173	506	326	**1,810**
Value of Cyber Guides discussion forum	47.9%	10.2%	26.7%	15.1%	
	867	185	484	274	**1,810**
Educational materials (e.g., online resources, etc.) used during program activities	13.8%	9.7%	41.7%	34.8%	
	250	176	755	629	**1,810**
eCYBERMISSION website	6.1%	10.1%	43.5%	40.3%	

	111	182	787	730	**1,810**
Mission control (phone) response time	49.8%	10.2%	23.0%	17.0%	
	902	184	417	307	**1,810**
Mission control (email) response time	46.4%	11.5%	24.3%	17.9%	
	839	208	439	324	**1,810**

In order to understand more about students' satisfaction with their overall eCM experience, overall eCM and eCM-N students were asked to respond to an open-ended item on the questionnaire asking them to comment on their satisfaction with eCM. Nearly all (92%) of the 150 overall eCM student responses sampled contained positive comments, and 74% made positive comments only. Some students who responded positively also included caveats about their experiences (18%). Very few overall eCM students (7%) made no positive comments about eCM, instead expressing dissatisfaction with various features of their experiences. Overall eCM students' positive comments focused upon satisfaction with various aspects of eCM including teamwork, real-world problem-solving, career information, and the organization of the program. Students said, for example,

> *"I was satisfied with my overall eCYBERMISSION experience. I enjoyed being able to work with others and to help solve real world problems with solutions that could work. The whole website/directions was very easy to understand and that made the whole process much easier."* (Overall eCM Student)

> *"This year (6th grade) I used eCYBERMISSION as a learning tool. I learned to be patient with my work, lead my team if there were to be a disagreement, and to learn how to use my resources in an efficient way."* (Overall e-CM Student)

> *"Participating in eCYBERMISSION was really fun. It helped me develop an interest in science and engineering, which I had never had before. I've always wanted to help the world, and …eCYBERMISSION made that dream come true. I also made some new friends along the way who shared my interests and helped the project become real. It's probably the hardest I've worked on a project, and that taught me many life skills such as time management, thinking creatively, and working with a team. I had an amazing learning experience with eCYBERMISSION, and I hope that more students will do it next year so they can experience and learn the skills they need for our growing world."* (Overall e-CM Student)

The eCM-R students who included caveats qualifying their positive comments mentioned various issues including difficulties in working with the website and Mission Folders, the difficulty and/or stressfulness of completing their project, a general lack of enthusiasm about STEM, dissatisfaction with aspects of the judging, and problems accessing online meetings. Students said, for example,

"I really enjoyed my experience, and I will do it again hopefully. The only issue I had was Mission Folder submission. There were lots of technicalities and glitches we encountered, and if that is resolved, there is nothing else I could say. It was a great experience." (Overall eCM Student)

"I would rate my satisfaction with my eCYBERMISSION experience 8 out of 10. I think eCYBERMISSION should grade more and give more points to how well the project is executed and not how good the solution to the project is." (Overall eCM Student)

The few eCM-R students (7%) who had no positive comments to make about their eCM experience cited dissatisfaction with the amount of work, the format of Mission Folder questions, teammates, being required to participate, and boredom with their projects as reasons for their dissatisfaction. One student said, for example,

"If there were less redundancies in the Mission Folder questions there would've been far less questions to answer meaning that we would've had more time to work on our actual project." (Overall eCM Student)

Students participating in the NJ&EE were also asked to respond to an open-ended questionnaire item about their overall satisfaction with eCM. All 47 eCM-N students who responded had positive things to say about their experiences. Slightly less than a quarter (23%) added caveats to their positive statements. eCM-N students cited the opportunity to help their communities and solve real world problems, the presentation skills they gained, opportunities to network with peers and professionals, teamwork, and the Army/DoD and career information they received as sources of satisfaction. Students said, for example,

"I've done eCYBERMISSION for 3 years and it's been the best STEM experience I've had. Being able to work with a team of my close friends and use our passion for science to solve a community problem was a great opportunity. I've become more outgoing in my presentation skills and the experiences I've had at nationals has been very educational and fun." (eCM-N Student)

"I love eCYBERMISSION because of how it has pushed WAY past my comfort zone. I love how the participants can choose a world-saving topic and gets to choose it themselves, as well as an AMAZING experience to meet important people in the US Army. Overall, I am very satisfied with my experience in eCYBERMISSION." (eCM-N Student)

A variety of caveats were added by the 23% of eCM-N students who qualified their positive comments. These caveats included dissatisfaction with missing the in-person NJ&EE event, the length of Zoom presentations during the NJ&EE, the timing of NJ&EE events for those in western time zones, comments about judging at the state level, and suggestions for including more creativity and art in challenges. These students said, for example,

"I was really looking forward to going to Washington D.C with my team. However due to the COVID19 pandemic that was not able to happen. Instead, we had to stay on Zoom calls for 1 to 3 1/2 hours! I would have been more satisfied with the Zoom calls if we were allowed to turn off our cameras. However, it was still a great experience for me as I was able to develop new talents and share my ideas with my team! But I still wish that we were able to go somewhere or get something with the money that you did not use because we didn't go to D.C I would have been a ton more satisfied if we would have won something or if we were able to go somewhere after the pandemic is over." (eCM-N Student)

"I was very happy to work with eCYBERMISSION, and it's has helped my improve my understanding of STEM and my communication skills. I understand that this issue was most likely due to COVID, however I would have liked a bit more consideration to the different time zones, for example for the national showcase, while it was 8:15 central time, it was 6:15 where I live in NM." (eCM-N Student)

"Overall, I was very satisfied with my eCYBERMISSION experience, particularly NJ&EE. If I could improve one thing, it would be how the mission folders are judged at the State level. The current system involves the judges giving a number score (ex. 591) and then the team with a higher number score gets State first. I think all folders in the 500-600 range should be judged again or reviewed (or at least the top 20) so teams with great projects don't get eliminated at the state level. (Although, I'm not really sure how the process for judging at the state level works). Otherwise, it's a great competition and I really enjoy it!" (eCM-N Student)

It is important to note that most eCM-N students who commented upon the virtual format of the NJ&EE made positive comments about the event in their phone interviews. The following is typical of eCM-N student comments about the event:

"I think it ran really smoothly this year, especially because they have probably been planning that trip to DC, and to be able to change that over and get it all done virtually in around a month or two, I think that [went] very well…all the hard work that the staff put in it just made it a great competition." eCM-N Student)

Students were also asked in an open-ended questionnaire item to list three ways in which eCM could be improved. A wide variety of suggestions were included in the 100 overall eCM student responses sampled, including the following:

- improving the website by improving the save function or autosaving work, making the submission process more user-friendly, improving the organization, or making printing from the site easier (33 comments)
- providing better or clearer instructions (20 comments)

- shortening the process, making it simpler, including fewer questions, or less writing (19 comments)
- providing more or different topics or challenges (15 comments)
- including more examples of projects (13 comments)
- providing mentors throughout the process and/or opportunities for feedback throughout the process (11 comments)
- providing more flexibility in teams sizes, including larger teams, smaller teams, or individual work (8 comments)
- communicating more frequently with Team Advisors and students regarding due dates and deadlines (6 comments)

The 45 eCM-N students who offered at least one suggestion for improvements also made a wide variety of suggestions. Comments included the following topics:

- more time and/or opportunities to connect with mentors (11 comments)
- improving communication (8 comments)
- problems with technology and/or suggestions for less time on Zoom (7 comments)
- providing more opportunities for students to connect with students from other teams (6 comments)
- providing more interactive and/or hands-on activities (6 comments)
- considering western time zones in planning the virtual event (5 comments)
- improvements to the website, including allowing interfaces with Google Slides and Google Docs (5 comments)
- improvements to judging, including providing feedback from judges, standardizing scoring at the state level, and having the judges ask better questions (5 comments)
- providing clearer instructions (4 comments)
- improving program organization and/or planning (4 comments)

eCM-N students participating in interviews had few suggestions for improvements, but those who did offer suggestions echoed the questionnaire responses and added suggestions for allowing more time to complete the mission folder, providing more workshops on different topics, and pairing students with mentors in students' fields of interest.

Team Advisors' responses to survey items asking about their satisfaction with various eCM features are similar to students' (Table 36). More than 90% of eCM Team Advisors reported being somewhat or very much satisfied with: Submission process (92%); eCM website (92%); and Application/registration process (90%). Large proportions (more than 50%) of Team Advisors also indicated they did not experience Cyber Guides Team Talk feedback (57%); Discussion forum (51%); and Live chat (55%).

Table 36. Team Advisor Satisfaction with eCM Program Features (n=187)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	2.1%	7.5%	20.3%	70.1%	
	0	4	14	38	131	**187**
Communication with National Science Teachers Association (NSTA)	20.9%	2.1%	7.5%	17.1%	52.4%	
	39	4	14	32	98	**187**
Submission process	1.1%	1.1%	5.9%	20.9%	71.1%	
	2	2	11	39	133	**187**
Value of Cyber Guide live chat	55.1%	3.7%	7.5%	15.5%	18.2%	
	103	7	14	29	34	**187**
The variety of STEM Mission Challenges available	4.8%	0.5%	8.0%	25.7%	61.0%	
	9	1	15	48	114	**187**
Value of Cyber Guides Team Talk feedback	57.2%	2.1%	7.0%	12.3%	21.4%	
	107	4	13	23	40	**187**
Value of Cyber Guides discussion forum	51.3%	3.7%	9.6%	14.4%	20.9%	
	96	7	18	27	39	**187**
eCYBERMISSION website	0.5%	1.1%	7.0%	20.9%	70.6%	
	1	2	13	39	132	**187**
Educational materials	9.1%	1.1%	9.6%	26.2%	54.0%	
	17	2	18	49	101	**187**
Mission control (phone) response time	43.3%	1.1%	1.1%	11.8%	42.8%	
	81	2	2	22	80	**187**
Mission control (email) response time	27.3%	4.3%	2.1%	15.0%	51.3%	
	51	8	4	28	96	**187**

Like the student questionnaires, the Team Advisor questionnaire included open-ended items asking participants to share their opinions about the program. Of the 145 adults who responded to an item asking them to comment on their overall satisfaction with eCM, nearly all (98%) made positive comments about the program. Some (14%) qualified their positive comments with caveats, and very few adult respondents (2%) made no positive comments. The 98% of Team Advisors who made positive comments about eCM focused on the real-world problem-solving aspects of the competition, the STEM or research skills students gained, and the opportunity for students to improve their communication skills. Adult respondents said, for example,

