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ARMY EDUCATIONAL OUTREACH PROGRAM

GEMS

2020 Annual Program Evaluation Report
Findings

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ARMY EDUCATIONAL OUTREACH PROGRAM

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2 | Executive Summary

GEMS, administered by the National Science Teaching Association (NSTA) on behalf of the AEOP, is a non-residential summer STEM enrichment program for elementary, middle, and high school students (herein referred to as students). GEMS is hosted by Army laboratories and centers on site or in close coordination off site with the area Army laboratories and centers (herein referred to as GEMS sites). Due to the COVID-19 pandemic, all GEMS programs (a total of nine) were held in virtual formats in 2020; six program sites canceled activities.

The following overarching mission drives the GEMS program: to interest youth in STEM through a hands-on Army laboratory experience that utilizes inquiry-based learning and Near-Peer mentoring. GEMS is an entry point for a pipeline of AEOP opportunities affiliated with the U.S. Army research laboratories and centers. The various GEMS sites are run independently, with NSTA providing support and guidance in program execution to Local Program Coordinators. Although they operate under a shared mission, GEMS sites are free to include different topics in their curricula that highlight the mission of the laboratory or center, and sites may set, in addition to the overall program goals, individual laboratory or center goals. Instead of prescribing a specific program-wide model and curriculum, individual sites are able to design curricula (using the hands-on, inquiry-based model) and procedures that make sense considering the specialties of each facility and available resources. GEMS programs run from one to four weeks in length, depending on the program site. For example, Silver Spring typically provides nine weeks of programs.

The mentorship model also varies by GEMS site. Many of the GEMS sites use Army scientists and engineers (Army S&Es) to lead GEMS educational activities while other sites use Near-Peer Mentors (NPMs) as a key element in their instructional model. NPMs are developing scientists and engineers (college and high school students) who translate and communicate complex STEM content and their own STEM experiences to the younger GEMS participants. Many sites also leverage the expertise of in-service Resource Teachers (RTs). RTs assist Army S&Es and NPMs in translating STEM research, STEM concepts, and STEM practices into educational curricula as well as provide coaching and instructional supervision to NPMs. RTs also provide adaptive support to individual student participants to ensure maximal engagement and learning. Herein, Army S&Es, NPMs, and RTs are referred together as GEMS mentors except where it is appropriate to differentiate their roles and experiences.

All GEMS programs are designed to meet the following objectives:

1. To nurture interest and excitement in STEM for elementary, middle, and high school participants;
2. To nurture interest and excitement in STEM for mentor participants;
3. To implement STEM enrichment experiences using hands-on, inquiry-based, educational modules that enhance in-school learning;
4. To increase participant knowledge in targeted STEM areas and laboratory skills;
5. To increase the number of outreach participants inclusive of youth from groups historically underrepresented and underserved in STEM;
6. To encourage participants to pursue secondary and post-secondary education in STEM;
7. To educate participants about careers in STEM fields with a particular focus on STEM careers in Army laboratories and centers; and
8. To provide information to participants about opportunities for STEM enrichment through advancing levels of GEMS as well as other AEOP initiatives.

In 2020, GEMS 17 Army research centers and laboratories operating at 15 program sites in ten states accepted GEMS applications. GEMS provided outreach via virtual programs to 2,203 students at nine sites in 2020. Because of the COVID-19 pandemic, only six of the 15 program sites canceled their programs.

GEMS 2020 Fast Facts	
Description	STEM Enrichment Activity - at Army laboratories, hands-on
Participant Population	5th-12th grade students (secondary audience: college undergraduate near-peer mentors, teachers)
Number of Applicants	4,533
Number of Participants	2,203
Number/Percentage Underserved Participants*	832 (40%)
Placement rate	48%
Total Number of Adults	214
Number of Near-Peer Mentors	106
Number of Resource Teachers	38
Number of Army S&Es	40
Other Adult Volunteers	30
Number of Army Research Laboratories & Centers	17
Number of K-12 Teachers	38
Number of K-12 Schools	747
Number of K-12 Schools – Title I	250
Number of Colleges/Universities	33
Number of HBCU/MSIs	9
Other Collaborating Organizations	0
Number of DoDEA Students	21
Number of DoDEA Teachers	0
Number of DoDEA Schools	1
Total Cost	$1,253,707
Total Travel**	$7,443
Participant Travel	$0
Total Awards	$801,049
Student Awards/Stipends	$282,864
Adult/Teacher/Mentor Awards	$518,185
Cost Per Student	$569

* Underserved calculation based upon Cvent participation data that reflects enrollment of n=2,087

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

Summary of Findings

The 2020 evaluation of GEMS collected data about participants; participants' perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the Table 41.

