Department of Defense

DoDSTEM

Science · Technology · Engineering · Mathematics

FY 2020 YEAR IN REVIEW

JULY 2023

FY 2020 YEAR IN REVIEW

Significance

DoD STEM is building an internal culture of evaluation to ensure accountability for progress toward stated goals and objectives of the DoD STEM Strategic Plan[1], as well as alignment with the America COMPETES Reauthorization Act[2], the American Innovation and Competitiveness Act[3], and others. In doing so, DoD STEM must establish a baseline for comparison to the future program portfolio. The intent is to establish a portfolio-level baseline using five years of data (i.e., Year in Review reports from fiscal year (FY) 2018 – FY 2022), to include years both pre- and post-COVID-19 pandemic.

Introduction

This Year in Review is a snapshot of DoD STEM's programming in FY 2020 and is developed in alignment to the FY 2019 Year in Review[4] and follows previous portfolio-level reporting[5], to include a descriptive analysis for FY 2017-2018[6]. The data in this report was collected via an annual data call issued to DoD STEM programs and leadership to collect essential information of STEM education and outreach programs performed across the Department.

As the largest employer of Federal scientists and engineers across the Federal agencies, the DoD employs a comprehensive approach to develop STEM talent with PreK-12, postsecondary, and workforce STEM education and talent development efforts, known as DoD STEM[7]. The mission of DoD STEM is to inspire, cultivate, and develop exceptional STEM talent through a continuum of opportunities to enrich our current and future DoD workforce poised to tackle evolving defense technological challenges. DoD STEM activities support this mission by providing authentic learning experiences through a variety of education and outreach initiatives in the form of scholarships, internships, enrichment activities, competitions, mentorships and more (*i.e.*, evidenced-based approaches supported by the literature[8]) and by leveraging partners from industry, academia, and other government organizations with a shared STEM mission. A robust portfolio of programs and activities are executed either at the local installation level, or as portfolios across individual DoD offices, Services, or agencies, and those programs are executed and overseen by the DoD components[9].

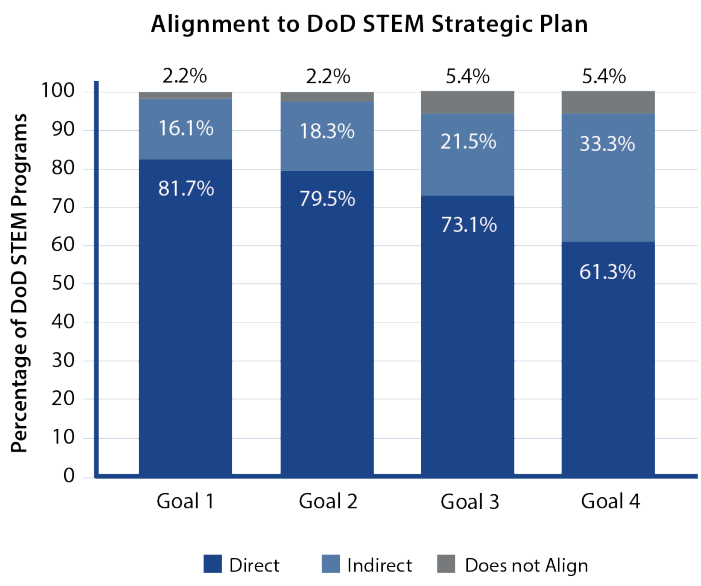
1. https://dodstem-assets.dodstem.us/files/DoD_STEM_Strategic_Plan_2021.pdf
2. https://www.congress.gov/111/plaws/publ358/PLAW-111publ358.pdf
3. https://www.congress.gov/bill/114th-congress/senate-bill/3084
4. https://dodstem-assets.dodstem.us/files/STEM_Year_in_Review_FY2019.pdf
5. https://dodstem.us/about/impact/
6. https://dodstem-assets.dodstem.us/files/DoD-STEM-Education-and-Outreach-Portfolio-Overview-FY2017-18.pdf
7. dodstem.us
8. https://dodstem-assets.dodstem.us/files/STEM_Year_in_Review_FY2019.pdf
9. Components: The Office of the Secretary of Defense (OSD), the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within DoD.

Overarching Themes

1. DoD STEM programming is designed to achieve the goals and outcomes of the DoD STEM Strategic Plan and Logic Model

The FY 2021-2025 DoD STEM Strategic Plan was developed in alignment with Federal and DoD priority areas to address the unique role the Department can play in STEM education. In order to translate the high-level goals and pathways of the Federal and DoD STEM Strategic Plans into meaningful programs and activities, a Logic Model for DoD STEM[10] was developed and is regularly updated. The goals of the DoD STEM Strategic Plan align (directly or indirectly) to the intended outcomes of the current DoD STEM Logic Model, towards which there are identified measures of success collected from programs on an annual basis. (Note that not all measures of success outlined are captured in this or other reports.)

Beginning in FY 2020, DoD STEM programs were asked to report alignment to the specific goals of the DoD STEM Strategic Plan and to the intended outcomes outlined in the DoD STEM Logic Model. For FY 2020, alignment reporting showed the majority of programs identified as directly aligning to all four DoD STEM Strategic Goals, with the greatest strengths in the areas of Goals 1 and 2. Programs indicated "indirect" or "no alignment" most frequently to Goal 4, reflecting an opportunity for growth. FY 2020 programmatic alignment to the intended outcomes outlined in the DoD STEM Logic Model reveals that "Education provides DoD-relevant STEM skills" represents the most common shared intended outcome of DoD STEM programs.



FY 2021-2025 DoD STEM Strategic Plan Goals

Goal 1: Inspire community engagement in DoD STEM education programs and activities to provide meaningful STEM learning opportunities for students and educators.

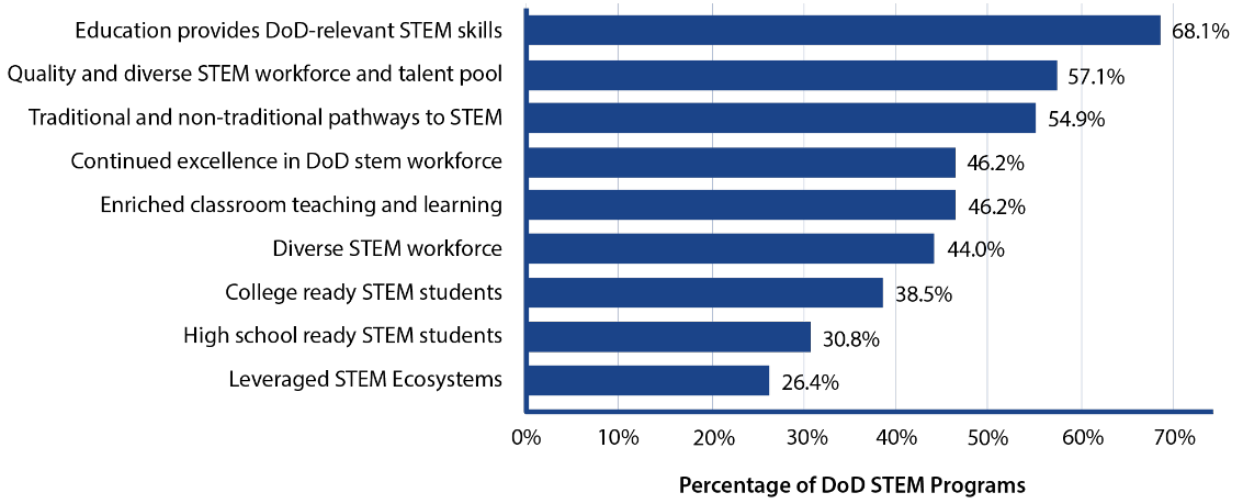
Goal 2: Attract the Nation's and DoD's current and future STEM workforce through multiple pathways to educational and career opportunities.

Goal 3: Increase participation of underserved and underrepresented groups in STEM education and workforce development programs, activities, and outreach.