> *"eCYBERMISSION has allowed me to connect student learning to the real world. Students are able to take what they are learning in class and apply it to a real-world problem. To say I am satisfied with my eCYBERMISSION experience is an understatement."* (eCM Team Advisor)

> *"The eCYBERMISSION experience has changed my students' lives for the better. They are LOVING STEM and the project-based learning style. The day after submission deadline, the kids were already talking about next year's topic ideas. The kids grew leaps and bounds in their critical thinking, interest in solving problems, and ability to communicate. BEST. STEM. COMPETITION. EVER."* (eCM Team Advisor)

> *"eCYBERMISSION is an amazing opportunity that can truly change students' lives. My 9th grade son competed last year with his high school science teacher. He was not considering STEM as a career and didn't even want to go to college. Now he has goals to go to college and in planning on a lifelong STEM career. Amazing. Thank you for giving him the opportunity to feel a part of STEM and for increasing his self-confidence. Because of this amazing success, I mentored my own 9th grade team this year! They say it has changed their lives too!"* (eCM Team Advisor)

The 14% of Team Advisors who added caveats to their positive comments mentioned issues including the difficulty of completing eCM requirements while meeting learning standards within their classrooms, improvements to the website (e.g., students losing work in Mission Folder), the times at which live chats were scheduled, the difficulty of the requirements for some students, the organization of and abundance of resources for teachers, lack of career and AEOP information, suggestions to expand the grade levels included in eCM, and a desire for the timing of eCM to be more aligned with the school year. For example, Team Advisors said,

> *"I like the competition, but there was too much information for me to get a handle on what to do. We didn't know if we had to do the worksheets and upload them to the mission folders. We didn't know what else we could upload to the mission folder. The students are so used to autosave that they kept losing their work over and over. I think that once I go over everything this summer, then we will be able to do a better job next year. Also, we had no idea about the programs that we were supposed to talk to the students about and didn't find information or know that I was*

supposed to talk about the DoD and careers in the DoD. Too much information for teachers makes it harder to know where to begin." (eCM Team Advisor)

"I truly feel that my students learned how to navigate the engineering design process and I love that they got to choose their own problem…They did an intense amount of research and were elated to be a part of the solution by creating their own. I loved this process. The only issue of the mission folder is that it is mostly just answering questions…for middle school aged kids it made them lose steam when day in and day out they had to answer question after question…If it was broken up into another format, they may have been able to stay engaged everyday (example requiring them to tap into their creativity by doing videos, commercials, posters, etc.)." eCM Team Advisor)

"The flaw of working on [eCYBERMISSION] in class is that we aren't covering 9-12 weeks of curriculum. However, I think the skills they learn are incredibly valuable…I also see that this program is HARD. Doing independent research and following a thought from A to Z is difficult for a 12-year-old. It is even more difficult for a 12-year-old who comes to the US as a political refugee with parents who can barely speak English…Sometimes I feel the requirements are a burden and lightening the requirements would help students enjoy the FUN of the projects, and less of the load." (eCM Team Advisor)

Only three (2%) of Team Advisor respondents made no positive comments about eCM in their responses. These respondents commented upon their students' loss of interest in the program, issues with the Mini-Grant process, and lack of DoDEA support for eCM. These Team Advisors commented, for example,

"The mini-grant process should be adjusted to run more smoothly. The amount wasn't specified, which delayed the planning because the students didn't have a budget to reference. The disbursement dates were also way off, so when we did receive the first disbursement, of only $28, more than that had already been spent on supplies. Also…when we received the check, it was made out to the wrong name." (eCM Team Advisor)

"My school is about to not allow me to use eCYBER because it is not supported by DoDEA for curricular purposes. I have embedded into my classroom for 10 years. The new NGSS standards…which I believe it addresses through my guidance works great but there is move afoot... my teaching partner was asked to write a point paper to justify the program." (eCM Team Advisor)

Adults were asked in another open-ended questionnaire item to list the three most important strengths of eCM. Among the 100 responses sampled eCM's focus on solving real-world problems was the most frequently cited strength (53 comments). Another 29 comments cited the research and STEM skills students gain, and 27 cited teamwork as a program strength. The online format of the program and ease of use were mentioned in 24 comments as were program resources and support materials, and 21

comments focused on the value of the student-led nature of eCM projects. Other benefits, mentioned in 11-14 comments included the variety of topics and categories available, the program organization and staff, and the creativity students are challenged to use.

Team Advisors who participated in phone interviews echoed the strengths of eCM noted above when asked about how eCM benefits students. These participants added that the career information students gain, the prizes, students' connections with peers, and opportunities to network with STEM professionals are strengths of eCM. Interview participants said, for example,

> *"eCYBERMISSION is a great teaching tool in the classroom, especially for…students that sometimes are coming from elementary schools that haven't had much science background. It allows me to teach engineering design process as well as scientific inquiry and to teach the similarities and the differences between the two and guide them along the way through a whole project. So, I'm thrilled with the program, and we'll continue to use it."* (eCM Team Advisor)

> "*Having [students] focus on local community problems and publishing and how they will be judged, certainly helps them shape their research and thought processes and how they can create solutions much, much better than many of the competitions that I've seen. And presenting them an opportunity to go and to look for the major community problem and try to spend no more than certain amount of dollars to find a solution that is actually practical to adapt and to deploy…it's really training their young minds to do the right thing."* (eCM Team Advisor)

> *"I kind of think of [eCYBERMISSION] as the best way for kids to learn. It incorporates social skills. It incorporates skills for the kids to get out of their comfort zone. It incorporates skills for them to address real world problems. And then they get this beautiful tapestry of science and English and math, all kind of woven together in order for them to be able to produce a successful mission folder…They get problem solving experience... They get the chance to fail and learn that failure is part of the journey. They get a chance to really experience teamwork, which is another valuable skill for them in the future. And then they get the ability to tie all of those pieces together and to synthesize all the information, all the failure, all the successes, and try to paint the picture in a written composition… There's so much good to this competition. It's just hard to not say a million things that are great about it.*" (eCM Team Advisor)

Team Advisors participating in phone interviews also commented upon ways that eCM benefitted them personally and professionally. These Team Advisors noted the professional growth they had experienced as a result of participating in eCM, the framework the program provided for teaching scientific inquiry and engineering design, the opportunity to learn about and give back to their communities, the satisfaction of acting as a mentor and coach to students, the support the program provided to them, the fact that the program addressed many learning standards, and the opportunity to network with others and collaborate with other Team Advisors.

Adults were also asked to respond to an open-ended questionnaire item asking them to describe three ways eCM could be improved for future participants. Among the 100 responses sampled, the most frequently mentioned suggestions were related to improvements to the website (34 comments), including incorporating an autosave feature, allowing an interface with Google Docs, allowing larger file uploads, simplifying the submission process, and including the flexibility to show models. The next most frequently mentioned suggestion topic was program resources (30 comments), including suggestions to provide examples of previous projects, update videos, consolidate educational resources into fewer documents to allow for easier downloads, streamlining resources, recording webinars and making them available for asynchronous viewing, and providing document templates. Sixteen comments suggested providing more or clearer guidance, seven comments suggested streamlining registration, and another seven comments suggested reducing the amount of work for Team Advisors. Improvements mentioned in five or six comments included: providing flexibility in team sizes and make-up (e.g., allowing multiple grade levels on a team), including more labs or activities, providing clearer questions or elaboration of questions in Mission folder, providing more DoD or AEOP information to Team Advisors, improving program communication or support,

Team Advisors participating in phone interviews were also asked for their ideas about how eCM could be improved. These participants suggested several improvements focused on events in virtual settings, including providing ways for students to connect with each other in virtual settings, finding ways to showcase and celebrate NJ&EE students in virtual settings, finding ways to incorporate hands-on activities in virtual settings (e.g., send students science kits), breaking up presentations on Zoom into shorter segments, and providing online platforms to engage students when schools are in distance or hybrid learning situations. Other suggestions included connecting regional students with DoD representatives, aligning the program with the school year, finding ways to standardize regional judging, holding competitions on weekends rather than weekdays, connecting finalists with STEM professionals who are experts in the team's topic, and providing incentives for Team Advisors. Team Advisors said, for example,

> *"I would love to see something for the teams that don't get to nationals, to have a connection, to talk to some of these [military mentors], because they are fun, and they are nice, and they are interesting, and they do get the kids motivated."* (eCM Team Advisor)

> *"I'd love to see the timetable change to be more aligned with the school year. I'd love to do eCM in April and May, or September and October - instead of over Christmas, due by Valentine's Day. I'd love to get certificates for my students immediately after they finish and submit - rather than 5 months later when they've moved on to other topics…I'd like it if the Live Chats happened during the school day on the East Coast."* (eCM Team Advisor)

> *"I wish there would have been something sent out to the kids…some little STEM little doodad that could have been thrown together and sent out…I expected there to be an active component. I kept expecting it. And there wasn't this year…[The program staff] were thrown into rearranging this*

whole thing, you know, last minute…So, I can't say that it was bad for what they were given, but do I think it could have been better in a virtual setting? Yeah, I do." (eCM Team Advisor)

"It's really frustrating and heart wrenching…to see a team that really knows that they did a better job than the other team and then come up second next to them...It happens frequently where you might have a score… [for example, a] subpar team got four hundred ninety-nine, but then the really great team got judged by a harder judge and got four hundred and ninety-five." eCM Team Advisor)

"[In] other competitions I've been involved in…there is something to make the TA want to participate...teachers aren't paid huge amounts of money and a lot of what they give, they give in their off time. You know, they're reading mission folders, you know, at night and they're home from school... If [the eCM program] did something or they considered something to help the teacher some… We have the grant, but you have to have…ten teams in order to qualify for grants. So, that's still in my opinion, not the best like incentive." (eCM Team Advisor)

Team Advisors participating in interviews were also asked for their suggestions for ways that the program could serve more underrepresented and underserved populations. Team Advisors made a range of suggestions, mostly focused on outreach to teachers and providing additional funding. Participants suggested providing professional development to teachers at the elementary level aimed at getting students and teachers interested in AEOP and eCM, targeting specific schools and sharing real-life stories from diverse alumni of the AEOP, providing mentors for school teams, having teachers who have been involved in eCM act as ambassadors for the program, and ensuring that there are diverse speakers at events to make speakers relatable for all students. Interview participants said, for example,

"The best way to get a teacher involved and many teachers involved is to let them see it firsthand and talk to the people…I would love to be able to go out and talk to the people in person who do this and bring a teacher colleague maybe from another school and another district [to the NJ&EE]. (eCM Team Advisor)

There was a presentation yesterday and it was about ten people who presented. They had their Zoom cameras on, and they had PowerPoint presentation and just seeing the different variety of people, men, women, a bunch of different races, I mean, there's someone that every student can connect to in that group. (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 Combat Capabilities Development Command (DEVCOM) 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 $2,695 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 mentoring 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 of and interest in STEM content and using authentic real-world content developed by their teachers.

