Select photos used throughout this report are from the following DoD STEM-sponsored programs during Option Year Two and may not be reproduced or used without the written consent of DoD STEM: Emerging Leaders in Biotechnology program at Prince George’s Community College in Largo, MD; FIRST Championship in Houston, TX; Gains in the Education of Mathematics and Science (GEMS) program for Bowie State University students at Walter Reed Army Institute of Research in Silver Springs, MD; and STEM Academy Summer Bridge program at Sinclair College in Dayton, OH.
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# Abbreviations and Acronyms

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<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AFB</td>
<td>Air Force Base</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AiC</td>
<td>Aspirations in Computing</td>
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<td>AIR</td>
<td>American Institutes for Research</td>
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<tr>
<td>AP</td>
<td>Advanced Placement</td>
</tr>
<tr>
<td>APP</td>
<td>Annual Program Plan</td>
</tr>
<tr>
<td>ASU</td>
<td>Arizona State University</td>
</tr>
<tr>
<td>BEST</td>
<td>Building Engineering and Science Talent</td>
</tr>
<tr>
<td>BSU</td>
<td>Bowie State University</td>
</tr>
<tr>
<td>C4C</td>
<td>Counselors for Computing</td>
</tr>
<tr>
<td>CEE</td>
<td>Center for Excellence in Education</td>
</tr>
<tr>
<td>CEMSE</td>
<td>Center for Excellence in Mathematics and Science Education</td>
</tr>
<tr>
<td>CGEST</td>
<td>Center for Gender Equity in Science and Technology</td>
</tr>
<tr>
<td>CMC</td>
<td>Consortium Management Committee</td>
</tr>
<tr>
<td>COVID-19</td>
<td>Coronavirus Disease</td>
</tr>
<tr>
<td>CREATE</td>
<td>Center for Research on Educational Equity, Assessment, and Teaching Excellence</td>
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<tr>
<td>CRP</td>
<td>College Readiness Program</td>
</tr>
<tr>
<td>CSTA</td>
<td>Computer Science Teachers Association</td>
</tr>
<tr>
<td>CSU</td>
<td>Central State University</td>
</tr>
<tr>
<td>DMV</td>
<td>The metropolitan region that includes Washington, DC; Maryland; and Northern Virginia</td>
</tr>
<tr>
<td>DRSC</td>
<td>Dayton Regional STEM Center</td>
</tr>
<tr>
<td>DoD</td>
<td>Department of Defense</td>
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<tr>
<td>DoDEA</td>
<td>Department of Defense Education Activity</td>
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<tr>
<td>DSEC</td>
<td>Defense STEM Education Consortium</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
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<td>-------------</td>
</tr>
<tr>
<td>FIRST</td>
<td>For Inspiration and Recognition of Science and Technology</td>
</tr>
<tr>
<td>GPA</td>
<td>Grade Point Average</td>
</tr>
<tr>
<td>HBCU</td>
<td>Historically Black Colleges and Universities</td>
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<tr>
<td>IPA</td>
<td>Individual Program Administrator</td>
</tr>
<tr>
<td>K-12</td>
<td>Kindergarten Through 12th Grade</td>
</tr>
<tr>
<td>K-16</td>
<td>Kindergarten Through 12th Grade and Postsecondary Education Programs</td>
</tr>
<tr>
<td>LTF</td>
<td>Laying the Foundation</td>
</tr>
<tr>
<td>MI</td>
<td>Minority-serving Institution</td>
</tr>
<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>MSRTC</td>
<td>Middle School Research Teachers Conference</td>
</tr>
<tr>
<td>MSU</td>
<td>Morgan State University</td>
</tr>
<tr>
<td>NCWIT</td>
<td>National Center for Women &amp; Information Technology</td>
</tr>
<tr>
<td>NIHF</td>
<td>National Inventors Hall of Fame</td>
</tr>
<tr>
<td>NMSI</td>
<td>National Math and Science Initiative</td>
</tr>
<tr>
<td>NSTA</td>
<td>National Science Teaching Association</td>
</tr>
<tr>
<td>PGCC</td>
<td>Prince George's Community College</td>
</tr>
<tr>
<td>RADC</td>
<td>[Robotics Education &amp; Competition] Aerial Drone Competition</td>
</tr>
<tr>
<td>REC</td>
<td>Robotics Education &amp; Competition</td>
</tr>
<tr>
<td>RSI</td>
<td>Research Science Institute</td>
</tr>
<tr>
<td>SCC</td>
<td>Sinclair Community College</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering, and Mathematics</td>
</tr>
<tr>
<td>TIES</td>
<td>Teaching Institute for Excellence in STEM</td>
</tr>
<tr>
<td>UC</td>
<td>University of California</td>
</tr>
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EXECUTIVE SUMMARY

This Annual Program Review provides a summary of activities and outcomes executed by the Defense Science, Technology, Engineering, and Mathematics (STEM) Education Consortium (DSEC) over Option Year Two, September 1, 2021 – August 31, 2022.