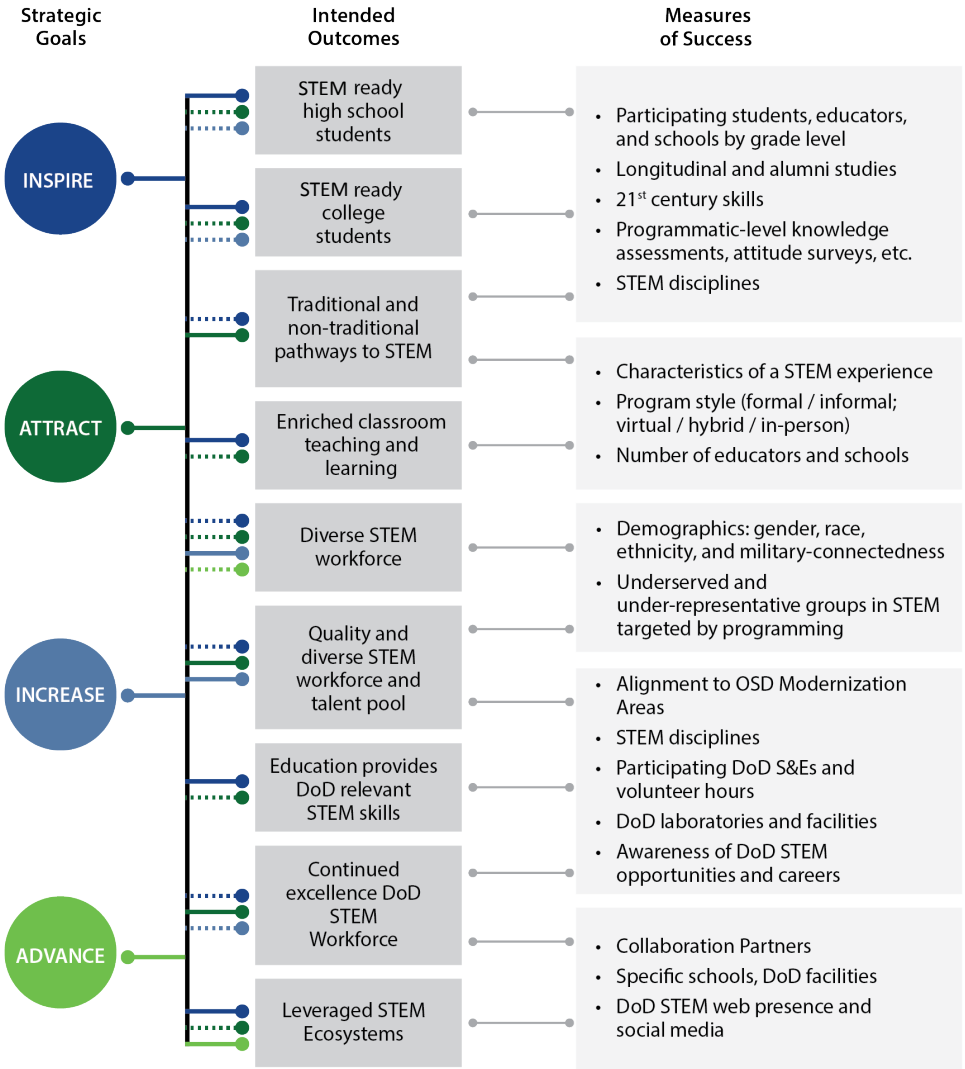
Goal 4: Advance the efficiency and effectiveness of STEM education and workforce development programs, activities, and outreach through evaluation and assessment.

10. https://dodstem-assets.dodstem.us/files/DoDSTEM-LogicModel.pdf

Alignment to DoD STEM Logic Model Outcomes



Alignment to DoD STEM Logic Model Outcomes

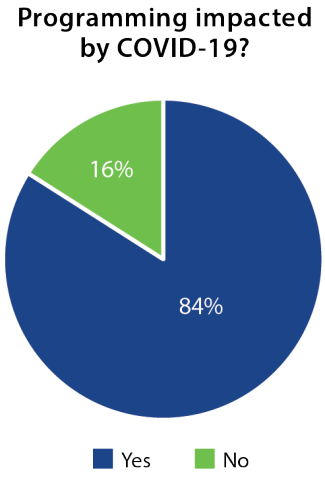


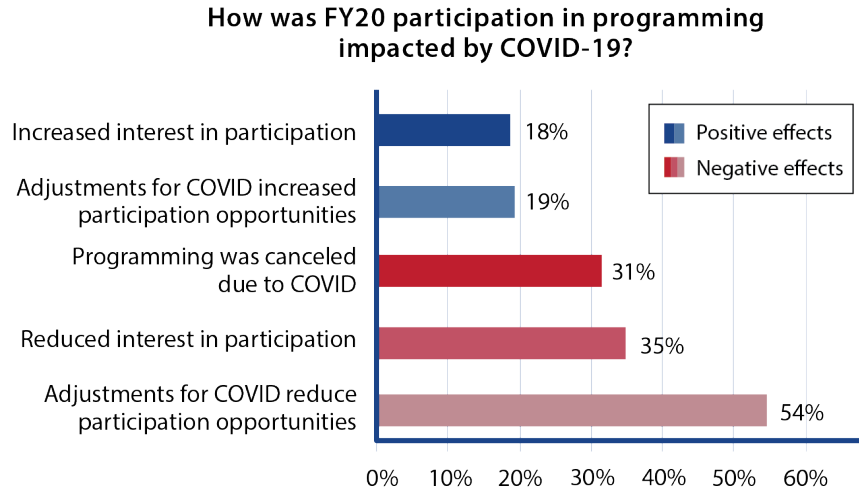
2. DoD STEM programming was affected by COVID-19, with largely negative impacts, but some positive outcomes and best practices were also revealed

As one might expect, DoD STEM programs were largely adversely affected by COVID-19. Portfolio-level data revealed several examples of these effects, from program cancellations to program adjustments leading to shifts in student participation and the ways in which programs were conducted. For example, in FY 2020, 84 percent of 207 DoD STEM programs reported noticeable impacts due to the COVID-19 pandemic, and these were largely negative. Of the 173 programs affected by COVID-19, 94 programs (54 percent) adjusted to COVID-19 in ways they believe reduced opportunities for participation, 60 programs (35 percent) reported reduced student interest in participation, and 54 programs (31 percent) were cancelled altogether. Fewer programs however reported positive impacts including: 33 programs (19 percent) adjusted to COVID-19 in ways they believe increased participant opportunities, and 31 programs (18 percent) reported increased student interest. Of the 33 DoD STEM programs reporting being unaffected by COVID-19, nine (27 percent) were implemented during COVID-19, with the remaining 24 (73 percent) reporting participation numbers similar to non-COVID years.

DoD STEM provides programs in a variety of settings, with different durations, and via different platforms, allowing DoD STEM to reach student learners with diverse needs. Several programmatic shifts were reported in FY 2020, two of which were statistically significant at the portfolio level: program platform (in-person, virtual, or hybrid) and program duration (single day vs. multiday and beyond).

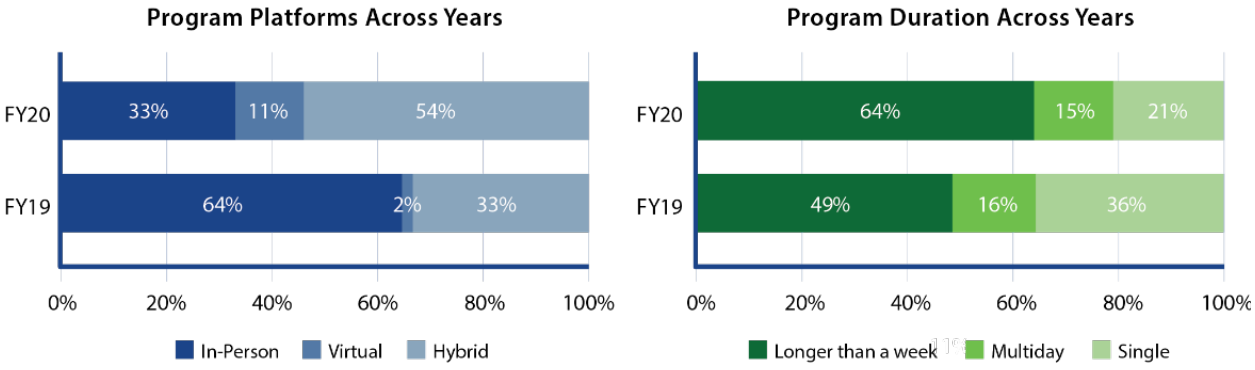
In FY 2019, most programs were conducted in-person; whereas in FY 2020, the majority were conducted in either a blended or virtual environment[11]. Also, between FY 2019 and FY 2020, the proportion of