The program is national in scope, and the NGSTP project coordinator worked with NSTA to recruit teachers participating in eCM. In the 2019-2020 school year, ten teachers participated in NGSTP, eight as first-time teacher participants and two as mentors who had participated in NGSTP previously. Eight of the participants were female and two were male. All participating teachers taught grades 6, 7, and/or 8 and two of the teachers also taught high school students. Seven of the teachers taught science, two taught Project Lead the Way, one was a STEM and engineering teacher, and one was a career technical teacher. One participant, a science teacher, taught at a charter school where all instruction was delivered online. Six of the teachers had mentored eCM teams, either currently or in the past, and one had been a judge for eCM in the past. The teachers were from states across the U.S., including Colorado, Florida, Missouri, Nebraska, Ohio, South Dakota, Utah, West Virginia, and Wisconsin. Seven participants indicated that they taught at Title I schools.

Because of the small population size, the NGSTP evaluation was conducted using participant interviews. Phone interviews were conducted with all ten participating teachers. It should be noted that interviews were conducted in late March and early April 2020, and all teachers reported that their school buildings had recently closed due to the viral pandemic and that teaching was being done entirely online or through other remote means. Because of the school closures, many of the inquiry learning activities associated with lessons developed in NGSTP could not be completed, and some teachers' eCM teams had been unable to complete their projects.

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 of and interest in STEM and STEM careers

As teachers of science, engineering, and integrated STEM, NGSTP participants had a strong awareness of and interest in STEM. Participants reported learning about STEM careers in the Army and DoD primarily from their interaction with the Army S&Es with whom they were paired in the program and from their own research. One teacher reported that general information about STEM careers had been incorporated into the program content, one reported learning about STEM careers by talking with members of the NGSTP cohort, and one reported learning about STEM careers by speaking with people at the NSTA conference she attended. Two of the participants reported incorporating career information into their lessons, although several noted that plans to introduce their students to career information or connections with Army S&Es were thwarted due to school closures.

Six participants engaged with the Army S&Es with whom they had been matched. All but one of these teachers felt that the collaboration was useful to them in preparing their lesson plans and that the S&Es often provided insights or ideas that added depth or breadth to the lessons. Participants appreciated the opportunities to collaborate with research professionals, receive feedback, and one teacher noted that her collaborating S&E created a presentation of chemistry content for students who were struggling with concepts. For example, participants said the following:

> *"The ability to talk to someone with real world experience, to bring that into the classroom, and make it a real project for the students has been by far the best thing of this whole training."* (NGSTP Participant)

> "*[I asked the S&E], 'Do you have a really interesting way to explain to them the chemistry, because this is college level stuff?'…He prepared a whole PowerPoint for that eCYBERMISSION group. So,*

the beauty of my Army scientists is they were supportive in more than just my lesson." (NGSTP Participant)

"*[The Army scientist] came back with a lot of really good ideas about using phototaxis and additional things and [saying] 'It looks like you're on the right track [with the lesson plan].'*" (NGSTP Participant)

The one teacher who found the collaboration less helpful noted that one of the S&Es with whom she was paired was interested in viewing students' final projects but not in mentoring her as she developed her lesson plans, and she described her connection with the other S&E as weak due to a lack of structure for interactions. Two other teachers did not interact with the S&Es assigned to them due to the timing of the pairing or, in the case of a first-year teacher, lack of capacity to take on this extra task. The program was unable to find a match for one participant because of the unusual content area of the lesson plans (therapeutic toys for students with cerebral palsy). Some teachers noted that the timing of the pairing with the S&Es (as late as January) prevented them from collaborating effectively with the S&Es while designing their lessons. The following comments were typical of those who did not leverage the connection with their S&Es:

"We just never got further than the first couple e-mails back and forth… I would take responsibility for that because I probably could have done more to you know, set up webinars and things like that for that person to interact with our science class." (NGSTP Participant)

"She was there for me to piggyback ideas off of but ultimately, I didn't end up using the scientist that I was paired with in the full capacity" (NGSTP Participant)

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

Six of the participants commented that their primary motivation for participating in NGSTP was to learn more about NGSS and how to create NGSS-aligned lesson plans. All participants reported learning about NGSS standards and how to implement them. Most participants reported that their learning occurred through participation in the workshop, through the webinars, and through brainstorming and communicating with others in their cohort. Participants said, for example,

"I think I personally have grown tremendously in my lesson writing abilities…based on phenomenon, designing everything around phenomenon…[designing lessons that are] student-led I think is the hardest part. As a teacher sometimes it's hard to let go and let the students truly take the reign which is what NGSS is designed to do." (NGSTP Participant)

"I liked getting the feedback in our various webinar trainings from people who were teaching NGSS in other states." (NGSTP Participant)

"[In the seminar], we were able to look at good assessments, bad assessments, kind of in between assessments. We were able to look at how… how we could take assessments that we had and make them better." (NGSTP Participant)

'It was a… a great experience, and [it was] nice to meet with other teachers across the U.S. [who were] motivated and interested in education and…to be able to sit down learn more about the science and what they're doing and hopefully improve my own instruction." (NGSTP Participant)

One of the mentor teachers specifically noted that the act of creating webinars for other teachers had resulted in learning for her. In her words,

"One of those [webinars we created] was focused specifically on three-dimensional assessment and just the act of creating that webinar and then leading all the other members of the cohort through it in and of itself was actually a really good professional development [experience]." (NGSTP Participant)

Three participants expressed some dissatisfaction with the Salt Lake City workshop, however, noting that the content lacked depth and that the workshop did not provide sufficient support to teachers in creating and implementing NGSS lessons. One teacher noted that "the presenters weren't great" and that it was "kind of a disappointing professional development" experience. Teachers made the following comments:

"I would completely change the [Salt Lake City] workshop - the material, how it was presented. I think if the presenters were talking to the group, knowing…what they want to learn, I think we would've gotten way more out of it instead of just a general introduction." (NGSTP Participant)

"The [Salt Lake City workshop] was very just much like 'these are the standards, and this is how you use them,' …there were maybe two hands-on activities that were like, this is how you could introduce this." (NGSTP Participant)

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

As part of the NGSTP experience, participating teachers formulated lesson plans incorporating the NGSS and three-dimensional learning approach. Teachers' lesson plans spanned a wide variety of topics and included the following:

- Cellular respiration
- Electricity and circuitry (focus on textiles)
- Photosynthesis (focus on cellular respiration)
- Marine biology (students acting as citizen scientists collecting data from local waterway)
- Cell biology (focus on what happens within a fertilized chicken egg)
- Development of therapeutic toy for students with cerebral palsy
- Hydroponics
- Computer science (military applications)
- Renewable energy sources

As noted above, participants valued the real-world expert input of the S&Es as they created their lesson plans. The S&Es brainstormed with teachers about lesson content, provided feedback, created content for students and offered to communicate directly with students. Most teachers were not able to complete the implementation of the lessons they developed due to school closures, so it was not always possible for teachers to comment on how the lessons influenced students understanding of STEM careers and STEM in real-world contexts. Participants did express overall satisfaction with the lesson plans they developed and reported that implementation had gone well up until the time their schools closed.

Other than their connections with Army S&Es and their own personal research, NGSTP participants reported gaining little information about STEM careers in the Army and DoD. Likewise, most had not learned about the portfolio of AEOP initiatives during NGSTP. Most participants who were familiar with AEOP cited previous participation in eCM and the NJ&EE as the source of this information. Some teachers reported learning about eCM through discussions with other members of the cohort, and one participant noted that the AEOP support of NGSTP piqued her interest in the programs available. This teacher said,

> *"I didn't even know this Army program even existed. That the STEM teaching program existed. So, it just kind of opened my eyes to the availability of projects like this, and…it made me want to research eCYBERMISSION a little more."* (NGSTP Participant)

Program Strengths and Successes

Participants in phone interviews were asked to comment upon the strengths of NGSTP. All participants noted at least one strength of the program, including the following:

- Learning about NGSS and how to design and implement NGSS-aligned lessons

- Interaction with other teachers
- Flexibility in developing lesson plans appropriate to various contexts
- Accessibility of mentors and the formation of a community of practice
- Partnership with Army S&Es
- Funding
- Program administration, organization, and communication
- Program content (webinars, focus on assessment)

Participants made the following comments:

> *"It's been a fabulous program…I'm very appreciative of the resources that it provided me and the professional learning experiences."* (NGSTP Participant)

> *"What made [NGSTP] great is that we were given a very generous stipend to implement the program. And for me, that included technology… I wanted things that would help me with editing video, with producing phenomena…And so, the generous stipend allowed me…to take the lesson to the next level."* (NGSTP Participant)

> *"[A strength of NGSTP was] the learning… I would say it was vast…I was trying to…incorporate online teaching with Next Generation Science, which relies heavily on collaboration...And in that online setting it's very hard to get students to engage with each other."* (NGSTP Participant)

> *"I've taken part in some professional development things where they're pretty strict about [designing lessons that meet] certain criteria...so for this one I really appreciated that it was just kind of 'What works for you? What's going to work best in your classroom and you're setting with what you teach?'"* (NGSTP Participant)

> *"[My students] are becoming [Local Waterway] Guardians, and they're learning about their environment, water quality testing, living shorelines, fish health, etcetera through the NGSS type lessons. And [they are] learning how to conduct all the tests and how to become environmental stewards of [our local waterway]."* (NGSTP Participant)

> *"I liked getting the feedback in, or various webinar trainings from people who were teaching NGSS in other states."* (NGSTP Participant)

> *"It was just very well organized, and Matt did really well with communicating with people...It's just cool I know all these teachers from across the United States now."* NGSTP Participant)

"*The experience was great… the program administrators were excellent and supportive, and just having the people in my cohort, along with the mentors, that was helpful too just knowing that there were other people to reach out to if I needed guidance or advice."* (NGSTP Participant)

