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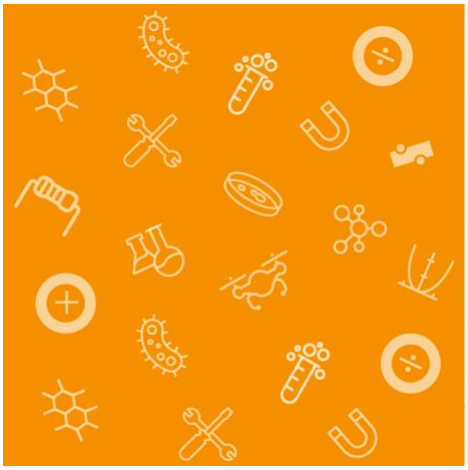

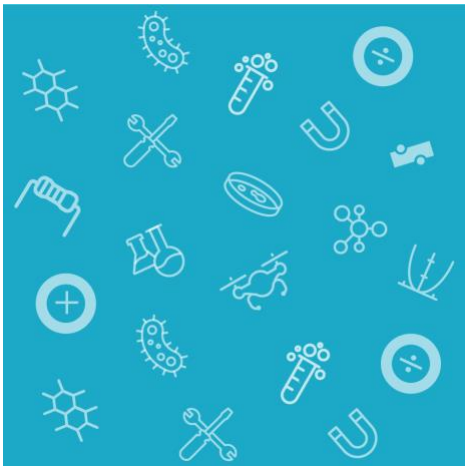

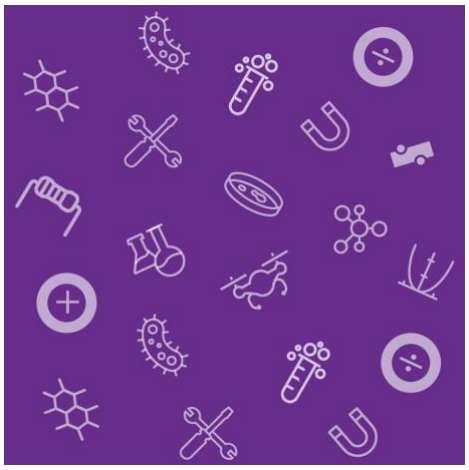


ARMY EDUCATIONAL OUTREACH PROGRAM

GEMS

2019 Annual Program Evaluation Report
Executive Summary

April 2020

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ARMY EDUCATIONAL OUTREACH PROGRAM

1 | AEOP Consortium Contacts

U.S. Army Contacts

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

Jack Meyer
Army Educational Outreach Program (AEOP) Director
Office of the Deputy Assistant Secretary of the Army
for Research and Technology
jack.m.meyer2.ctr@mail.mil

AEOP Cooperative Agreement Manager

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

Battelle Memorial Institute – Lead Organization

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

GEMS Program Administrators

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

Renee Wells
GEMS Program Administrator
National Science Teaching Association (NSTA)
rwells@nsta.org

Evaluation Team Contacts – NC State University

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

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

Janet B. Walton, Ph.D.
Assistant Director, AEOP CA
jwalton2@ncsu.edu

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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). 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 provides 9 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 2019, GEMS sites included 18 Army research centers and laboratories operating in 10 states. GEMS provided outreach to 2,985 students at 14 sites.

GEMS 2019 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	5,296
Number of Participants	2,985
Number/Percentage U2 Participants*	997(42%)
Placement rate	56%
Number of Adults	351
Number of Near-Peer Mentors	128
Number of Resource Teachers	33
Number of Army S&Es	175
Other Adult Volunteers	15
Number of Army Research Laboratories & Centers	18
Number of K-12 Teachers	33
Number of K-12 Schools	1,463
Number of K-12 Schools – Title I	409
Number of Colleges/Universities	68
Number of HBCU/MSIs	3
Other Collaborating Organizations	17
Number of DoDEA Students	8
Number of DoDEA Teachers	1
Number of DoDEA Schools	8
Total Cost	$1,206,887
CCDC Cost	$161,559
IPA Cost	$1,045,328
Total Travel	$9,755

CCDC Travel	$0
IPA Travel	$9,755
Participant Travel	$0
Total Awards	$775,267
Student Awards/Stipends	$270,800
Adult/Teacher/Mentor Awards	$504,467
Cost Per Student	$404

* U2 calculation based upon Cvent participation data that reflects enrollment of n=2,380

Summary of Findings

The FY19 evaluation of GEMS collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the following table.