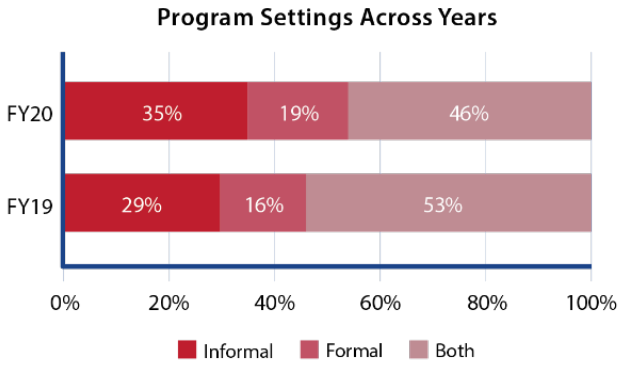


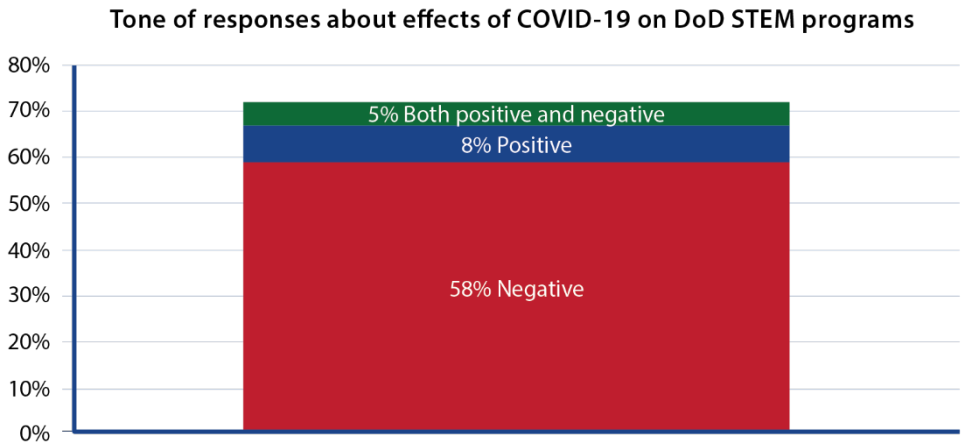


11. FY 2019: 58 out of 90 (64%) programs conducted face-to face; FY 2020: 67 out of 206 (33%) conducted face-to face. The remainder of programs in both years were conducted in either a blended or virtual environment. $\chi^2(2, 296) = 28.4638$, $p < 0.0001$.

single day programs fell, whereas the proportion of programs longer than a week rose[12]. In contrast, there was no statistical difference between the proportions of programs in informal, formal, and mixed (formal + informal) settings between FY 2019 and FY 2020[13].







12. Single day programs: FY 2019: 36% (32 out of 90); FY 2020: 21% (44 out of 207). Programs longer than a week: FY 2019: 49% (44 out of 90); FY 2020: 64% (132 out of 207). $\chi^2(2, 297) = 7.3697$, $p = 0.025$. Notably, there was a change in the survey question about program duration, which allowed respondents to provide more detail about the duration of programs lasting more than one week. For the purposes of comparing FY 2019 and FY 2020, all FY20 responses about program duration that were greater than 1 week were binned to perform the Chi-square analyses.

13. FY 2019: 26 programs were in informal settings (29%), 14 were in formal settings (16%), and 48 were conducted in both formal and informal settings (53%); FY 2020: programs were in informal settings (35%), 39 were in formal settings (19%), and 95 were conducted in both formal and informal settings (46%); $\chi^2(2, 297) = 1.8509$, $p = 0.396$

Of the 139 open-ended responses to a survey question about the effects of COVID-19 on DoD STEM programs, 98 (71 percent) had an unambiguous and clear tone that could be classified as negative, positive, or mixed. While the tone in these responses were largely negative, there were also some notably positive impacts. Some of the benefits of COVID-19-related program adjustments included: (1) increased participation on virtual platforms; (2) increased program reach on virtual platforms (*e.g.*, allowing programs to move from local to national impact); and (3) the creation of new programs. Exemplary positive, negative, and mixed responses about COVID-19 effects on DoD STEM programs are in the table below.

Exemplary Responses for Each Code	
Code	**Response**
both positive and negative	"...some....who transitioned to virtual delivery experienced an increase in participation, whereas others cancelled or experienced a reduced interest in participation."
	"A virtual platform was created and used that allowed for more students to receive career awareness information - however the tours were eliminated."
	"We were able to increase the number of students. However, [many students] did not have to the equipment need to participate."
positive	"Increased participation due to adoption of virtual alternatives…"
	"We expanded our in-person/local area program to virtual/national reach."
	"Created and implemented new activities that can be accessed on the web and used to deliver asynchronous STEM exploration as well as to enhance our existing Missions."
negative	"More than 90% reduction in K-12 student participation."
	"Facial coverings and physical distancing resulted in reduced engagement and lower participation."
	"Employers were in a hiring freeze and in-person outreach and engagement stalled. Enrollment dropped. Students struggled with virtual formats…"

In a separate survey question, in which respondents were asked to share their best programming practices, 18 out of 126 responses again commented on virtual programming; noting not only did some of them reach fairly large audiences, but they were able to offer virtual speakers via Zoom, which presumably implies they would not have had as much capacity to do so if speakers were volunteering in person. Going forward, some programs may decide to continue offering virtual in addition to in-person programming, to increase program reach.

"We had over 32K hits on the various virtual events combined, so we feel that we experienced success in our virtual programming."

- Response about best practices

An important question which emerged is "whether increased reach of virtual programming during FY 2020 led to increased equity of access across different demographic groups?" There were declines in reported proportions of programs intentionally serving most groups that DoD STEM considers underserved and underrepresented in STEM (see section 4). However, note that there was also an overall decline in the proportion of programs reporting demographic information. In FY 2019, 25 percent of programs reported collecting demographic information versus only 13 percent in FY 2020. This is possibly due to increased difficulty of collecting demographic information during virtual versus in-person programs. Nonetheless, this caveat makes it difficult to compare demographics between FY 2019 and FY 2020.

There is some anecdotal evidence that within certain individual DoD STEM programs, participant populations maintained similar demographics across years FY 2019 and FY 2020. For example, the Walter Reed Army Institute of Research (WRAIR) reported demographics of participants and interns in their summer STEM program, "*Gains in the Education of Mathematics and Science"* or "*GEMS"*, were remarkably similar in FY 2019 and FY 2020.[14] Furthermore, their pre-/post-program data suggested that gains in student attitudes toward STEM education and careers remained similarly positive in FY 2019 and FY 2020, for students both with and without underrepresented status.

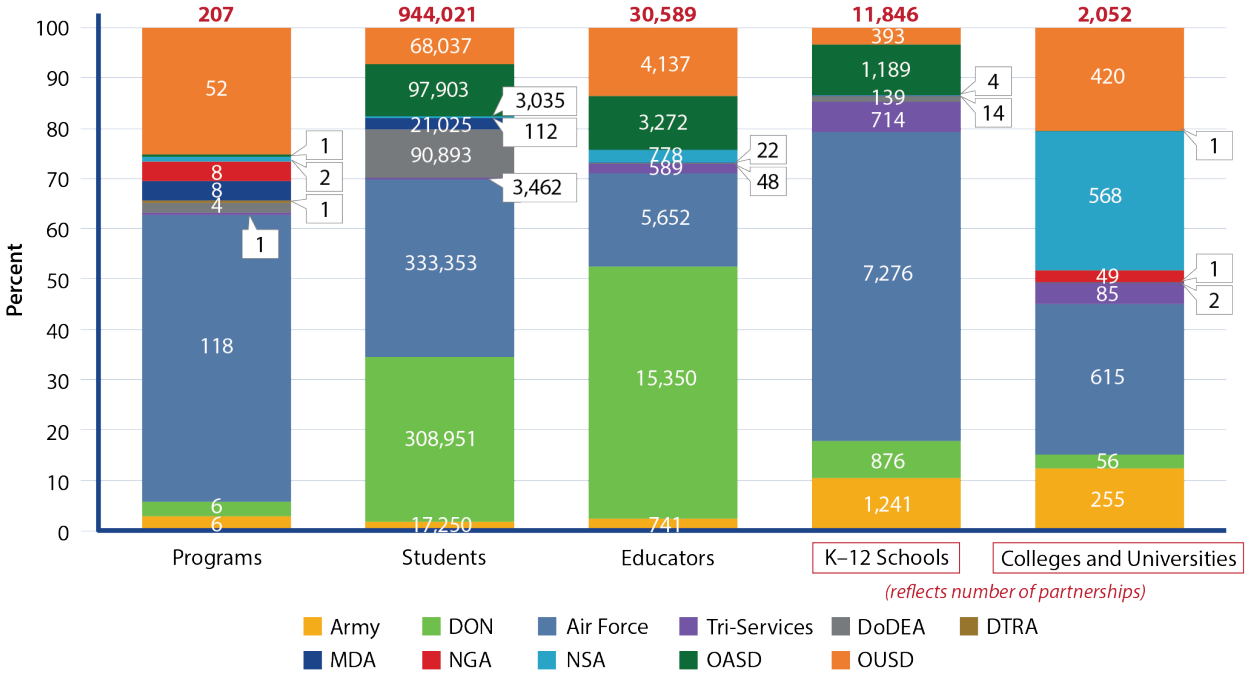
3. DoD STEM education and outreach activities impact a significant number of students, educators, educational institutions, and geographic locations