"[Program administrators] communicated extremely well. I don't think I've ever been part of a program where the communication has been so good. [Matt Hartman] was a big strength in mentoring us, and showing us, and telling us what to do; keeping us on task." (NGSTP Participant)

One teacher noted that he had been able to share his learning with other teachers in his district and throughout his state, saying,

"It was awesome to be able to bring [my NGSTP learning] back and share it with other teachers in my school and in my district and…around the state." (NGSTP Participant)

Suggestions for Program Improvement

While teachers were satisfied with most aspects of NGSTP, they also offered suggestions for program improvement. These suggestions included the following:

- Beginning the program earlier (e.g., late summer) or making the program longer
- Making earlier connections with Army S&Es
- Providing an alternate means of delivering grant funds so that teachers do not have to pay up front for supplies (one first-year teacher noted that she had not purchased any supplies because she did not have the disposable income to pay for them)
- Providing an orientation for teachers and S&Es and providing a structured way for teachers and S&Es to interact
- Providing a spreadsheet or dashboard with assignment deadlines and verification that participants have completed tasks
- Streamlining communication/fewer emails
- Providing videos modeling NGSS lessons being implemented in classrooms
- Aligning workshops with participant interests and needs
- Focusing workshops on deeper content, lesson plan development, teacher collaboration
- Choosing participants from states that have adopted NGSS

Participants said, for example,

> *"I think [if the professional development were] spread out a little bit more [it would provide] some time maybe to think through [plans] and communicate with the mentors or the scientists."* (NGSTP Participant)

> *"I think they should have told us that we were going to have to purchase the materials out-of-pocket be reimbursed. It ended up I wasn't going to get any materials because, as I said, I wasn't having school support. So, I was going to have to pay for them and then get reimbursed and so I said, 'no, never mind I won't get anything,' But, then they were able to arrange it so I created shopping carts and they purchased the materials for me."* (NGSTP Participant)

> *"It would be helpful if we had some sort an of orientation together where [teachers and S&Es] all meet in cyberspace and really get to know each other. I think it's best, you know, even if it's like I don't know fifteen or thirty minutes. I think it sets that tone for yeah, we're part of a team and we're working together."* (NGSTP Participant)

> *"Some of us [who were first-time participants] were kind of awkward outliers, and we probably could've done more to bring in the awkward outliers, so maybe more…team dynamics or building the group might help."* (NGSTP Participant)

Overall, there is evidence that NGSTP met its objectives in 2019-2020. All participants reported experiencing benefits from participating and, while school closures made definitive assessments of implementation impossible, most reported that their participation impacted their classroom practice. Connections with Army S&Es were made successfully for most participants, and many participants were able to enhance the lesson plans they created through the input and feedback of these professionals. In addition, participants formed relationships with other teachers from around the country, effectively forming a community of practice that will support them in the future as they create and implement NGSS lessons. Relatively few of the interview participants had gained information about Army and DoD STEM careers and AEOP during NGSTP, suggesting that this is an area for potential program growth. Several participants commented on the high quality of the program's organization, communications and overall administration.

7

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

AEOP recruitment methods were determined through survey items related to how students learned about eCM (Table 37). Similar to past years, nearly all students (90%) said they learned about eCM from their teachers.

Table 37. How eCM Students Learned about eCM (n=1,130)

Choice	Response Percentage	Response Total
My teacher	89.6%	1,012
My school	41.6%	470
Past participant of program	16.4%	185
My friend	8.1%	92
eCM website	6.1%	69
My family	5.4%	61
Choose not to report	2.9%	33
Social media	1.6%	18
Community group or program	1.5%	17
Army Educational Outreach Program (AEOP) website	<1%	7
Print advertising	<1%	6
School or university newsletter, email, or website	<1%	3
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	<1%	3

eCM-N students participating in phone interviews reported learning about eCM through teachers or Team Advisors, family members, or friends.

Table 38 shows combined national and overall eCM participant motivational factors. A third or more of students indicated that they were motivated to participate by external factors: Teacher encouragement to participate (71%) and Academic requirement or school grade (35%). Twenty percent or more of students also cited two internal motivators: Interest in STEM (23%) and the desire to learn something new or interesting (20%).

eCM-N interview participants were also asked about their motivations for participating. Some focus group participants indicated that they had participated in eCM previously and enjoyed it. Some participants noted their interest in STEM topics motivated them to participate in eCM. Others cited the opportunity to help their communities, learn about careers, work with friends, or simply to have fun as reasons for participating Students said, for example,

> *"I chose to participate in eCYBERMISSION because I heard it was about creating something that will help your community and I thought that it would be fulfilling to create something that would help people."* (eCM-N Student)

> "*I've been doing eCYBERMISSION since sixth grade because my older brother also did this competition when he was in middle school. And science and STEM has always interested me. And, I thought being able to work on a project with my friends, that would help make an impact on my community would be really special and I would learn a lot. So that was probably one of the biggest motivators.*" (eCM-N Student)

> *"in sixth grade I was part of the team… we went all the way to the national level and participated in NJ&EE and that was just a really fun experience for me…I would actually consider it one of like the happiest moments in my life…it was fun to meet all the different teams that have participated in eCYBERMISSION. So, I decided to participate in eCYBERMISSION in seventh grade too. And then again, this year"* (eCM-N Student)

Table 38. Factors Motivating Students to Participate in eCM (n=1,123)

Choice	Response Percentage	Response Total
My teacher encouraged me to participate	71.4%	802
Academic requirement or school grade	34.7%	390
Interest in STEM	22.7%	255
Desire to learn something new or interesting	20.1%	226
Opportunity to have some fun with my friends	16.1%	181
My college application or resume	15.2%	171
Earning awards and recognition	14.3%	161
Exploring education and/or career goals	14.1%	158
Exploring how school learning applies to real life	12.6%	141
Interest in expanding my laboratory or research skills	12.6%	141
My friends participated in eCYBERMISSION	11.1%	125
Serving the community or country	11.0%	123
Choose not to report	8.4%	94
Interest in STEM careers with the Army	3.9%	44
Learning in ways that are not possible in school	<1%	2
Opportunity to use advanced laboratory technology	<1%	2
Networking opportunities	<1%	1
Building college application or résumé	0%	0
Desire to expand laboratory or research skills	0%	0
Earning stipends or awards for doing STEM	0%	0
Exploring a unique work environment	0%	0
Recommendations of past participants	0%	0
The mentor(s)	0%	0

Previous Program Participation and Future Interest

As part of the registration process, eCM participants reported on their previous participation in AEOP (Table 39). While 24% reported having participated in eCM during past years, nearly half (48%) indicated never having participated in any past AEOP. Less than 5% reported previous participation in Camp Invention (3%), GEMS (2%), and JSS (<1%). Additionally, approximately a third of students (33%) said they had participated previously in other STEM programs.

Table 39. Previous Program Participation (n=1,049)

Choice	Response Percentage	Response Total
Camp Invention	3.1%	33
eCYBERMISSION	23.9%	251
Junior Solar Sprint (JSS)	<1%	7
Gains in the Education of Mathematics and Science (GEMS)	1.8%	19
Unite	0%	0
Junior Science & Humanities Symposium (JSHS)	0%	0
Science & Engineering Apprenticeship Program (SEAP)	0%	0
Research & Engineering Apprenticeship Program (REAP)	0%	0
High School Apprenticeship Program (HSAP)	0%	0
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	48.1%	505
Other STEM Program	32.6%	342

Tables 40 and 41 show findings related to students' interest in participating in future AEOP. More than two-thirds of students across program levels indicated they were somewhat or very much interested in participating in eCM again (overall eCM – 70%, NJ&EE – 91%). Smaller proportions of students reported future participation interest in other AEOP, although more NJ&EE participants expressed an interest than overall eCM participants (overall eCM: 19%-33%; NJ&EE: 38%-53%). It should be noted that more than half of overall eCM students reported never hearing of all programs other than eCM (53%-67%).

Most eCM-N students participating in interviews indicated that they had not learned about AEOP, although some indicated they had learned about them in previous years' NJ&EE participation, from their own research, or from their team advisors. All but one Team Advisor participating in interviews had some familiarity with AEOP, citing past NJ&EE events, fliers, and the introductory session at the NJ&EE as sources of information. Team Advisors made several suggestions regarding how to more effectively disseminate information about AEOP, including holding workshops at the NJ&EE, creating webinars (shorter than the two-hour webinars at the NJ&EE), using social media, holding alumni panels, and reaching out to schools' afterschool activity coordinators. Two team advisors specifically noted the lack of availability of other AEOP in their geographic regions. One noted about an NJ&EE session focused on AEOP, saying

> *"The question was posed, you know, in rural areas or areas that aren't like the East coast, what does the Army Education Outreach Program have to offer our students? And the person talking was like, well, go to the website because I can't really individualize everyone. But I've been to the website, and I know what programs are available. And there just isn't. The reality is there just a lot for those areas of the US that aren't kind of centralized."* (eCM Team Advisor)

Table 40. eCM-NJ&EE Participant Interest in Future AEOP (n=53)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
Camp Invention (CI)	54.7%	3.8%	28.3%	13.2%	
	29	2	15	7	**53**
eCYBERMISSION (eCM)	1.9%	7.5%	26.4%	64.2%	
	1	4	14	34	**53**
Junior Solar Sprint (JSS)	41.5%	7.5%	39.6%	11.3%	
	22	4	21	6	**53**
Gains in the Education of Mathematics & Science (GEMS)	43.4%	7.5%	34.0%	15.1%	
	23	4	18	8	**53**
Unite	49.1%	3.8%	28.3%	18.9%	
	26	2	15	10	**53**
Junior Science & Humanities Symposium (JSHS)	39.6%	7.5%	24.5%	28.3%	
	21	4	13	15	**53**
Science & Engineering Apprenticeship Program (SEAP)	47.2%	5.7%	28.3%	18.9%	
	25	3	15	10	**53**
Research & Engineering Apprenticeship Program (REAP)	47.2%	7.5%	34.0%	11.3%	
	25	4	18	6	**53**
High School Apprenticeship Program (HSAP)	45.3%	5.7%	26.4%	22.6%	
	24	3	14	12	**53**
College Qualified Leaders (CQL)	52.8%	9.4%	24.5%	13.2%	
	28	5	13	7	**53**
GEMS Near Peer Mentor Program	56.6%	5.7%	26.4%	11.3%	
	30	3	14	6	**53**
Undergraduate Research Apprenticeship Program (URAP)	45.3%	7.5%	26.4%	20.8%	
	24	4	14	11	**53**
Science Mathematics, & Research for Transformation (SMART) College Scholarship	45.3%	3.8%	28.3%	22.6%	
	24	2	15	12	**53**