Launched in 2019 by the Department of Defense (DoD), DSEC is a collaborative partnership that aims to broaden STEM literacy and develop a diverse and agile workforce with the technical excellence to defend the United States. By addressing and prioritizing critical STEM challenges, DoD is investing in evidence-based approaches to inspire and develop the country’s science and technology workforce. The consortium is aligned to the Federal STEM Education Strategic Plan.

To achieve its goals, DSEC is organized into five management elements:

- **Element 1**, provides leadership and coordination of DSEC, including planning and execution of consortium-wide deliverables;
- **Element 2**, manages data collection, assessment/analysis, and reports for DSEC;
- **Element 3**, promotes DoD STEM and DSEC as a coordinated and cohesive effort offering students and teachers a pathway of STEM educational opportunities;
- **Element 4**, implements STEM alumni studies that focus on targeted DSEC outcomes (i.e., building interest in and awareness of STEM careers in and outside of the DoD) among participants; and
- **Element 5**, ensures that STEM outreach activities are supported, are of high quality, and are coordinated across all partner programs and initiatives.

The management elements made considerable progress during Option Year Two in designing tools and processes to support a high-functioning consortium. Specifically, all elements collaborated to design and launch a new DSEC Event Tracker, which also includes pre-event surveys to assess partners’ need for support with their programming and post-event surveys to collect data needed for program evaluation and alumni studies efforts. Element 1 began facilitating bimonthly meetings for Individual Program Administrators (IPAs) to enhance collaboration and coordination between elements and streamline support for DSEC STEM education and outreach partners. Notably, Element 3 continued to develop multiple sections of the DoD STEM Website, including the “Opportunities” section, which received 60,000 page views in Option Year Two, a 32% increase from the prior year.

During Option Year Two, 53,053 students, educators, and other participants engaged in DSEC-funded activities.
Additionally, DSEC focuses on a set of continuous improvement concepts that will lead to better outcomes for the consortium and greater alignment with the DSEC fundamentals. While there is still more work to be done on some of these areas, the consortium made strong progress toward many. Intentional opportunities for communication and collaboration strengthened relationships between the consortium management team and partners, as well as between partners. The addition of four new partners to DSEC completed the work that began with institutional planning and engagement in Option Year One to create a Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) Pathways Network. The launch of the Military-Connected Resource Toolkit enhanced DSEC partners’ abilities to serve one of the consortium’s key student populations.

During Option Year Two, DSEC partners built on momentum from previous years and launched new initiatives to serve students and educators. As in Option Year One, DSEC programming reached students in all 50 United States; the District of Columbia; and the United States territories of Puerto Rico, the U.S. Virgin Islands, and Guam. As in previous years, the consortium’s hub strategy increased the concentration of students served in San Diego, California; Dayton, Ohio; and the Washington, DC, Maryland, and Virginia (DMV) area. The presence of DoD installations in these communities allows the three hubs to focus their efforts on serving military-connected students.

Exhibit 1. DSEC Programming and Hubs

As in Option Year One, several programs also reached students and educators in international locations.
“I didn’t think I would ever go for my degree. Now that I have, it’s eye-opening. I can really do anything.”

– Participant in St. Petersburg College Internship Program
DSEC Strategy

DSEC is purposefully designed to foster cohesion with the United States DoD and federal STEM strategic priorities. This section summarizes the strategic rationale and organizational approach of the consortium.
The DoD depends on nearly 300,000 STEM professionals across the Defense Laboratory Enterprise to meet national defense challenges and critical technology areas (outlined in the appendix). Aligned to the Federal STEM Education Strategic Plan, the DoD is investing in evidence-based approaches to inspire and develop the science and technology workforce pipeline across the United States.

DSEC is a collaborative partnership among academia, industry, not-for-profit organizations, and government that aims to broaden STEM literacy and develop a diverse and agile future workforce to power the United States’ innovative defense infrastructure.

**VISION**

Envisioned as a 5-year investment by the DoD, DSEC’s strategy is grounded in five consortium fundamentals to which all programming and activities align.