DoD STEM is committed to providing STEM education, outreach, and workforce development opportunities to students of all ages and their educators throughout the country. In FY 2020, DoD STEM supported 207 STEM education and outreach programs across 10 Services/Agencies/Offices that served 944,021 students and 30,589 educators. Forty-six percent of programs were able to report the number of students served disaggregated by grade band. The vast majority served students in PreK-12 (97 percent) with the remaining three percent serving postsecondary students in community college, undergraduate, and graduate programs. While the post-secondary learners represent the smallest proportion of DoD STEM programs in FY 2020, these programs represent an essential piece of the PreK-20+ continuum of STEM opportunities offered across the Department, account for roughly 1.5 times the funding spent on PreK-12 initiatives.

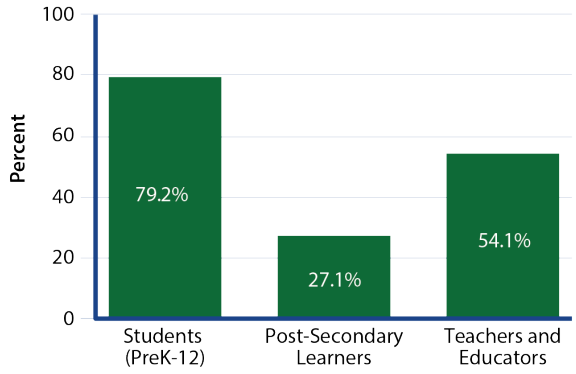
DoD STEM programs engage with a large number of PreK-12 schools and colleges and universities. In FY 2020, DoD STEM programs reported a total of 11,846 partnerships with PreK-12 schools and 2,052 partnerships with colleges and universities. STEM programming occurred in all 50 states and the District of Columbia, U.S. territories of Puerto Rico and Guam, and DoDEA regions abroad.

14. Morris, KJ, Brown, HKM, Swift, BC, Hall, EQ, Umayam, K, Tenenbaum, LT, Ekanem, NB, Ramadorai, SB, Canas, EE, Shearer, LN, and Yourick, DL. 2021. Conversion of Summer STEM Program from In-Person to Virtual Learning Offers Unexpected Positives and Pitfalls. *Journal of STEM Outreach* 4(4):1-18.

FY 2020 DoD STEM Programs and Participants by Component

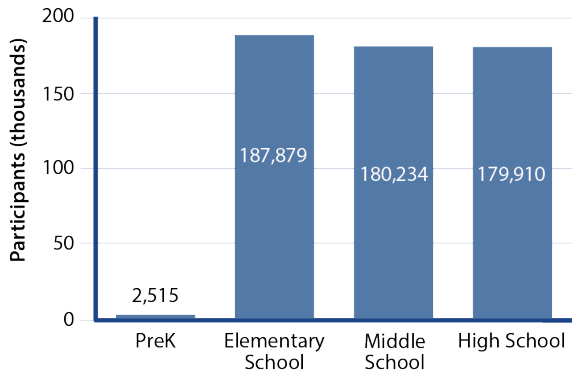


Intended Program Audience

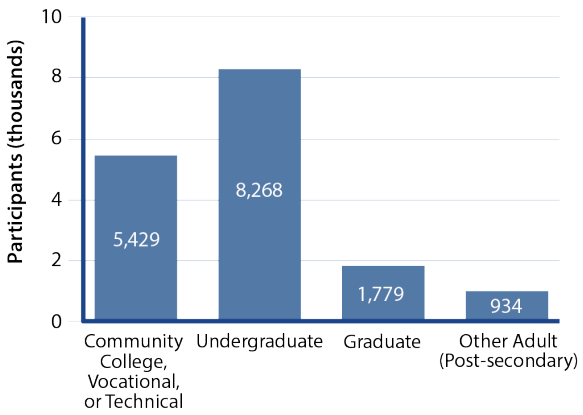


DoD STEM programs engaging post-secondary learners leverage an approximate **1.5x** the amount of funds as those engaging PreK-12 learners.

Participants by Grade Level*: PreK- 12

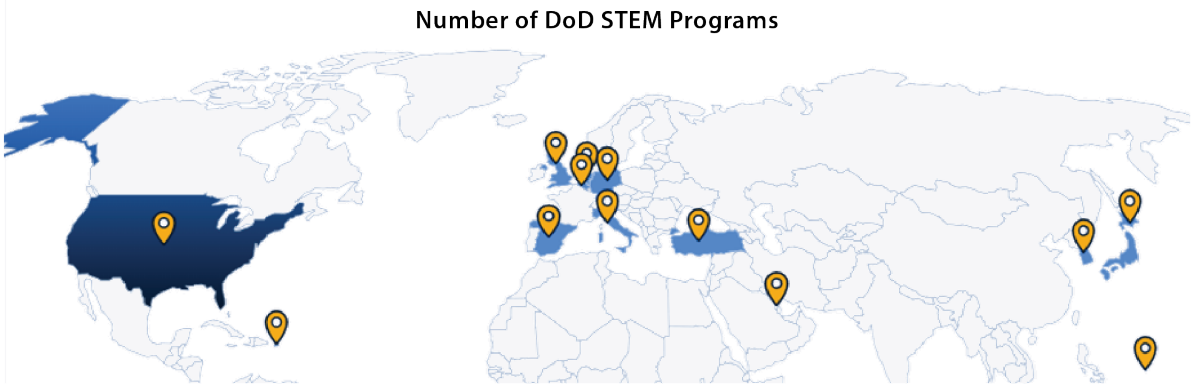


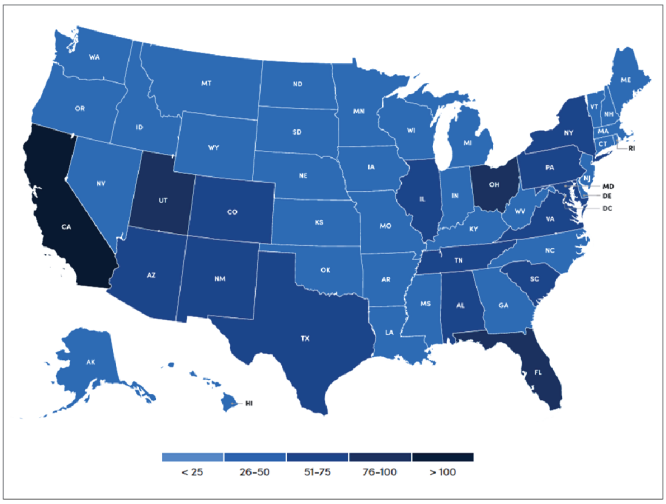
Participants by Grade Level*: Post-secondary

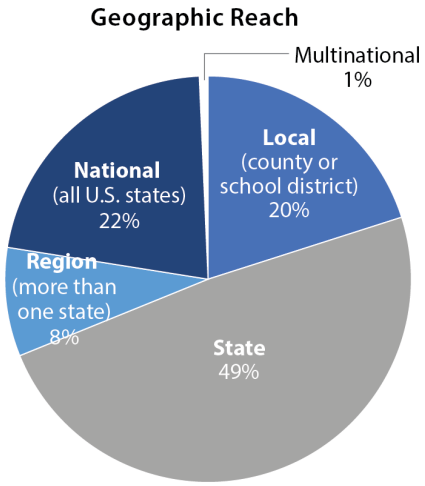


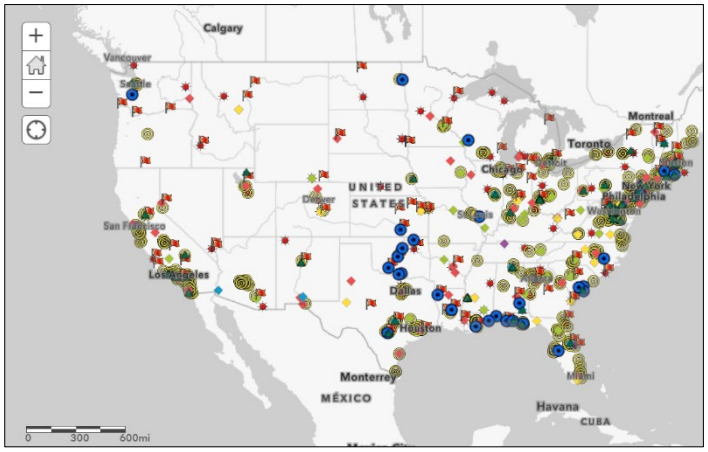
**46.4% of FY20 DoD STEM programs reported student participants by grade level.*