National Defense Science & Engineering Graduate (NDSEG) Fellowship	52.8%	5.7%	22.6%	18.9%	
	28	3	12	10	**53**

Table 41. Overall eCM Participant Interest in Future AEOP (n=1,810)

	I've never heard of this program	Not at all	Somewhat	Very much	Response Total
eCYBERMISSION	6.3%	23.9%	41.2%	28.6%	
	114	433	746	517	**1.810**
Junior Solar Sprint (JSS)	65.2%	16.1%	13.2%	5.5%	
	1,180	291	239	100	**1.810**
Gains in the Education of Mathematics and Science (GEMS)	57.8%	15.6%	17.3%	9.3%	
	1,046	282	313	169	**1,810**
Unite	66.7%	14.5%	13.3%	5.5%	
	1,207	263	240	100	**1.810**
Junior Science & Humanities Symposium (JSHS)	63.7%	14.2%	15.2%	6.9%	
	1.153	257	275	125	**1.810**
Science & Engineering Apprenticeship Program (SEAP)	61.8%	13.9%	16.5%	7.8%	
	1,119	251	299	141	**1,810**
Research & Engineering Apprenticeship Program (REAP)	62.0%	14.4%	15.5%	8.1%	
	1,123	260	280	147	**1,810**
High School Apprenticeship Program (HSAP)	63.6%	13.4%	15.8%	7.2%	
	1.152	242	286	130	**1.810**
College Qualified Leaders (CQL)	62.5%	13.8%	16.3%	7.4%	
	1.132	249	295	134	**1.810**
GEMS Near Peer Mentor Program	65.2%	14.9%	13.8%	6.1%	
	1.180	269	250	111	**1.810**
Undergraduate Research Apprenticeship Program (URAP)	65.6%	14.5%	13.9%	6.0%	
	1,187	263	251	109	**1,810**

Science Mathematics, and Research for Transformation (SMART) College Scholarship	53.3%	13.5%	21.7%	11.6%	
	964	244	392	210	**1,810**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	63.3%	14.1%	15.0%	7.6%	
	1,145	256	271	138	**1,810**

Awareness of STEM Careers and DoD STEM Careers and Research

Increasing both the number and diversity of students who pursue STEM careers is an important AEOP goal. Thus, students are asked on the survey how many STEM jobs/careers in general (Tables 42 and 43) as well as DoD STEM jobs/careers (Tables 44 and 45) they learned about during eCM. All NJ&EE students (100%) and two-thirds (67%) of overall eCM participants indicated they had heard about at least one STEM job/career through eCM. Much larger proportions of NJ&EE participants (70%) indicated they had learned about 5 or more STEM jobs/careers compared to overall eCM participants (13%).

Table 42. Number of STEM Jobs/Careers National Students Learned About During eCM (n=53)

Choice	Response Percentage	Response Total
None	0%	0
1	1.8%	1
2	5.7%	3
3	17.0%	9
4	5.7%	3
5 or more	69.8%	37

Table 43. Number of STEM Jobs/Careers Regional Students Learned About During eCM (n=1,810)

Choice	Response Percentage	Response Total
None	32.8%	594
1	15.5%	281
2	17.7%	320
3	15.9%	287
4	4.7%	85
5 or more	13.4%	243

Results related to DoD STEM job/career information learned from participating in eCM were similar to findings above with all NJ&EE (100%) and fewer regional students (31%) reported hearing about one or more DoD STEM job/career. Approximately two-thirds (68%) of NJ&EE students indicated learning about 5 or more DoD STEM Jobs/Careers as compared to only 4% of overall eCM students.

Table 44. Number of DoD STEM Jobs/Careers NJ&EE Participants Learned About During eCM (n=53)

Choice	Response Percentage	Response Total
None	0%	0
1	5.7%	3
2	1.9%	1
3	9.4%	5
4	15.1%	8
5 or more	67.9%	36

Table 45. Number of DoD STEM Jobs/Careers Overall eCM Participants Learned About During eCM (n=1,810)

Choice	Response Percentage	Response Total
None	68.6%	1240
1	10.4%	188
2	9.2%	167
3	5.7%	104
4	2.3%	42
5 or more	3.8%	69

eCM-N students participating in phone interviews were also asked about whether and how they had learned about STEM career opportunities in the DoD during eCM. Students reported learning about these careers at the national event, citing interacting with judges and presentations at the NJ&EE as sources of information about STEM careers in the Army or DoD. Some students also reported learning about Army/DoD STEM careers as part of their project research. Students said, for example,

> *"We definitely learned a lot about STEM careers. So first of all, we had to… we had to use a lot of like STEM knowledge in our project, and that gave us incentive to like, learn more about careers in STEM and at the final competition, the Army taught us [about]… STEM careers in the Army."* (eCM-N Student)

> *"Yesterday we had a chat on Zoom and they had different departments within the Department of Defense talk about what they do…[The speakers] were very interesting and we learned more about what they do and like where they are in their jobs too."* (eCM-N Student)

> *"[NJ&EE career workshop speakers] were really interesting to me because they showed me a lot of really interesting career paths that I had never really considered before. But after seeing all the amazing work that they had done, it was really something that I could consider for my future and it was really helpful."* (eCM-N Student)

Team Advisors participating in interviews echoed students' comments about the availability of Army/DoD STEM career information at the national event. These adults had several suggestions for ways to disseminate career information more widely within eCM. Team Advisors suggested field trips to military facilities or online sessions with DoD representatives to talk about careers, additional mentoring sessions throughout the year, holding career sessions for all eCM participants rather than just for finalists, posting career videos on the eCM website, and creating more interactive and personal ways to engage students with Army/DoD representatives. Most Team Advisors concurred that Army/DoD STEM career information is not widely available at the state level. Team Advisors said, for example,

> *The answer [to whether students learned about STEM careers in the Army or DoD] would've been no until this year and now that we're national finalists, it's really amazing to sit through the panels that they have. Of course, being in DC would be even better, but sitting through and listening to the guest speakers talk…they talked to us about the career fields they're in and so I think you just really get an understanding of a wide variety of careers that can be involved in the STEM field."* (eCM Team Advisor)

> *"You don't really get a lot of [career] information until you make it to the national level. It's called a national judging and educational event for that reason, because they are educating these kids about the Department of Defense career opportunities. They're educating them about the ways that civilians can interact and have jobs. And then they have panels where people who have gone*

through AEOP programs, talk to the students, and then they also provide workshops." (eCM Team Advisor)

Student perspectives on the importance of DoD research are an important prerequisite to continued interest in STEM and possible DoD STEM future involvement. As such, students were asked to rate their agreement with items related to DoD researchers and the value of DoD research (Tables 46 & 47). Nearly all NJ&EE students (96%-98%) expressed agreement with all statements, and more than three-quarters of overall eCM students (84%-88%) reported similarly.

Table 46. eCM-NJ&EE Participant Opinions about DoD Researchers and Research (n=53)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.9%	0.0%	41.5%	56.6%	
	1	0	22	30	**53**
DoD researchers develop new, cutting edge technologies	0.0%	1.9%	32.1%	66.0%	
	0	1	17	35	**53**
DoD researchers solve real-world problems	1.9%	1.9%	30.2%	66.0%	
	1	1	16	35	**53**
DoD research is important to society	0.0%	1.9%	34.0%	64.2%	
	0	1	18	34	**53**

Table 47. Overall eCM Participant Opinions about DoD Researchers and Research (n=1,810)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	5.8%	9.8%	64.6%	19.8%	
	105	177	1,170	358	**1,810**
DoD researchers develop new, cutting edge technologies	4.6%	11.8%	61.2%	22.4%	
	83	213	1,108	406	**1,810**
DoD researchers solve real-world problems	4.6%	7.9%	58.9%	28.6%	
	84	143	1,066	517	**1,810**
DoD research is important to society	4.8%	8.6%	56.7%	29.8%	
	87	156	1,027	540	**1,810**

Interest and Future Engagement in STEM

To assess the AEOP goal of developing a STEM-literate society, students were asked about their interest in engaging with STEM activities outside of required school courses as a result of participating in eCM (Tables 48 & 49). Overall, NJ&EE respondents (79%-91%) expressed stronger likelihood of participating in future STEM activities compared to overall eCM students (48%-70%). Approximately two-thirds or more of students from each group indicated they were more likely to participate in the following activities due to program participation: Tinker with a mechanical/electrical device (eCM - 70%, NJ&EE - 89%); Use a computer to design or program something (eCM - 67%, NJ&EE - 85%); Help with a community service project related to STEM (eCM - 62%, NJ&EE - 91%); and Work on solving mathematical or scientific puzzle (eCM - 62%, NJ&EE - 81%).

A composite score[19] was computed from these Future STEM Engagement items to compare subgroups of students. Statistical differences were not found by overall underserved status. Significant STEM interest and future engagement differences were found by race/ethnicity (minority students reporting lower; very small effect size of $d = 0.121$), first generation status (students whose parents had not attended college reporting lower; very small effect size of $d = 0.094$), and competition level (national reporting higher; small effect size of $d = 0.265$).[20]

[19] These 10 items for Future STEM Engagement had a Cronbach's alpha reliability of 0.928.
[20] Independent samples *t*-tests –Race/Ethnicity: $t(1861) = 2.62$, $p = 0.009$; First Generation: $t(1861) = 2.02$, $p = 0.044$; Competition Level: $t(1861) = 5.71$, $p < 0.001$.