Table. 2020 GEMS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
GEMS continues to receive applications from more students than it can accommodate but served fewer students than in previous years.	GEMS sites collectively received 4,533 participant applications in 2020, a 14% decrease compared to 2019 when 5,296 student applications were submitted, and an 18% decrease compared to the 2018 when 5,500 applications were received.
	GEMS enrolled 2,203 students at nine program sites, a 26% decrease in enrollment compared to 2019 when 2,985 students were enrolled at 14 sites and a 34% decrease in enrollment compared to 2018 when 3,341 students were enrolled at 15 sites. Much of this decrease in enrollment is due to the cancellations of GEMS programs at six program sites due to the COVID-19 pandemic.
GEMS continued to reach students from populations historically underrepresented and underserved in STEM.	Overall student demographics for 2020 are similar to those of previous years. Half of GEMS students (50%) were female in 2020 (47% in 2019 and 2018). The proportion of students identifying as White decreased somewhat in 2020 as compared to previous years (36% in 2020, 44% in 2019, and 40% in 2018). The proportion of Asian students increased as compared to recent years, with 19% of students identifying as Asian in 2020, compared to 14% in 2019 and 17% in 2018. The proportion of Black or African American students remained relatively constant, with 24% of students identifying themselves as Black or African American in 2020 as compared to 23% in 2019 and 24% in 2018. There was a slight decrease proportion of students identifying themselves as Hispanic or Latino/a (7% in 2020 and 9% in both 2019 and 2018).
	As in 2019, relatively few students reported being eligible for free-or reduced-price school lunch (FARMS), a commonly used indicator of low socioeconomic status (12% in 2020 and 13% in 2019), nearly all (97%)

	spoke English as their first language; and few (8%) would-be first-generation college attenders. The proportion of students who met the AEOP definition of underserved in 2020 (40%) was similar to 2019 (42%) but slightly higher than in 2018 (35%).
Most students reported engaging in all STEM practices during GEMS and reported being more engaged in STEM practices in GEMS than in school; students meeting the AEOP definition of Underserved, students who would be first generation college attenders, and low-income students reported greater frequency of engagement than their peers.	Sixty percent or more of students (60%-94%) reported engaging in all STEM practices at least once during GEMS. Activities engaged with most often (most or every day) by approximately two-thirds of students or more were: Examining data to make a conclusion (75%); Using scientific tools and steps to do an experiment (71%); and Planning to do an experiment (68%).
	Differences in engagement in STEM practices were found by Underserved classification (underserved students greater agreement; small effect size), by first generation college status (first generation students greater engagement; small effect size), and FARMS (FARMS students greater engagement; small effect size).
	Students reported significantly greater engagement in STEM practices in GEMS as compared to in school (medium effect size).
Students experienced gains in STEM knowledge during GEMS; students meeting the AEOP definition of Underserved, female students, students who would-be first-generation college attenders, and low-income students, ELL students, and minority students reported greater gains than their peers	Three-quarters or more of students (76%-87%) reported that they "learned more than a little" or "learned a lot" in each area. The impact of GEMS on students' new knowledge of a STEM topic (86%) was the most frequently reported area of impact.
	Significant differences in STEM knowledge gains were found by Underserved classification (Underserved students learned more; small effect size), by gender (females learned more; small effect size), first generation status (first generation students learned more; small effect size), FARMS status (FARMS students learned more; small effect size), ELL status (ELL students learned more; small effect size), and race/ethnicity (students from underserved minority groups learned more; small effect size).
Students experienced gains in their STEM competencies or skills during GEMS.	Sixty percent or more of students (66%-89%) reported learning at least a little in all STEM competencies with the exception of two items: How to create charts/graphs to show data/find patterns (45%) and How to identify strengths/limitations of information in technical/scientific books (49%). Areas where students indicated they learned the most (more than a little or a lot) were: How to use knowledge and creativity to come up with a solution (74%); How to support my ideas with my STEM learning (69%); and How to make a model to show how something works (67%).
	No significant differences in STEM competency gains were found by overall Underserved status or by any individual demographic component of Underserved status.
Students experienced gains in their 21st Century skills during GEMS.	Nearly half or more of students (40%-71%) reported that they learned more than a little or a lot in all 21st Century skills except for how to create videos, blogs, and social media posts (29%). Skills impacted the most were:

	How to solve problems (73%); How to use creative ideas to make something (71%); How to think about how systems work and how parts interact with each other (69%); and How to think creatively (67%).
	No significant differences in 21st Century skills gains were found by overall Underserved status or by any individual demographic component of Underserved status.
Students reported that participating in GEMS positively impacted their STEM identities - their interest in and feelings of capability about STEM; students who would be first generation college attenders reported greater impacts than their peers.	After participating in GEMS, extremely large proportions of students (82%-94%) either agreed or strongly agreed with each statement related to the impact of GEMs on their STEM identities. More than 90% of GEMS students reported positive impacts in the following areas: Feeling more prepared for more challenging STEM activities (94%) and Feeling like they accomplished something in STEM (93%).
	No significant differences in STEM identity gains were found by overall Underserved status. A difference was found by first generation college status (first generation students reported more gains; small effect size).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors reported using a range of mentoring strategies with students.	A majority of mentors reported using most strategies associated with each area of effective mentoring, including: • Strategies to help make the learning activities in GEMS relevant to students (71%-96%), with the exception of selecting readings/activities that relate to students' backgrounds (42%) • Strategies to support the diverse needs of students as learners (67%-100%) with the exception of highlighting under-representation of women and racial/ethnic minority populations in STEM (42%) and integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM (29%). • Strategies to support students' development of collaboration and interpersonal skills (50%-88%) • Strategies to support student engagement in authentic STEM activities (50%-100%) with the exception of having students search for and review technical literature to support their work (17%) • Strategies to support students' STEM educational and career pathways (50%-71%) with the exception of helping students with their resume, application, personal statement, and/or interview preparation (21%); and helping students build a professional network in a STEM field (42%).
Most students expressed high levels of satisfaction with features of GEMS that they had	Very few students (2%-9%) reported dissatisfaction with any program feature. Program features with which the most students reported satisfaction at the somewhat or very much satisfied levels were the

experienced and cited various benefits of participating; students had a variety of suggestions for program improvement.	teaching/mentoring provided during GEMS (70%) and STEM topics included in GEMS (70%).
	More than a third of GEMS students had not experienced program features such as invited speakers (36% did not experience) and virtual field trips/laboratory tours (52% did not experience).
	Nearly all students (97%) made positive comments about GEMS in open-ended questionnaire items, and a large majority (87%) commented only on positive aspects of the program. Positive comments focused on the learning they experienced, the quality of mentors and students' connections with mentors, the career information they received, the flexibility programs displayed in transitioning to virtual formats, providing students with "something to do" over the summer, and appreciation for the stipend.
	Among the various benefits of GEMS mentioned by students in open-ended responses, the most frequently mentioned benefits were the STEM learning they experienced, the career information and guidance they received, the opportunity to acquire specific STEM skills or research skills, increases in their motivation for or interest in STEM, and the hands-on nature of and real-world connections in GEMS.
	Students made a wide variety of suggestions for program improvement. The most frequently suggested improvements focused on activities, (requests for more hands-on activities, more or better speakers, virtual field trips, or more real-world demonstrations and examples); the virtual platform for the program (suggestions that the program be held in person, that more varied online tools be used, and comments about technology problems); and the schedule or logistical elements of GEMS (shorter presentations, providing more or longer breaks, and having longer days or a longer program).
Mentors reported satisfaction with GEMS features and noted a number of strengths of GEMS. Mentors also made suggestions for program improvement.	Half or more mentors indicated being at least somewhat satisfied with all program features (58%-100%) except for two which most did not experience: Communication with NSTA (67% did not experience) and Field trips/laboratory tours (63% did not experience). All or nearly all mentors indicated they were at least somewhat satisfied with support for instruction or mentorship during program activities (100%) and communication with GEMS organizers/site coordinators (96%).
	All but one of the mentors responding to open-ended questions made positive comments about their satisfaction with GEMS, attributing their satisfaction to the engaging program content and activities, the career information students received, and the ability of the program to adapt.
	The program strengths most frequently cited by GEMS mentors regarding students were the STEM learning students experience and the opportunity