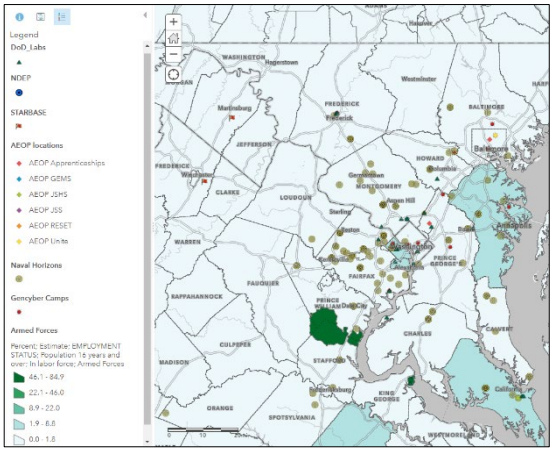
Interactive mapping of DoD STEM program locations and reach was also a focus of FY 2020 portfolio reporting efforts, with an example publicly available[15] and sample images from the map provided below.







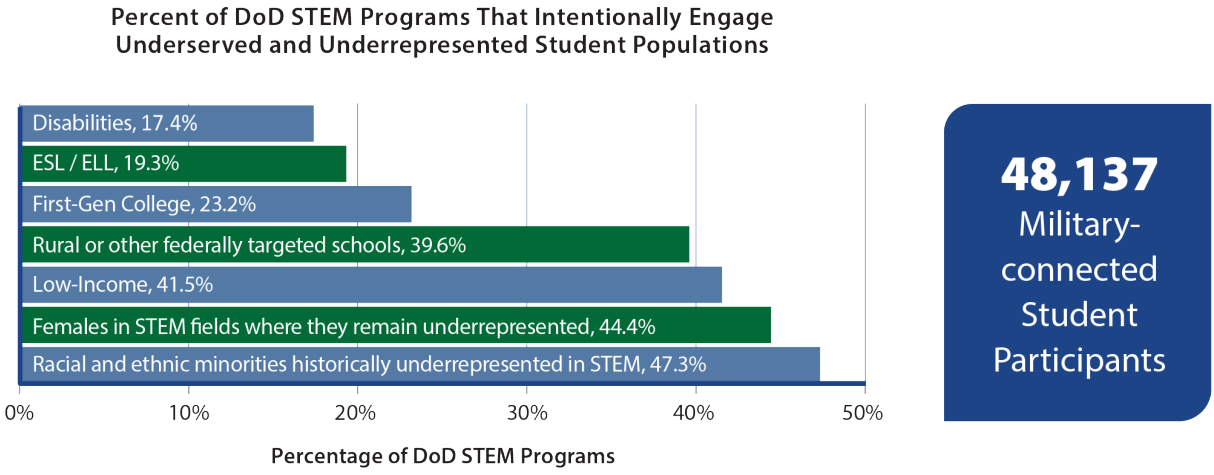


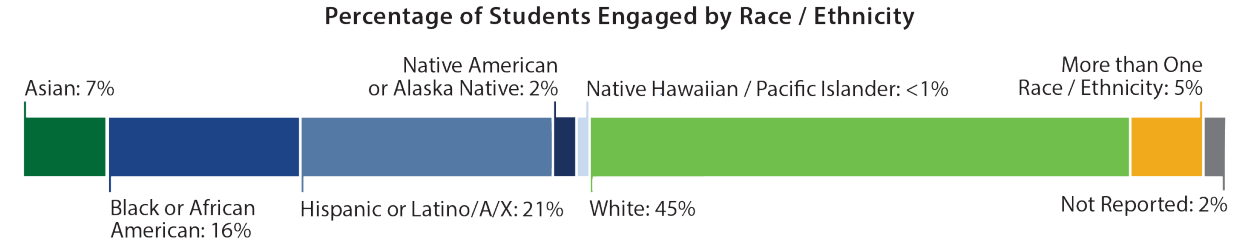


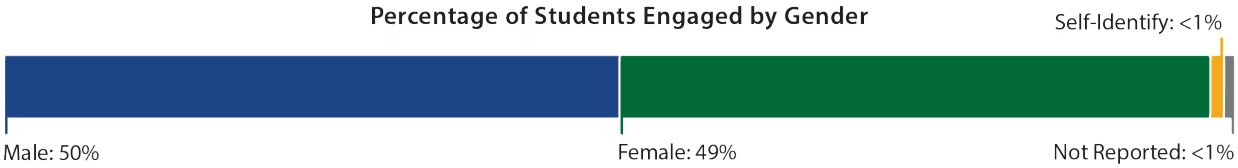
15. https://azusearcgis1.air.org/portal/home/webmap/viewer.html?webmap=f429653da08249eb9b76b5ce2fb92985

4. 58% of FY 2020 DoD STEM education and outreach activities intentionally engaged underserved and underrepresented populations

DoD STEM strives to improve its reach to individuals from groups underrepresented and underserved in STEM. DoD's commitment to diversity, equity, inclusion, and accessibility (DEIA) is expressed in the goals and objectives of the FY 2021-2025 DoD STEM Strategic Plan[16]. Strategically executed STEM programming can improve access and equity for underrepresented and underserved students, which subsequently improves DoD's ability to develop a STEM-literate citizenry with the potential for bolstering DoD's future STEM workforce. The DoD STEM Strategic Plan defines underrepresented/underserved as: military children; military-connected children; low-income students; racial and ethnic minorities underrepresented in STEM; individuals with disabilities; individuals with English as a second language or English language learners; first-generation college







12.5% of FY20 DoD STEM programs reported student participants by race/ethnicity
19.3% of FY20 DoD STEM programs reported student participants by gender

16. https://dodstem-assets.dodstem.us/files/DoD_STEM_Strategic_Plan_2021.pdf

students; students in rural, frontier, or other federally targeted schools, such as Title 1 schools; and females in STEM fields where they remain underrepresented. The importance of documenting the participation rates of individuals, who are underrepresented and underserved in STEM, is a mandate of the America COMPETES Reauthorization Act of 2010[17] and the American Innovation and Competitiveness Act of 2017[18]. Fifty-eight percent of programs were intentional in their outreach to students from underrepresented or underserved groups, serving at least one of the identified groups and in many cases, engaging more than one of the defined groups. Across the Department, STEM programs and activities continued to reach a significant number of military-connected students. There was equal participation by gender. Approximately 45 percent of participants were from groups that are traditionally underrepresented or underserved in STEM.

5. DoD STEM programs are tailored to a variety of participant interest areas through diverse program activities and STEM experiences and skills, program duration, and STEM disciplines

The capacity to provide meaningful STEM learning opportunities represents a strength of the Department. DoD STEM educational opportunities serve as a continuum for learners, educators, and professionals across all ages, grades, and career stages and reflect a commitment to providing authentic STEM experiences, which go beyond single discipline experiences, connect to real-world complex problems, and enable development of employability skills. Collectively, DoD STEM emphasizes the capability to offer a continuum and robust diversity of opportunities across ages, grade levels, career stages, interests, learning approaches and more.

DoD STEM programs provide a diversity of program and opportunity types, defined in part by program functional activities, characteristics, duration, and STEM disciplines. Programs with a focus on outreach, awareness, and the incorporation of hands-on activities continue to represent a strength of DoD STEM programs. Many programs also include explicit or indirect development of 21st century skills and competencies[19] (*e.g.*, collaboration, communication, creativity, critical thinking, flexibility, information literacy, initiative, leadership, media literacy, productivity, social skills, and technology literacy). In FY 2020, 89 percent of DoD STEM programs reported to be designed to promote development of at least one of these 21st century skills, with 75 percent reporting the promotion of 6 or more.

Collaboration is a critical 21st century skill for students, and an essential element of sustained success for many DoD STEM programs. In FY 2020, 80 percent of programs were identified as collaborative between DoD components, other Federal agencies, or a broad range of non-Federal partners.