Table 48. eCM-NJ&EE Impact on Participants' Intent to Engage in STEM Out of School (n=53)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	3.8%	17.0%	66.0%	13.2%	
	2	9	35	7	**53**
Tinker (play) with a mechanical or electrical device	1.9%	9.4%	58.5%	30.2%	
	1	5	31	16	**53**
Work on solving mathematical or scientific puzzles	3.8%	15.1%	56.6%	24.5%	
	2	8	30	13	**53**
Use a computer to design or program something	1.9%	13.2%	49.1%	35.8%	
	1	7	26	19	**53**
Talk with friends or family about STEM	1.9%	13.2%	62.3%	22.6%	
	1	7	33	12	**53**
Mentor or teach other students about STEM	5.7%	11.3%	50.9%	32.1%	
	3	6	27	17	**53**
Help with a community service project related to STEM	1.9%	7.5%	50.9%	39.6%	
	1	4	27	21	**53**
Participate in a STEM camp, club, or competition	1.9%	13.2%	45.3%	39.6%	
	1	7	24	21	**53**
Take an elective (not required) STEM class	0.0%	15.1%	41.5%	43.4%	
	0	8	22	23	**53**
Work on a STEM project or experiment in a university or professional setting	3.8%	9.4%	43.4%	43.4%	
	2	5	23	23	**53**

Table 49. Overall eCM Impact on Participants' Intent to Engage in STEM Out of School (n=1,810)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	18.2%	27.8%	42.7%	11.3%	
	330	503	772	205	**1,810**
Tinker (play) with a mechanical or electrical device	10.7%	19.5%	46.2%	23.6%	
	193	353	837	427	**1,810**
Work on solving mathematical or scientific puzzles	13.5%	24.6%	43.8%	18.1%	
	244	445	793	328	**1,810**
Use a computer to design or program something	11.8%	21.5%	42.8%	23.9%	
	213	390	775	432	**1,810**
Talk with friends or family about STEM	18.8%	27.5%	37.7%	16.0%	
	341	497	682	290	**1,810**
Mentor or teach other students about STEM	23.4%	29.1%	34.8%	12.7%	
	424	527	630	229	**1,810**
Help with a community service project related to STEM	15.1%	22.8%	45.0%	17.1%	
	273	412	815	310	**1,810**
Participate in a STEM camp, club, or competition	23.6%	28.6%	31.5%	16.3%	
	427	518	570	295	**1,810**
Take an extra STEM class	23.9%	28.3%	33.0%	14.8%	
	433	512	597	268	**1,810**
Work on a STEM project or experiment in a university or professional setting	21.1%	24.5%	36.7%	17.6%	
	382	444	665	319	**1,810**

Tables 50 and 51 show the educational aspirations of eCM students after participating in the program. A large proportion of overall eCM students (88%) and all NJ&EE students (100%) reported intending to at a minimum finish college (get a bachelor's degree). In terms of a more advanced post-secondary education, more NJ&EE students (57%) reported a desire to continue their education after college than overall eCM students (39%).

Table 50. NJ&EE Participant Education Aspirations After eCM (n=53)

Choice	Response Percentage	Response Total
Graduate from high school	0%	0
Go to a trade or vocational school	0%	0
Go to college for a little while	0%	0
Finish college (get a bachelor's degree)	43.4%	23
Get more education after college	56.6%	30

Table 51. Overall eCM Participant Education Aspirations After eCM (n=1,810)

Choice	Response Percentage	Response Total
Graduate from high school	4.9%	88
Go to a trade or vocational school	1.7%	31
Go to college for a little while	5.4%	97
Finish college (get a bachelor's degree)	48.7%	881
Get more education after college	39.3%	713

Resources

Team Advisors reported on resources most valuable for exposing students to AEOP (Table 52). Two resources were identified frequently as somewhat useful or very useful: Participation in eCM (85%) and the AEOP website (48%). Approximately half to three-quarters of Team Advisors (49%-72%) reported not experiencing the other resources.

Team Advisors were asked how useful the same resources were for exposing students to DoD STEM careers (Table 53). The same pattern of resource usefulness emerged, but responses were not quite as strong. Adults were again most likely to rate participation in eCM (81%) and the eCM website (47%) as somewhat/very useful for exposing students to DoD STEM careers. More than half of adults (55%-73%) reported having not experienced the remaining AEOP resources.

Table 52. Usefulness of Resources for Exposing Students to AEOP (n=187)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	40.1%	1.6%	10.2%	14.4%	33.7%	
	75	3	19	27	63	**187**
AEOP on Facebook, Twitter, Pinterest or other social media	70.1%	4.3%	8.0%	10.2%	7.5%	
	131	8	15	19	14	**187**
AEOP printed materials	49.7%	3.7%	10.2%	19.3%	17.1%	
	93	7	19	36	32	**187**
NSTA staff	48.7%	2.7%	6.4%	17.1%	25.1%	
	91	5	12	32	47	**187**
Invited speakers or "career" events	71.7%	5.3%	5.9%	7.0%	10.2%	
	134	10	11	13	19	**187**
Participation in eCYBERMISSION	3.7%	0.5%	10.7%	17.6%	67.4%	
	7	1	20	33	126	**187**

Table 53. Usefulness of Resources for Exposing Students to DoD STEM Careers (n=187)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	42.8%	1.6%	9.1%	18.2%	28.3%	
	80	3	17	34	53	**187**
AEOP on Facebook, Twitter, Pinterest or other social media	72.7%	3.2%	6.4%	10.2%	7.5%	
	136	6	12	19	14	**187**
AEOP printed materials	55.1%	3.7%	11.2%	12.8%	17.1%	
	103	7	21	24	32	**187**
NSTA staff	59.9%	4.3%	7.5%	11.8%	16.6%	
	112	8	14	22	31	**187**
Invited speakers or "career" events	72.2%	4.3%	4.8%	8.6%	10.2%	
	135	8	9	16	19	**187**
Participation in eCYBERMISSION	7.0%	2.1%	9.6%	21.9%	59.4%	
	13	4	18	41	111	**187**

Overall Impact

The overall impact of eCM on students was evaluated by items on the survey (Tables 54 & 55). Similar to other findings, NJ&EE students were more likely to report overall positive impacts (72%-96%) compared to overall eCM participants (33%-74%). Half of more of both competition groups agreed that eCM impacted them in the following areas: Confidence in STEM knowledge, skills, and abilities (eCM - 74%, NJ&EE - 96%); Interest in participating in STEM activities (eCM - 52%, NJ&EE - 85%); and interest in taking STEM classes in school (eCM - 50%, NJ&EE - 76%). As in FY19, items with the greatest difference in eCM impact by competition level (approximately 40%) were related to the AEOP/DoD: Having a greater appreciation of Army/DoD STEM research (eCM - 41%, NJ&EE - 91%) and being more interested in pursuing a STEM career with the Army or DoD (eCM - 39%, NJ&EE - 72%).

A composite variable[21] was calculated for Overall eCM Impact survey items to look for differences between student subgroups. The only significant difference found for the overall impact was for the student demographic of FARMS (low-SES reporting higher; very small effect size of $d = 0.133$).[22]

[21] The Cronbach's alpha reliability for these 7 Overall eCM Impact items was 0.910.
[22] Independent samples *t*-tests –FARMS: $t(1820) = 2.84$, $p = 0.005$.

Table 54. NJ&EE Participant Opinion of eCM Impacts (n=53)

	Disagree - This did not happen	Disagree - This happened but not because of eCM	Agree - eCM somewhat made me feel this way	Agree - eCM was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	3.8%	0.0%	54.7%	41.5%	
	2	0	29	22	**53**
I am more interested in participating in STEM activities outside of school requirements	7.5%	7.5%	50.9%	34.0%	
	4	4	27	18	**53**
I am more interested in taking STEM classes in school	11.3%	13.2%	49.1%	26.4%	
	6	7	26	14	**53**
I am more interested in earning a STEM degree	17.0%	5.7%	45.3%	32.1%	
	9	3	24	17	**53**
I am more interested in pursuing a career in STEM	15.1%	9.4%	52.8%	22.6%	
	8	5	28	12	**53**
I have a greater appreciation of Army or DoD STEM research	3.8%	5.7%	35.8%	54.7%	
	2	3	19	29	**53**
I am more interested in pursuing a STEM career with the Army or DoD	20.8%	7.5%	43.4%	28.3%	
	11	4	23	15	**53**

Table 55. Overall eCM Participant Opinion of eCM Impacts (n=1,810)

	Disagree - This did not happen	Disagree - This happened but not because of eCM	Agree - eCM somewhat made me feel this way	Agree - eCM was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	12.7%	13.5%	55.0%	18.8%	
	229	245	996	340	**1,810**
I am more interested in participating in STEM activities outside of school requirements	24.7%	23.1%	36.2%	16.0%	
	447	419	655	289	**1,810**
I am more interested in taking STEM classes in school	26.3%	23.3%	35.2%	15.2%	
	476	421	637	276	**1,810**
I am more interested in earning a STEM degree	32.3%	26.2%	29.5%	12.0%	
	584	475	534	217	**1,810**
I am more interested in pursuing a career in STEM	32.4%	26.4%	28.1%	13.1%	
	586	478	509	237	**1,810**
I have a greater appreciation of Army or DoD STEM research	33.2%	17.7%	33.1%	16.0%	
	601	321	599	289	**1,810**
I am more interested in pursuing a STEM career with the Army or DoD	47.1%	20.3%	22.4%	10.2%	
	853	368	405	184	**1,810**

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 overall eCM students, the most frequently mentioned benefits were teamwork (42 comments), STEM learning (40 comments), research or STEM skills (30 comments), and the opportunity to learn about and solve real world problems (23 comments). Other benefits mentioned in 12-15 comments included:

- gaining career information
- increasing motivation for or interest in STEM
- making friends
- develop problem solving skills
- learning time management skills
- gaining confidence or developing leadership skills

Students competing at the national level cited similar benefits. Among the 52 eCM-N students who listed at least one benefit, the most frequently mentioned were teamwork (23 comments), career information (17 comments), research or STEM skills (15 comments), increasing motivation for or interest in STEM (15 comments), presentation and communication skills (14 comments), STEM learning (14 comments), and learning about and solving real world problems (12 comments). Other benefits, mentioned by in between five and 10 eCM-N included:

- increasing confidence
- using creativity
- develop problem solving skills
- gaining Army/DoD information
- making friends

eCM-N students participating in phone interviews mentioned similar benefits of eCM participation and adding as benefits the opportunity to meet peers from across the country, the opportunity to network with STEM experts, the student-led nature of the project, the judging, and the feedback they received on their projects. In students' own words:

> *"I had the opportunity to create… actually create something and share my product with people so that I could help others."* (eCM-N Student)
>
> *"I think eCYBERMISSION helped with teamwork because we have to work as a team for everything. And it taught us a lot of skills on how to work together efficiently and how to get a lot of work done. And we also learned a lot in the STEM field because our projects were based off of STEM."*
>
> *"I really liked how in eCYBERMISSION we could completely choose a topic and I think this is the most I've ever learned from all these competitions…We learned everything from scratch and we chose the topic."* (eCM-N Student)
>
> *'We were able to have conversations with other [students] and we talked about potentially working together on projects and integrating both of our projects to make all the entire everything better. So, I'll definitely keep these connections that I made in this process and I think they'll be great resources for me in the future."* (eCM-N Student)
>
> *"The judges asked some really good questions that we had to think about and kind of in the way they ask the questions, they also gave feedback of things that we could improve on."* (eCM-N Student)
>
> *"I think the main thing about eCYBERMISSION is that you learn a lot about science and engineering. Like I never would have learned about the scientific method if I hadn't participated in eCYBERMISSION. And same with engineering, you get a little bit of a start into engineering or*

science… [What] is really nice about eCYBERMISSION [is] you get to brainstorm yourself and like do projects with the team. And then it's the questions that they ask for the mission folder. Those are particularly helpful because they're… the kind of things real scientists would answer." (eCM-N Student)

"Originally, I had no interest particularly in the Army, I thought maybe I'd do computer science. But after this [NJ&EE] presentation, I think that the Army really has some great programs…I'd be missing out if I didn't look more into those opportunities for career options. So, I think I could see myself definitely working for the Army in the future." (eCM-N Student)

8 | Findings and Recommendations

Summary of Findings

The FY20 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 the findings is provided in Table 56.