	to acquire a range of 21st Century skills (e.g., problem solving, communication, work ethic, workplace skills, the ability to work independently), the opportunity for hands-on learning, and the NPMs.
	Mentors noted benefits to themselves from serving as mentors, including the following: • GEMS RTs focused on the value of being able to take their experiences in STEM back to their classrooms • Army S&E mentors noted that they benefit from the new perspective they gain on their work from presenting it to others, the satisfaction of working with participants and NPMs, the incentive to keep abreast of information from private industry that mentoring provides them, and improvements in their communication skills • NPMs noted a variety of benefits including developing leadership skills, and communication skills, and other workplace skills; the opportunity to learn science; improving their own teamwork skills; and the opportunity to network with Army S&Es.
	Mentors suggested a range of program improvements. The most frequently mentioned improvements were to provide more interaction between the students and the NPMs and S&Es, to provide participants with more opportunities for collaboration or teamwork and holding the program on site rather than virtually.
GEMS students and mentors responded positively to the virtual format of GEMS program, although most noted that the online program was less impactful than face to face programs.	A large majority of GEMS students (76%) reported that they had an excellent (44%) or very good (31%) opinion of GEMS in the virtual format used in 2020. Only 3% reported that their opinion of virtual GEMS was "not so good."
	In an open-ended questionnaire item, nearly all students (95%) made positive comments about the virtual format of GEMS, although many also noted that they would have preferred to attend in person. Students participating in phone interviews were similarly positive about the virtual format but also regretted not being able to attend an in-person format, and several noted that a significant deficit of the virtual format is the more limited opportunities to connect with peers and make friends. Students noted several strengths of the virtual GEMS format, including flexibility of the program, the availability of mentors, and the technology associated with program delivery.
	Mentors participating in phone interviews made positive comments about the virtual format of GEMS. Mentors noted that programs had made efforts to forge connections between students, between students and mentors, and between students and invited guest speakers. Some mentors pointed to the potential for virtual GEMS programs to broaden the reach of GEMS nationally. Mentors also noted some challenges with the online

	format, including the difficulties in keeping students attention and engaging them in learning.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students who provided information about how they learned about AEOP primarily cited past participation and personal connections; mentors reported similar sources of information.	After past participation in the program (42%), students' most frequently reported sources of information about AEOP were personal connections, including friends (34%) and family members (30%). Other sources of information with more than 10% endorsement were the AEOP website (24%) and a school or university newsletter, email, or website (14%).
	The most commonly reported sources of information about AEOP for mentors were past participation in GEMS (40%), a family member (33%), and someone who works with the program (33%). More than a quarter of mentors also indicated that they learned about AEOP through a friend (27%) and AEOPs website (27%).
Students reported being motivated to participate in GEMS primarily by their interest in STEM, the learning opportunities, and the opportunity to have fun.	A large majority (more than three-quarters of students) reported their interest in STEM (90%) and desire to learn something new or interesting (87%) as motivators. More than two-thirds of students also reported that the opportunity to have fun (68%) and learning in ways not possible in school (70%) motivated them to participate in GEMS.
Few students had participated in any AEOP other than GEMS and most had not heard of other AEOPs; few mentors discussed specific AEOPs other than GEMS and GEMS NPMs with students.	Half of students (50%) indicated being past GEMS participants. Smaller proportions reported having participated in Camp Invention (5%), eCM (1%), JSHS (<1%), JSS (<1%), and SEAP (<1%). Slightly less than a quarter (22%) indicated they had participated in other STEM programs in the past.
	With the exception of GEMS and GEMS NPMs, approximately half or more of students reported having never heard of each AEOP about which they were asked (49%-68%). Most students were, however, at least a little interested in participating in GEMS again (82%) and in the GEMS NPM program (68%), and few (3%-7%) said they had no interest in participating in other AEOPs.
	Nearly all mentors reported discussing GEMS (88%) and almost three-quarters discussed GEMS NPMs (71%) with their students. Slightly less than half of mentors (46%) reported discussing AEOPs generally with students but without reference to any specific program.
Mentors reported that GEMS participation and administrative staff were useful for exposing students to AEOPs; many had not	Mentors rated participation in GEMS most frequently as at least somewhat useful resource for exposing students to AEOPs (96%), followed by GEMS program administrators or site coordinators (75%).
	Nearly two-thirds of mentors (63%) reported not having experienced AEOP on social media and AEOP printed materials.