17. https://www.congress.gov/111/plaws/publ358/PLAW-111publ358.pdf

18. https://www.congress.gov/114/statute/STATUTE-130/STATUTE-130-Pg2969.pdf

19. National Research Council (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. The National Academies Press, Washington, D.C.

Program Activities / Type

Outreach: activities that support formal or classroom-based education, as well as informal education that occurs outside the classroom, especially providing services to people who might not otherwise have access to those services.

Hands-On Activity: any instructional approach involving activity and direct experience with natural phenomena or any educational experience that actively involves students in manipulating objects to gain knowledge or understanding; doing science as opposed to simply hearing or reading about it.

Awareness: activities that promote interest in and cognizance of STEM opportunities or programs that specifically promote/increase familiarity with DoD. This includes expanding awareness through marketing efforts.

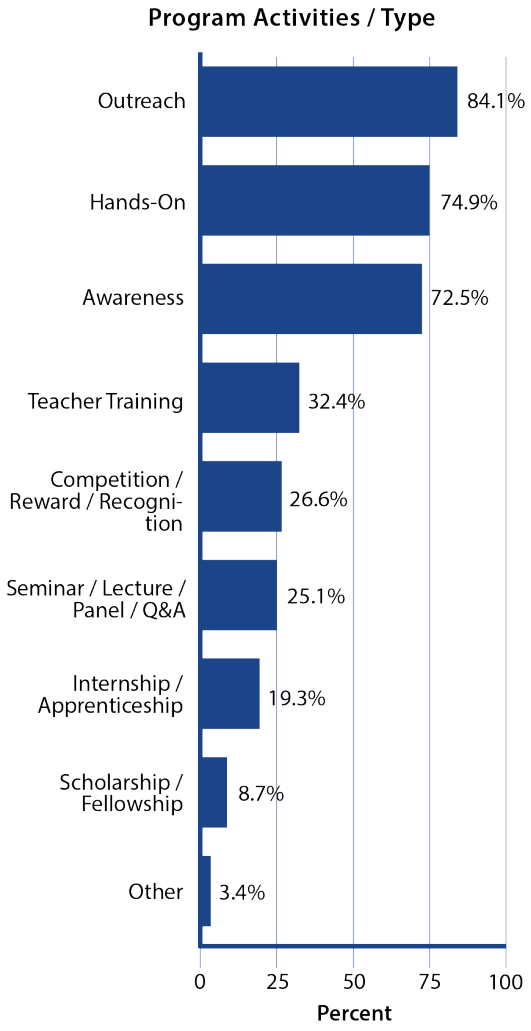
Teacher Training: educators, usually K-12, are the target group for workshops, training, or other activities to boost their knowledge and ability in STEM to bring it to their students.

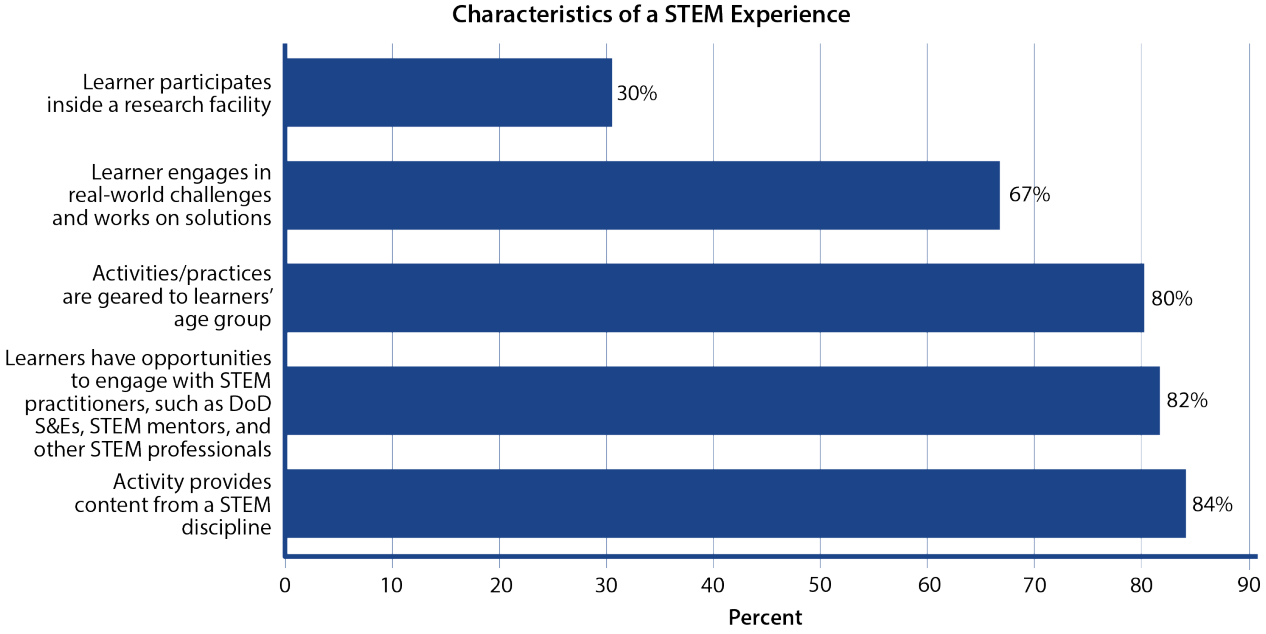
Competition / Reward / Recognition: students may compete in activities for recognition or rewards (e.g., scholarship, check).

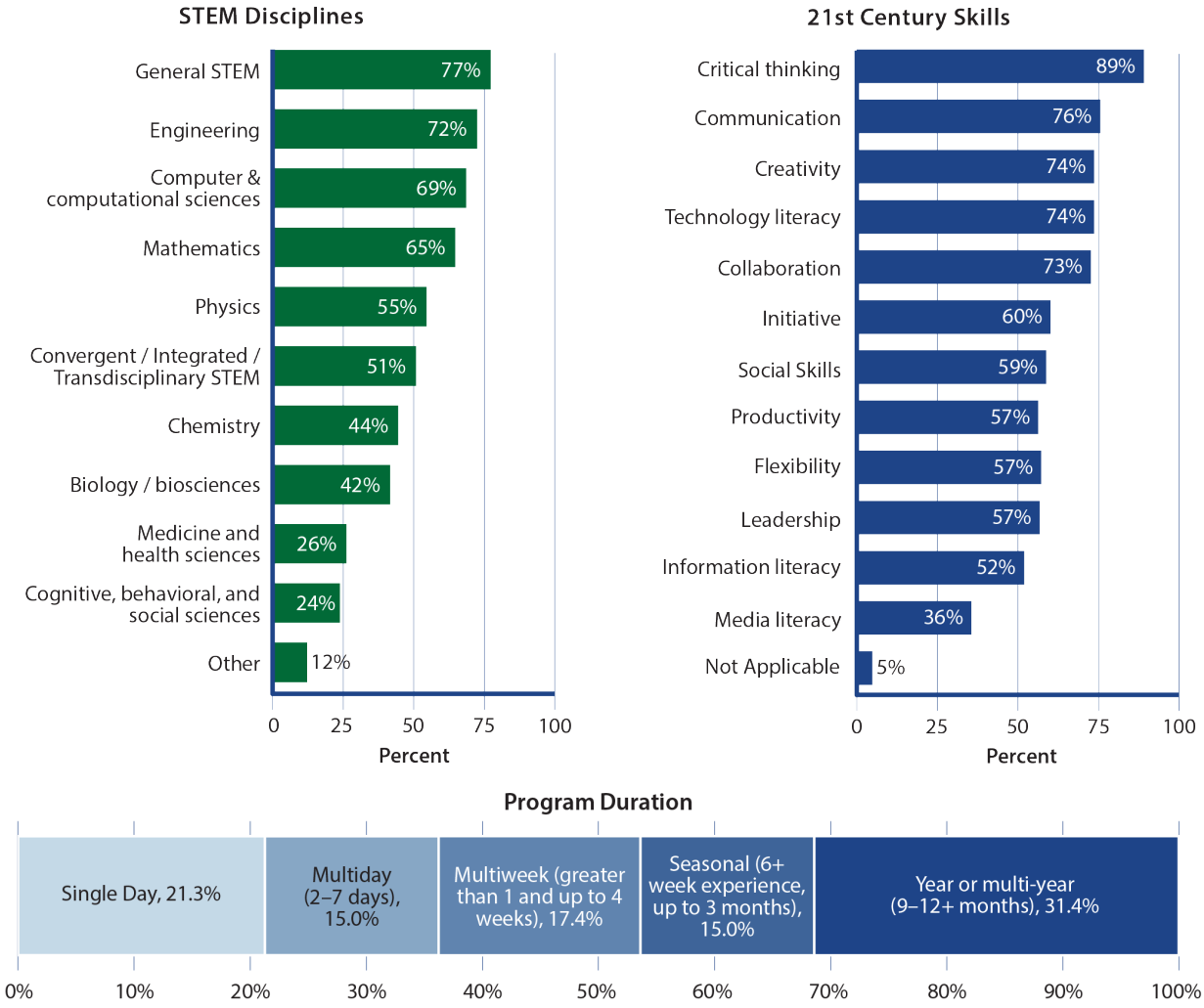
Seminar / Lecture / Panel / Q&A: activity includes invited speakers presenting on a specific topic, answer participant questions, and/or engaging in discussion.