Table 56. 2020 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 in FY20 as compared to previous years. The demographics of students participating in FY20 are similar to previous years, although the demographic make-up of NJ&EE students continues to be somewhat different than that of the overall population.	The number of students participating in state competitions in FY20 (14,245) was 21% lower than in FY19, when 17,944 students participated, and was 29% lower than participation in FY18 when 20,004 students participated. Likely the decrease was due to COVID-19 impacts. There has been a multi-year downward trend in participation since FY17 when 21,277 students participated.
	Over half of students (56%) met the AEOP definition of underserved (underserved), compared to 59% in FY19 and 53% in FY18, maintaining a strong representation of students from those demographic groups.
	As in previous years, overall eCM participants were about half (49%) female and nearly half (48%) male (in FY19, 49% were female and 48% were male; in both FY18 and FY17, 51% were female and 49% were male).
	Less than half (40%) of overall eCM students identified themselves as White (40% in FY19; 45% in FY18; 48% in FY17) with another 24% identifying themselves as Hispanic or Latino/a (22% in FY19; 18% in FY18; 19% in FY17). Similar to previous years, 12% of participants identified themselves as Black or African American (13% in FY19; 13% in FY18; 10% in FY17) while 11% identified themselves as Asian (9% in FY19; 9% in FY18; 10% in FY17).

	As in FY19, NJ&EE participants included a smaller percentage (38%) of underserved students than at the state level (56%). Slightly more than a third (37%) of NJ&EE participants were White (40% in FY19; 30% in FY18; 47% in FY17), and 43% were Asian (38% in FY19; 52% in FY18; 30% in FY17). While White and Asian students composed the majority of the NJ&EE population, 8% were Hispanic or Latino/a (7% in FY19; 7% in FY18; 5% in FY17) as compared with 24% in the overall population, and 3% were Black or African American (3% in FY19; 3% in FY18; 4% in FY17) as compared with 12% in the overall population.
eCM student participants reported engaging in STEM practices more frequently in eCM than in their typical school experiences; females, and NJ&EE students reported greater engagement in STEM practices than their peers, and students from underrepresented racial/ethnic groups and low-SES students reported lower levels of engagement in STEM practices than their peers.	Three-quarters or more of NJ&EE and more than a third of overall eCM participants reported engaging in all STEM practices at least once during eCM. Both eCM and NJ&EE students noted engaging in the following four practices most frequently (50% or more reporting weekly or every day): Working collaboratively as part of a team (eCM - 76%; NJ&EE - 92%); Analyzing data or information and draw conclusions (eCM - 67%; NJ&EE - 85%); Designing and carrying out investigations (eCM - 56%; NJ&EE - 77%); and Solving real world problems (eCM - 58%; NJ&EE - 72%).
	Students reported significantly greater engagement with STEM in eCM than in school regardless of the competition level (NJ&EE - medium effect size; overall eCM - large effect size).
	No significant differences in engagement in STEM practices were found by overall underserved status, however there were differences by gender (females reporting higher; very small effect size), competition level (national reporting higher; small effect size), race/ethnicity (minority students reporting lower; very small effect size), FARMS (low-SES reporting lower; very small effect size).
Most eCM student participants reported gains in their STEM knowledge as a result of participating in eCM, although NJ&EE students were more likely to report large knowledge gains and reported significantly larger gains than their peers; underserved students generally, students from underserved racial/ethnic minority groups, and low SES students reported lower levels of gains in STEM knowledge than their peers.	More than 85% of overall eCM and all NJ&EE students indicated they experienced at least small gains in their STEM knowledge as a result of participating in eCM. More students in NJ&EE agreed the program had medium to large impacts across STEM knowledge and skills items compared to overall eCM students, approximately 60% of whom reported medium to large gains.
	Significant differences in STEM knowledge gains were found by overall underserved status (underserved reporting lower gains; very small effect size), race/ethnicity (underserved minority students reporting lower; very small effect size), FARMS (low-SES students reporting lower; very small effect size), and competition level (NJ&EE reporting higher; small effect size).

eCM student participants reported gains in their STEM competencies, although students competing at the NJ&EE were more likely to report large STEM competency gains; female students and NJ&EE students reported larger gains than their peers while students from underserved racial or ethnic minority groups and low SES students reported smaller gains than their peers.	More than half of the survey participants reported medium or large gains across STEM competency items. Participants in NJ&EE (72%-91%) reported greater gains in STEM competencies compared to their state peers (58%-75%) across all items. Items with the largest group differences in reported medium or large gains (20% points or more) were: Identifying the limitations of the methods and tools used for collecting data (eCM - 62%; NJ&EE - 91%); Defining a problem than can be solved by developing a new or improved product or process (eCM - 66%; NJ&EE - 89%); Considering multiple interpretations of data to decide if something works as intended (eCM – 58%; NJ&EE - 79%); and Supporting an explanation with my STEM knowledge or data from experiments (eCM - 62%; NJ&EE - 83%).
	No differences in STEM competency gains were found by overall underserved status, however differences in gains were found by gender (females reporting higher; small effect size), competition level (national reporting higher; small effect size), race/ethnicity (minority students from underrepresented groups reporting lower; very small effect size), FARMS (low-SES students reporting lower; very small effect size).
Student participants reported that eCM had positive impacts on their 21st Century skills, although students competing at the NJ&EE were more likely to report large gains; females and NJ&EE students reported larger gains than their peers.	Overall eCM participants reported lower gains (39% to 79% medium/large gains) compared to NJ&EE participants (45% to 87% medium/large gains).
	No significant differences in 21st Century skills gains were found by underserved status, however, significant differences in gains were found by gender (females reporting higher; very small effect size) and competition level (national reporting higher; very small effect size).
Students reported gains in their STEM identities as a result of participating in eCM, although students competing at the NJE&E were more likely to report large gains; NJ&EE students reported larger gains than their peers and students from underserved racial/ethnic groups reported lower gains than their peers.	The impact of eCM on participants' STEM identities was greater for NJ&EE participants (64%-85% medium/large impact) compared to overall eCM participants (39%-65% medium/large impact). Items with the greatest eCM impact (medium/large) for both competition levels were: Sense of accomplishment from their work in the program (eCM - 65%; NJ&EE - 85%); Better prepared for more challenging STEM activities (eCM - 59%; NJ&EE - 77%); and Confidence to try out new ideas or procedures on their own in a STEM project (eCM - 55%; NJ&EE - 81%).
	No significant differences in STEM identity gains were found by underserved status, however differences were found by competition level (national reporting higher; small effect size) and race/ethnicity (students from underserved racial/ethnic minority groups reporting lower; very 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 (62%-95%), support the diverse needs of students as learners (57%-94%), support students' development of collaboration and interpersonal skills (68%-95%), and support students' engagement in authentic STEM activities (77%-98%). Most mentors also used several strategies to support students' STEM educational and career pathways (34%-73%), although less than half of mentors discussed STEM career opportunities within the DoD or other government agencies with students (36%) and recommending other AEOP that align with student goal (34%).
Very few eCM Team Advisors discussed any AEOP other than eCM with students.	Very few Team Advisors (2%-12%) reported discussing specific AEOP other than eCM (90%) with students during the program. Nearly a third (31%) of Team Advisors indicated they discussed AEOP in general with their students, but without specific references to any programs.
eCM students reported being satisfied with program features that they had experienced, although students competing at the NJE&E were more likely to report high levels of satisfaction. Students offered various suggestions for program improvement.	Few NJ&EE participants (2%-8%) reported being dissatisfied with any feature of eCM about which they were asked, and most had experienced each of the features, with the exception of Mission Control response time, and were at least somewhat satisfied (40%-96%) with each feature they had experienced. Overall eCM students reported somewhat lower rates of satisfaction with program features (27%-84%) than NJ&EE participants. Overall eCM participants were also more likely not to have experienced various program features (6%-62%) and were more likely (9%-12%) to express being "not at all" satisfied with features such as the submission process (13%) and Mission Control response times (10%-12%). Features that at least 75% of both national and state participants reported being somewhat or very much satisfied with included submission process (overall eCM - 80%; NJ&EE - 96%); applying or registering for the program (overall eCM - 79%; NJ&EE - 94%); eCM website (overall eCM - 84%; NJ&EE - 89%); and educational materials (overall eCM - 77%; NJ&EE - 87%).

	Overall eCM students' most frequently mentioned suggestions for improvement included: • improving the website by improving the save function or autosaving work, making the submission process more user-friendly, improving the organization of the website, or making printing from the site easier • providing better or clearer instructions • shortening the process, making it simpler, including fewer questions, or less writing • providing more or different topics or challenges
	NJ&EE students' suggestions for improvement were primarily focused on elements of the NJ&EE, and included the following: • more time and/or opportunities to connect with mentors • improving communication • problems with technology and/or suggestions for less time on Zoom • providing more opportunities for students to connect with students from other teams • providing more interactive and/or hands-on activities • considering western time zones in planning the virtual event • improvements to the website, including allowing interfaces with Google Slides and Google Docs • improvements to judging, including providing feedback from judges, standardizing scoring at the state level, and having the judges ask better questions • providing clearer instructions • improving program organization and/or planning
eCM Team Advisors reported being satisfied with the program features that they had experienced. Team Advisors cited the strengths of the program and also offered various suggestions for program improvements.	Very few Team Advisors (1%-4%) expressed dissatisfaction with any program features. More than half of Team Advisors reported not experiencing Cyber Guide live chats, Cyber Guides Team Talk feedback, and Cyber Guide discussion forums. Most Team Advisors were at least somewhat satisfied with all program features that they had experienced. More than 90% of eCM Team Advisors reported being somewhat or very much satisfied with: Submission process (92%); eCM website (92%); and Application/registration process (90%).
	Team Advisors cited a number of strengths of eCM for students, including eCM's focus on solving real-world problems, the research and STEM skills students gain, the teamwork students experience, the online format of eCM, the program resources and support provided, and the student-led nature of eCM projects.