experienced other AEOP resources.	
Students reported learning about STEM careers generally during their GEMS experiences and, to a somewhat lesser extent, about STEM careers within the Army or DoD; students had learned about these careers through program activities, speakers, and their mentors.	Nearly all students (97%) reported learning about at least one STEM job/career, while slightly fewer students this year as compared to past years indicated learning about five or more (43%). Fewer students (70%) reported learning about at least one DoD STEM job/career and only 16% reported learning about five or more.
	Students participating in interviews, who represented two GEMS sites, indicated that they learned about careers through connections made in program activities, speakers, and mentors.
Mentors reported that GEMS participation, administrative staff, and speakers were useful for exposing students to DoD STEM careers; many had not experienced other AEOP resources.	Mentors were most likely to rate participation in GEMS (83%) and the GEMS program administrator/site coordinator (75%) as at least somewhat useful for exposing students to DoD STEM careers, and half of mentors (50%) also indicated that invited speakers were useful.
	AEOP materials were reported as less useful resources, with a third or more of mentors (38%-67%) reporting not having experienced resources such as AEOP on social media (67%), AEOP printed materials (63%), and the AEOP website (38%).
	Mentors participating in focus groups indicated that their students were exposed to DoD STEM careers in GEMS from the hands-on activities, the speakers, and from the NPMs.
Students had positive perceptions of DoD researchers and research after participating in GEMS.	Nearly all students (91%-97%) agreed or strongly agreed with statements about DoD researchers and research, implying they have positive opinions about DoD researchers and research after their GEMS experiences.
Students reported being more likely to engage in STEM activities after participating in GEMS; females reported higher likelihood of future engagement than males.	Very large proportions of students (79%-89%) reported being more likely or much more likely to engage in each activity after GEMS. Activities with the greatest reported likelihood after GEMS participation were: Participate in a STEM camp, club, or competition (89); and Play with a mechanical or electrical device (89%).
	No significant differences in likelihood of future STEM engagement were found by overall Underserved status. A difference was found by gender (female students reported higher likelihood; small effect size).
Students reported aspiring to at least finish college after participating in GEMS.	Nearly all students (95%) indicated wanting to at least finish college (get a Bachelor's degree), and over half (59%) reported a desire to continue their education after college.

GEMS had positive impacts on students in areas of their STEM learning and interest, their appreciation for STEM research, and their interest in STEM careers; students who would-be first-generation college attenders, low income students, and ELL students reported greater impacts than their peers.	More than 60% of students (62%-93%) said GEMS contributed to each area of impact or was the primary reason for the impact. Areas in which students reported the greatest impact were related to: Confidence in personal STEM knowledge, skills, and abilities (92%); Interest in participating in STEM activities outside of school requirements (84%); and Appreciation of DoD STEM research (80%).
	No significant differences in the impact of GEMS were found by overall Underserved status. Significant differences in impact were found by first generation status (first generation students higher agreement; small effect size), FARMS (FARMS students higher agreement; small effect size), and ELL status (ELL students higher agreement; small effect size).

Recommendations for FY21 Program Improvement/Growth

Evaluation findings indicate that FY20 was a successful year for the GEMS program despite a need to shift to virtual program delivery due to COVID-19. As in previous years, GEMS participants reported growth in their STEM knowledge, skills, and identity after participating in the program. While the successes for GEMS detailed above are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY21 and beyond.

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

Due to COVID-19, GEMS sites were presented with the need to decide between virtual program delivery or cancelling summer programs. As a result, nine program sites moved forward with a virtual GEMS program for FY20, which is a sizable drop from 15 sites in FY19. Therefore, there were fewer students who had the opportunity to participate in GEMS in FY20 (2,203) compared to FY19 (2,985). It is commendable that GEMS maintained the representation of underserved students in the program at 40%, which was only a 2% decrease from FY19 overall. Of the 2,203 who participated in GEMS this year, 50% reported being repeat participants in the program. The demand for GEMS remains high – as 4,533 applications were received in FY20 – making the placement rate at less than 50% for the program. It is recommended that GEMS take lessons learned from the virtual program delivery in FY20 and apply these best practices to FY21 to attempt to support more GEMS sites to go virtual with programming. Given the large demand for GEMS and the number of GEMS sites and face-to-face facility requirements as potential barriers, NSTA should consider working with Army stakeholders to potentially conceptualize a virtual aspect of GEMS for the future that may be able to engage not only more students, but also a greater geographic reach for engaging participants in GEMS.

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

Though mentors reported using some of the effective strategies for mentoring students in FY20 (making learning relevant, supporting diverse student needs, and development of collaboration and interpersonal skills), there were some areas that were shared as less frequently used with GEMS participants. Those areas include connecting activities/readings to student backgrounds and highlighting underrepresented groups in STEM. These are strategies that are particularly important with underserved populations and NSTA should consider providing resources to GEMS program directors to help with integrating this into their programming.

The top area for improvement that mentors mentioned was to provide more interaction between the students and the Near Peer Mentors and S&E's. Additionally, more opportunities for collaboration and teamwork across the GEMS programs was also mentioned as an area for additional focus. Students noted the availability of mentors and flexibility of the program in FY20 were strengths, though many noted a face-to-face delivery format was more attractive.

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

As in the previous three years, many students (49-68%) had not heard of other AEOPs. Further, 46% of mentors reported discussing AEOPs generally with reference to any specific program. This means that in FY20 more than half (54%) of mentors did not discuss other AEOPs at all. It is recommended that NSTA work with GEMS sites to provide required guidance and activities for GEMS participants to learn about other appropriate AEOPs.