Internship / Apprenticeship: students generally work with mentors in a research environment where they gain experience and skills on a temporary basis (e.g., summer, holidays, part time).

Scholarship / Fellowship: help students pursue higher education through a type of financial aid; may involve service in return.





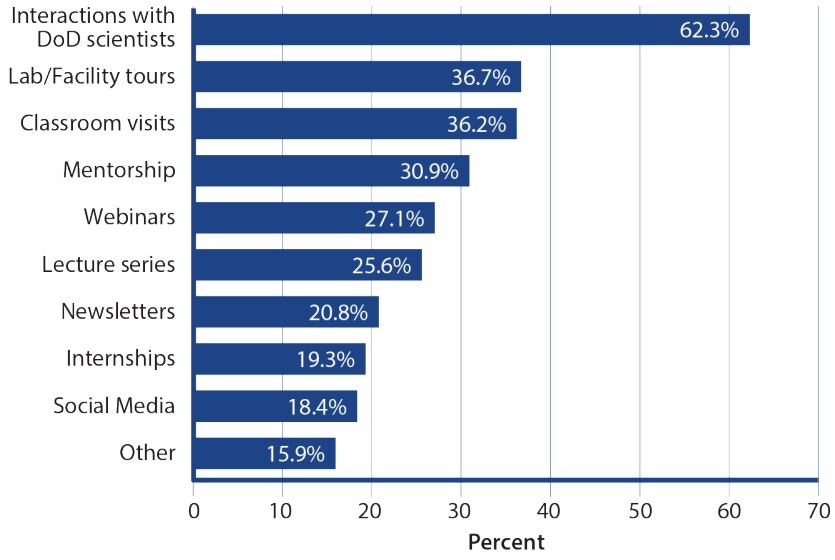


6. DoD STEM programs and activities leverage DoD's unique resources to promote connectivity to the DoD STEM workforce

Several objectives of the FY 2021-2025 DoD STEM Strategic Plan highlight the importance of connecting program participants with the DoD STEM enterprise.[20] DoD scientists and engineers (S&Es) continued to have high levels of engagement with STEM programs and activities as mentors, role models, speakers, and in other capacities, providing enriching connections that foster DoD STEM careers and opportunities. These programs and activities take place at various locations including DoD laboratories or facilities. One DoD STEM emphasis is to align STEM education and workforce development activities with DoD Modernization Priorities, including Artificial Intelligence, Autonomy, Biotechnology, Cyber, and Directed Energy. Exposure to DoD STEM careers, mentorship by DoD STEM professionals, and emphasis on DoD Modernization Priorities are key features of PreK-12 DoD STEM opportunities.

20. https://dodstem-assets.dodstem.us/files/2018-23-Federal-STEM-Education-Strategic-Plan.pdf (see Objectives 1.2, 1.3, 2.1 and 2.4)

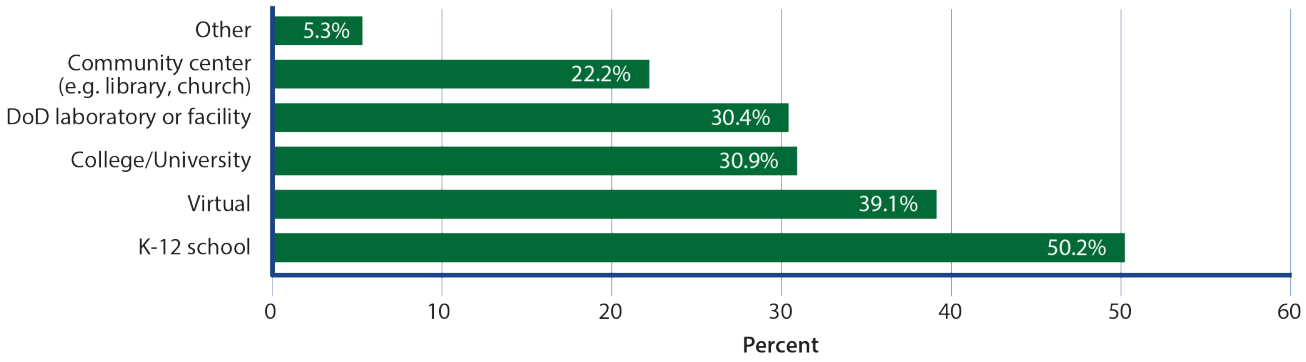
Awareness of DoD Careers



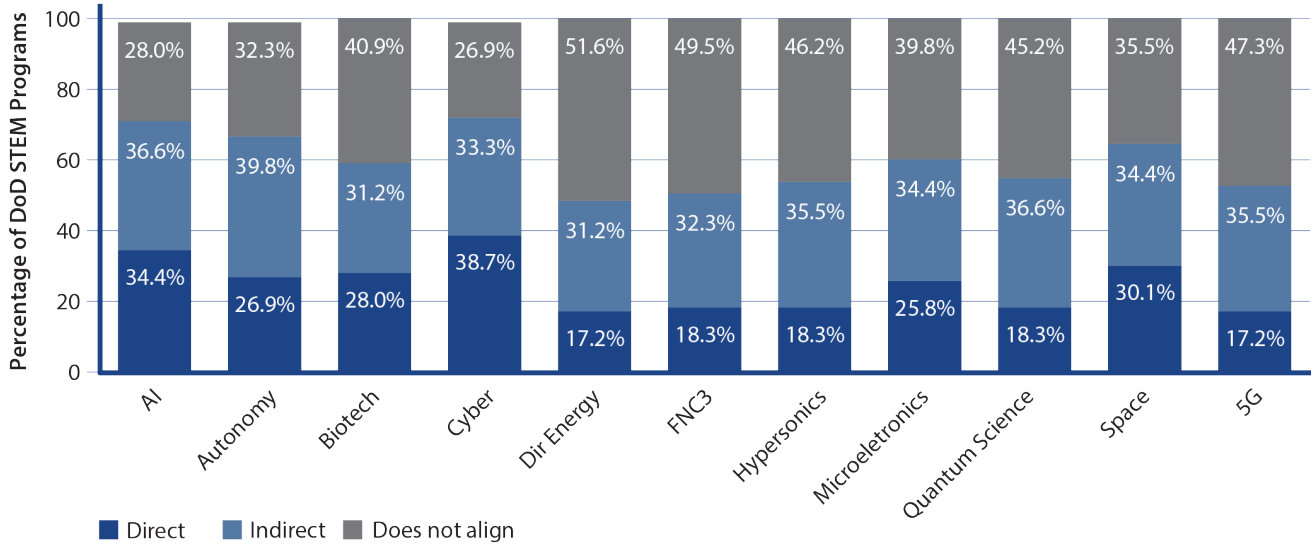
11,099
DoD Scientists and Engineers Volunteered

347,758
S&E Hours Volunteered for DoD STEM Programs

Location/Facility Type



Alignment to DoD Modernization Areas

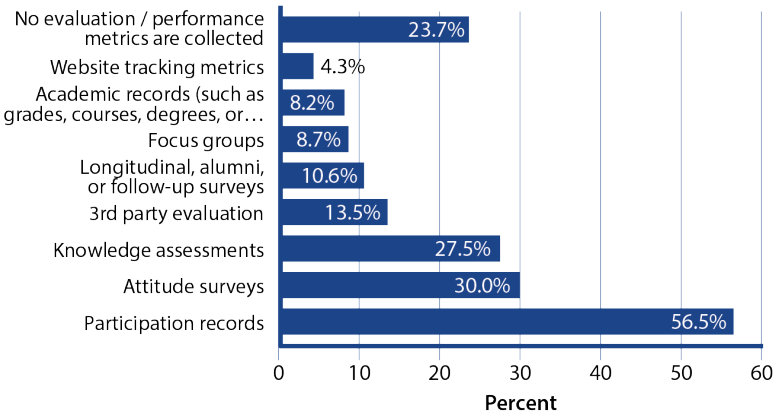


7. DoD STEM programs continue to emphasize transparency and accountability and to build a collective culture of evaluation