	Team advisors also noted that they experienced benefits for themselves including the professional growth they experienced as a result of participating in eCM, the framework the program provided for teaching scientific inquiry and engineering design, the opportunity to learn about and give back to their communities, the satisfaction of acting as a mentor and coach to students, the support the program provided to them, the fact that the program addressed many learning standards, and the opportunity to network with others and collaborate with other Team Advisors.
	Team Advisors suggested various program improvements including: • improving to the website, including incorporating an autosave feature, allowing an interface with Google Docs, allowing larger file uploads, simplifying the submission process, and including the flexibility to show models. • Improving program resources, including suggestions to provide examples of previous projects, update videos, consolidate educational resources into fewer documents to allow for easier downloads, streamlining resources, recording webinars and making them available for asynchronous viewing, and providing document templates • providing more or clearer guidance • streamlining registration • reducing the amount of work for Team Advisors • improvements to virtual events and programming, including providing ways for students to connect with each other in virtual settings, finding ways to showcase and celebrate NJ&EE students in virtual settings, finding ways to incorporate hands-on activities in virtual settings (e.g., send students science kits), breaking up presentations on Zoom into shorter segments, and providing online platforms to engage students when schools are in distance or hybrid learning situations.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Most eCM students learned about eCM from their teachers or through their schools.	Few students (<1%-16%) learned about eCM from any source other than their teachers (90%) or their schools (42%).
Students were primarily externally motivated to participate in eCM by teacher encouragement and academic requirements.	A third or more of students indicated that they were motivated to participate in eCM by the following external factors: Teacher encouragement to participate (71%) and Academic requirement or school grade (35%). Twenty percent or more of students also cited the

	following two internal motivators: Interest in STEM (23%) and the desire to learn something new or interesting (20%).
Most eCM participants had never participated in AEOP other than eCM, and eCM participants were likely to express interest in participating in eCM again, however the majority of students at the overall eCM level had not heard of other AEOP.	Nearly a quarter (24%) of students had participated previously in eCM, however very few had participated in any other AEOP (CI – 3%; GEMS – 2%).
	A large majority of students (91%) competing at the NJ&EE were at least somewhat interested in competing in eCM again, and 70% of students at the state level were at least somewhat interested in participating in eCM again in the future.
	Findings suggest that students are exposed to other AEOP at NJ&EE to a greater extent than at the state competition level, although this effect was less pronounced for FY20 than for previous years. NJ&EE students were less likely reported to report that they had not heard of other AEOP (40%-57%) than overall eCM students (53%-67%). Unlike previous years, most eCM-N students participating in interviews indicated that they had not learned about AEOP during eCM, although some indicated they had learned about them in previous years' NJ&EE participation, from their own research, or from their team advisors.
	More than two-thirds of students across program levels indicated they were somewhat or very much interested in participating in eCM again (eCM – 70%, NJ&EE – 91%). Smaller proportions of students reported future participation interest in other AEOP, although more NJ&EE participants expressed interest than overall eCM participants (eCM: 19%-33%; NJ&EE: 38%-53%).
	Team advisors identified the following two resources as most likely to be somewhat useful or very useful: Participation in eCM (85%) and the AEOP website (48%). Approximately half to three-quarters of Team Advisors (49%-72%) reported not experiencing the other resources.
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; adults made several suggestions for increasing students' exposure to DoD STEM jobs or careers.	All NJ&EE students (100%) and two-thirds (67%) of overall eCM participants indicated they had heard about at least one STEM job/career through eCM. Much larger proportions of NJ&EE participants (70%) indicated they had learned about 5 or more STEM jobs/careers compared to state participants (13%). Regarding DoD jobs/careers, all NJ&EE (100%) and just under a third of overall eCM students (31%) reported hearing about one or more DoD STEM job/career. Approximately two-thirds (68%) of NJ&EE students indicated learning about 5 or more DoD STEM Jobs/Careers as compared to only 4% of overall eCM students.
	Adults were most likely to rate participation in eCM (81%) and the eCM website (47%) as somewhat/very useful for exposing students to DoD STEM careers. More than half of adults (55%-73%) reported having not experienced the remaining AEOP resources.

	NJ&EE students reported learning about STEM careers in the Army/DOD at the national event, citing interacting with judges and presentations as sources of information. Some students also reported learning about Army/DoD STEM careers as part of their project research.
	Most Team Advisors participating in interviews concurred that Army/DoD STEM career information is not widely available at the state level. Team Advisors suggested the following to disseminate Army/DoD STEM career information to students more effectively: • field trips to military facilities or online sessions with DoD representatives to talk about careers • additional mentoring sessions throughout the year • holding career sessions for all eCM participants rather than just for finalists • posting career videos on the eCM website • creating more interactive and personal ways to engage students with Army/DoD representatives.
eCM students expressed positive opinions about DoD research and researchers.	Nearly all NJ&EE students (96%-98%) expressed agreement with various statements about DoD research and researchers, and more than three-quarters of overall eCM students (84%-88%) reported agreement.
Most NJ&EE students reported that they were more likely to engage in various STEM activities in the future after participating in eCM; overall eCM students reported substantially less increase in the likelihood of future STEM engagement, and there were significant differences in future likelihood of engaging by competition level, race/ethnicity, first generation college status.	Overall, NJ&EE respondents (79%-91%) expressed a stronger likelihood of participating in future STEM activities compared to overall eCM students (48%-70%). Approximately two-thirds or more of students from each group indicated they were more likely to participate in the following activities due to program participation: Tinker with a mechanical/electrical device (eCM - 70%, NJ&EE - 89%); Use a computer to design or program something (eCM - 67%, NJ&EE - 85%); Help with a community service project related to STEM (eCM - 62%, NJ&EE - 91%); and Work on solving a mathematical or scientific puzzle (eCM - 62%, NJ&EE - 81%).
	No significant differences in the likelihood of future STEM engagement were found by underserved status, however differences were found by competition level (NJ&EE reporting higher; small effect size), race/ethnicity (students from underserved racial/ethnic minority groups reporting lower; very small effect size), and first-generation college status (students whose parents had not attended college reporting lower; very small effect size).
Most eCM students planned to at least complete a bachelor's degree; NJ&EE students had somewhat higher educational	A large proportion of overall eCM students (88%) and all NJ&EE students (100%) reported intending to at a minimum finish college (get a bachelor's degree). More NJ&EE students (57%) reported a desire to continue their education after college than overall eCM students (39%).

aspirations than overall eCM students.	
eCM had positive impacts for students at all levels of competition, however NJ&EE students were more likely to report impacts; low SES students reported greater gains than their peers. Students identified a number of program strengths.	Half of more of both competition groups agreed that eCM impacted them in the following areas: Confidence in STEM knowledge, skills, and abilities (eCM - 74%, NJ&EE - 96%); Interest in participating in STEM activities (eCM - 52%, NJ&EE - 85%); and interest in taking STEM classes in school (eCM - 50%, NJ&EE - 76%). As in FY19, items with the greatest difference in eCM impact by competition level (approximately 40%) were related to the AEOP/DoD: Having a greater appreciation of Army/DoD STEM research (eCM - 41%, NJ&EE - 91%) and Being more interested in pursuing a STEM career with the Army or DoD (eCM - 39%, NJ&EE - 72%).
	No significant differences in eCM impacts were found by underserved status, however low SES students reported greater gains than their peers (very small effect size).
	Both students at the state and national competition levels cited the benefits of participating in eCM. Overall eCM students were most likely to identify the following benefits: • teamwork • STEM learning • research or STEM skills • the opportunity to solve real-word problems National Finalists were most likely to identify the following benefits: • teamwork • career information • research or STEM skills • increased motivation for or interest in STEM • presentation and communication skills • STEM learning • the opportunity to solve real-world problems • the opportunity to meet peers from across the country • the opportunity to network with STEM experts • the student-led nature of the project, • the judging, and the feedback they received on their projects.

Recommendations for FY21 Program Improvement/Growth

Evaluation findings indicate that FY20 was another successful year for the eCM program, as there were 56% underserved participants in the overall eCM this year and nearly 15,000 overall participants in the competition. eCM students reported gains in STEM knowledge, STEM competencies, and STEM identity.

While these successes are commendable, there are some areas that remain with the potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY21 and beyond:

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

FY20 was met with COVID-19 challenges that resulted in some expected impact on participation in eCM. There were 21% less participants overall in eCM at the state level (14,245 in FY20 compared to 17,944 in FY19). Therefore, the three-year downward trend has continued. It is recommended again for FY21 that eCM employ strategies to reach new participants as well as supports for previous participants to engage again, as 70% of FY20 overall eCM students indicated interest in participating again.

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

As shared in FY19, eCM is a key program in the AEOP consortium portfolio which enrolls by far the most students of any single program or other programs combined. Therefore, there is great opportunity to use eCM as a vehicle for exposing students to the many other opportunities that exist in AEOP and across DoD STEM. However, as in FY19, very few regional Team Advisors reported discussing specific AEOP with students (less than 15% compared to less than 10% in FY19). Further, only 36% (less than 2019) of Team Advisors discussed DoD or other government agencies with students. It is recommended that eCM adjust programming regarding DoD and promoting other AEOP mandatory for Team Advisors to include in their work with students beginning FY21.

Educators and students shared similar suggestions for improving eCM. First, both overall and NJ&EE students and Team Advisors shared that there should be some improvements made to the website organization and functionality. Additionally, better instructions and clearer guidance was requested from all groups as well. NSTA should review this feedback carefully and use it to guide program adjustments to better meet the needs of students and Team Advisors.

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

As in FY17, FY18, and FY19 eCM students overall continue to report having little knowledge of other programs in the AEOP besides eCM (more than 50%). Additionally, in FY20 a large percentage of NJ&EE students reported not hearing about any other AEOP (40-57%). In FY21 it is recommended that NSTA develop a coordinated strategy to address this across eCM, and it is also recommended that NSTA 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.