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

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

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

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

Few students had participated in any AEOP other than GEMS and most had not heard of other AEOPs; few mentors discussed specific AEOPs other than GEMS and GEMS NPMs with students.	Slightly more than half (55%) of the respondents who provided information about their past AEOP participation (n=182) indicated having participated in GEMS previously. Only very small proportions reported having participated in programs such as Camp Invention (7%), JSS (2%), eCM (2%), and JSHS (<1%). Approximately a quarter (24%) indicated they had participated in other STEM programs in the past.
	A majority of students reported having never heard of each AEOP about which they were asked (58%-75%). Most students were, however, at least a little interested in participating in GEMS again (80%) and in GEMS NPM (57%), and few (5%-9%) indicated having no interest in participating in other AEOPs.
	All mentors reported discussing GEMS (100%) and a large majority GEMS NPMs (89%) with their students. Approximately half of mentors (52%) reported discussing AEOPs generally with students but without reference to any specific program.
Mentors reported that GEMS participation and administrative staff were useful for exposing students to AEOPs; many had not experienced other AEOP resources.	More than half of mentors (56%-92%) reported that all resources were at least somewhat useful for exposing students to AEOPs with the exceptions of AEOP on social media (26%) and the AEOP brochure (44%). Participation in GEMS was most frequently rated as at least somewhat useful (93%), along with GEMS program administrators or site coordinators (85%).
	Nearly half of mentors (48%) had not experienced AEOP on social media and a third (33%) had not experienced the AEOP brochure.
Students reported learning about STEM careers generally during their GEMS experiences and, to a somewhat lesser extent, about STEM careers within the Army or DoD; students had learned about these careers primarily from their first-hand experiences.	Nearly all students (96%) reported learning about at least one STEM job/career, and slightly more than half (52%) reported learning about five or more. A slightly smaller number of students (85%) reported learning about at least one DoD STEM job/career and 25% reported learning about five or more DoD STEM careers.
	Students participating in focus group reported learning about DoD STEM careers primarily from being at a DoD site, their mentors, speakers, and career videos.
Mentors reported that GEMS participation, administrative staff , and speakers were useful for exposing students to DoD STEM careers; many had not experienced other AEOP resources.	Mentors were most likely to rate participation in GEMS (85%), the GEMS program administrator/site coordinator (85%), and invited speakers (82%) as at least somewhat useful for exposing students to DoD STEM careers.
	AEOP materials were reported as less useful, with a third or more of mentors reporting not having experienced resources such as AEOP on social media (48%), the AEOP website (37%) and the AEOP brochure (33%).

	Mentors participating in focus groups suggested using speakers, explicitly connecting activities to DoD careers, and incorporating DoD-related field trips into GEMS as means for exposing students to DoD STEM careers.
Students had positive perceptions of DoD researchers and research after participating in GEMS.	Large majorities of students (83%-86%) agreed or strongly agreed with each statement about DoD researchers and research, suggesting that they have positive opinions about DoD researchers and research.
Students reported being more likely to engage in STEM activities after participating in GEMS.	More than half of students (54%-70%) reported being more likely or much more likely to engage in each activity except for watching or reading non-fiction STEM (43%) after participating in GEMS. Areas with approximately two-thirds or more of students reporting an increase in likelihood of participation after GEMS were: participating in a STEM camp, club, or competition (61%); working on a STEM project/ experiment in a university/professional setting (65%); and talking with friends or family about STEM (65%).
Students reported aspiring to at least finish college after participating in GEMS.	A large majority of students (94%) reported wanting to at least finish college (get a Bachelor's degree), and over half (56%) indicated that they aspired to continue their education after college after participating in GEMS.
GEMS had positive impacts on students in areas of their STEM learning and interest, their appreciation for STEM research, and their interest in STEM careers; students who met the AEOP definition of U2 reported greater impacts than non-U2 students.	Most students (61%-90%) reported that GEMS contributed to each area of impact about which they were asked. Areas in which students reported the greatest impact were their confidence in personal STEM knowledge, skills, and abilities (90%); their appreciation of DoD STEM research (82%); and their interest in participating in STEM activities outside of school requirements (82%).
	Students who met the AEOP definition of U2 reported significantly greater impacts than non-U2 students (small effect size) on STEM learning and interest.

Recommendations for FY20 Program Improvement/Growth

Evaluation findings indicate that FY19 was a very successful year for the GEMS program, including growing the percentage of underserved students who participated in the program by 7% to 42% overall, compared to 2018. Additionally, GEMS participants (over 80 percent) reported growth in their STEM knowledge after participating in the program. While the successes for GEMS detailed above are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY20 and beyond.

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

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

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

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

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

As in FY17 and FY18, many students (58%-75%) had not heard of other AEOPs. Further, more than half of mentors (52%) reported discussing AEOPs generally, but not with reference to any specific program. This means that 48% of mentors did not discuss other AEOPs at all. It is recommended that NSTA work with GEMS sites to provide required guidance and activities for GEMS participants to learn about other appropriate AEOPs.

To view the rest of the report:

GEMS Evaluation Report Narrative Part 2
GEMS Evaluation Report Appendices Part 3