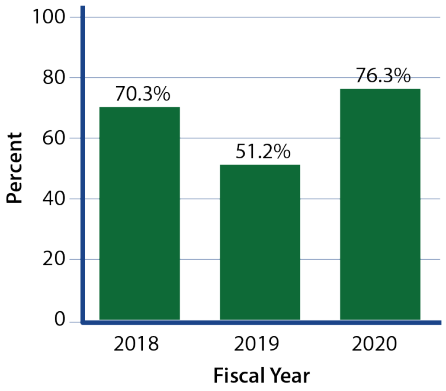
Component and DoD STEM programs engage in a range of evaluation and assessment activities both at the individual and DoD-wide level. DoD is committed to the continual improvement of the overall delivery of its STEM education, outreach, and workforce development programs and activities. Currently, many individual DoD STEM programs leverage evaluation and assessment efforts that include attitude surveys, focus groups, participation records, knowledge assessments, and third-party evaluations. These diverse approaches, and other metrics, are used to measure progress towards specific program goals and objectives. Programs are also asked to report on programmatic best practices and success stories, which enable lessons learned and promising practices to be shared across programs, within DoD and across the Federal government.

As previously noted, DoD STEM also endeavors to create a culture of evaluation. In FY 2020, 76.3 percent, the highest number to date, of DoD STEM programs reported collecting evaluations and performance metrics on programs. Initial evaluation across these early reporting years also reflects fluctuation in metrics such as total number of programs, participants, and demographic metrics collected that likely reflect a combination of adjusted reporting strategies from individual components/programs as well as impacts from COVID-19.

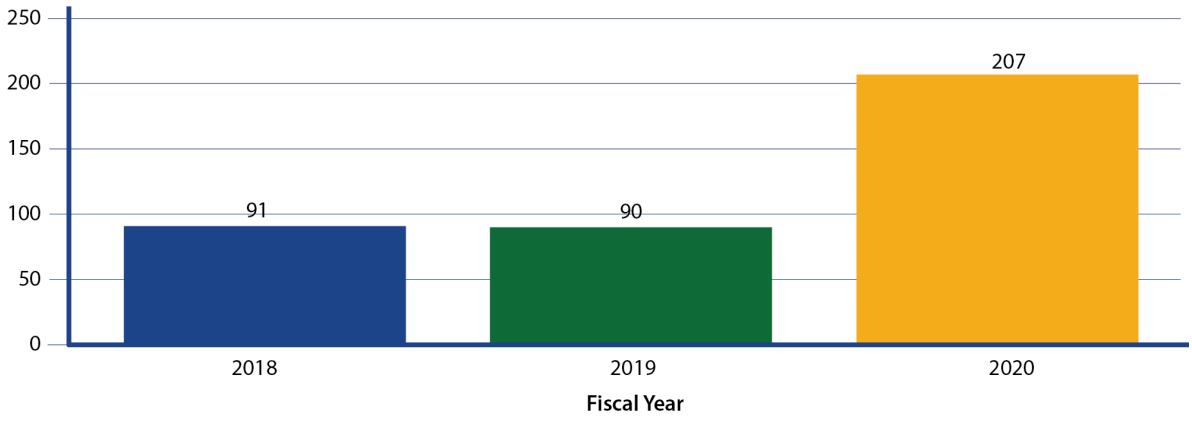
Types of evaluation methods used by DoD STEM programs

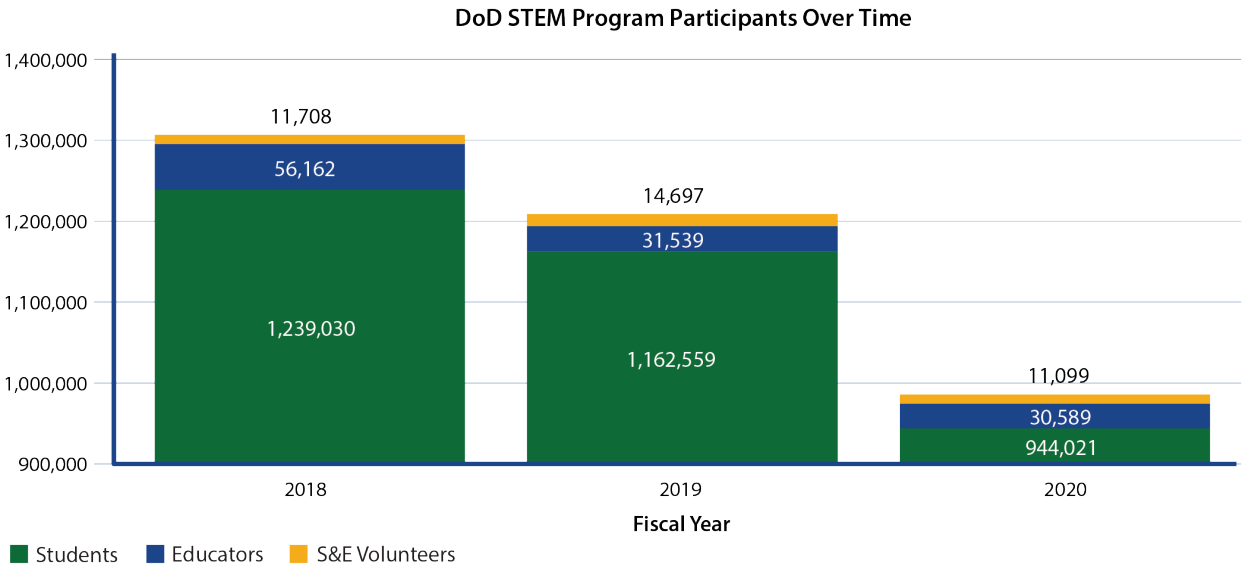


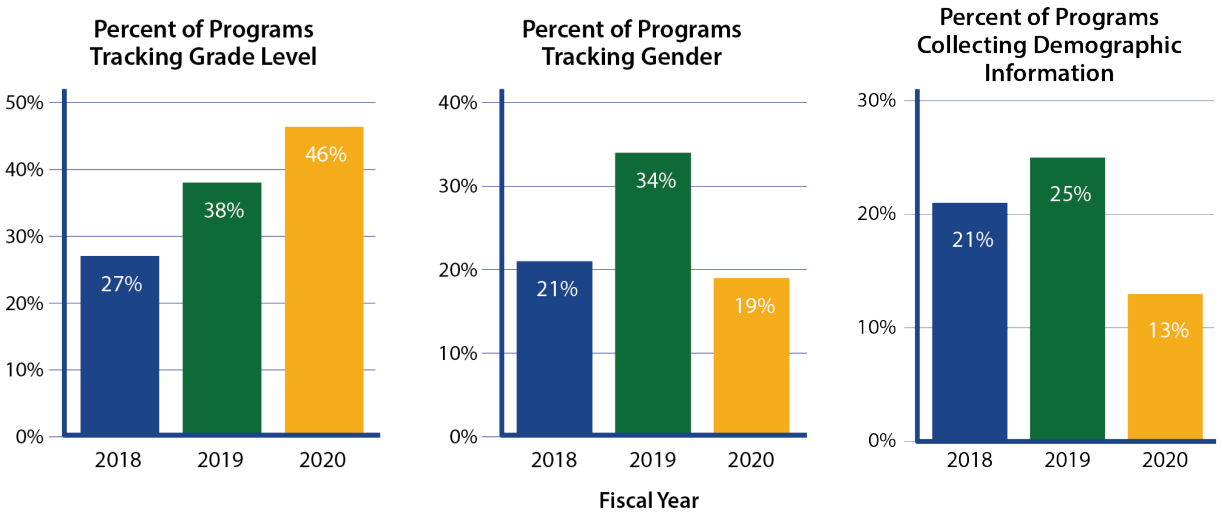
Percent of DoD STEM programs collecting evaluation and / or performance metrics



Total Number of DoD STEM Programs Reporting Over Time







Conclusion

As part of the continued development of the Evaluation and Assessment Capability for DoD STEM, this report focuses on data for FY 2020 only. Additional reporting on DoD STEM evaluation and assessment efforts are regularly updated on the DoD STEM "Our Impact" page[21]. In conclusion, in FY 2020, DoD STEM programming reached nearly two million (2M) participants through a diverse offering of over 200 programs and opportunities. Increased program evaluation and reporting efforts will further quantify how these programs benefit individuals, the DoD, and the Nation as a whole.

21. https://dodstem.us/about/impact/