**Exhibit 2: DSEC Fundamentals**

<table>
<thead>
<tr>
<th><strong>Engage</strong> students and educators in meaningful STEM experiences.</th>
<th>DSEC will engage K–16 students and educators in meaningful formal and informal DoD STEM learning experiences.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serve</strong> students who are military-connected and underrepresented in STEM.</td>
<td>DSEC will focus on serving students who are underrepresented in STEM (as defined by DoD STEM).¹</td>
</tr>
<tr>
<td><strong>Connect</strong> to the DoD STEM workforce.</td>
<td>DSEC will ensure STEM experiences are connected to the DoD STEM workforce and DoD careers.</td>
</tr>
</tbody>
</table>

**How will DSEC support these three priorities in a unique and innovative way?**

| **Leverage** the network as a force multiplier. | DSEC will leverage the consortium as a force multiplier to amplify the reach, visibility, and outcomes of DoD STEM. |
| **Evolve** the approach based on data. | DSEC will use a data-driven approach to evolve and evaluate how DSEC operates over time to ensure positive outcomes for students and educators. |

Each of these consortium fundamentals is backed by research literature (see the [base-period Annual Program Review](#) for details) that supports the causal pathway among activities, outputs, outcomes, and ultimately DoD STEM’s desired impact.

¹The official DoD STEM definition of underrepresented/underserved, including the definition of military-connected, appears in the appendix.
The DSEC strategy is purposefully aligned to both the federal and DoD STEM strategic plans. Specifically, the work of DSEC as a network and each of its STEM education and outreach partners is aligned with the four goals of the 2021-2025 DoD STEM Strategic Plan.

Exhibit 3: Goals of DoD STEM Strategic Plan

**Inspire**
community engagement in STEM

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

**Attract**
STEM workforce

Attract the United States’ and DoD’s current and future STEM workforce through multiple pathways to educational and career opportunities.

**Increase**
participation of underserved and underrepresented groups

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

**Advance**
efficiency and effectiveness of STEM programs

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

For more information on DSEC’s alignment with the DoD STEM Strategic Plan, see the DSEC partner alignment in the “STEM Education and Outreach Partners” section of this document.
THEORY OF CHANGE

The five consortium fundamentals work in concert to form a cohesive framework that enables near-term outcomes and long-term impact.

Exhibit 4: DSEC Overall Logic Model

**ACTIVITIES**

- Outreach partners **provide** DoD STEM programming serving students and educators.
- Regional hubs **coordinate** with partners and DoD facilities in select communities.
- DSEC **engages** and follows up with DoD STEM alumni.
- DSEC **provides** vision, alignment, coordination, and communication for DoD STEM.
- DSEC **connects** outreach partners to share learning and strengthen programming.
- DSEC **evaluates** its approach using formative and summative methods.

**OUTCOMES**

- Increase student and educator **interest and engagement in STEM**
- Increase STEM **knowledge and skills**
- Increase **connections** among DoD STEM learning opportunities for students and educators.
- Increase use of **evidence and continuous improvement** across DSEC-funded programs.
- Increase access to STEM opportunities for military-connected and underrepresented students.
- Increase **student awareness of and interest in DoD STEM research and careers**

**LONG-TERM IMPACT**

- Increase use of effective STEM learning and instructional strategies.
- Increase pursuit of postsecondary STEM and DoD careers.
- Increase diversity in STEM and DoD workforce.
- Increase STEM preparation for military-connected students.
STEM ECOSYSTEMS

The organization, structure, and planning of DSEC is closely related to a term that has gained significant traction in the last decade: STEM ecosystems. Also known as STEM learning ecosystems, STEM alliances, or STEM learning networks (Stevens Institute of Technology, 2022), STEM ecosystems grew from Bronfenbrenner’s (1977, 1986) ecological systems theory that places children as embedded in wider surroundings such as families, schools, and communities. This concept has grown in popularity in the context of learners placed in out-of-school learning settings with multiple influencers (Allen & Peterman, 2019). The Federal Government has taken an interest in STEM ecosystems. Recently, the government defined the terminology in the Creating Helpful Incentives to Produce Semiconductors and Science Act (CHIPS Act, 2022, p. 367):

The term “STEM ecosystem” means a local, regional, or statewide network, consortium, or multi-sector partnership, which may be led or co-led by a nonprofit organizational entity, that is operating in the United States with the goal of supporting participation in STEM study, activities, and career pathways…with a broad range of non-Federal partners.

Additionally, the Federal Government established a definition for a STEM education ecosystem in an update on the implementation of the Federal STEM Education Strategic Plan (Office of Science and Technology Policy, 2020, p. 6):

STEM education ecosystems consist of multi-sector partners united by a collective vision of supporting participation in STEM through the creation of accessible, inclusive STEM learning opportunities spanning all education stages and career pathways. A STEM education ecosystem continuously evaluates its activities and adapts as needed, plans for the long-term, and communicates its work to build broad support and advance best-practices.

As of 2022, one hundred STEM learning ecosystems worldwide are supported by the STEM Learning Ecosystems Community of Practice; ninety-six of these are in the United States. Each of DSEC’s regional hubs is intended to develop and/or support a STEM ecosystem in its geographic area. Correlational evidence has suggested that students participating in STEM ecosystems improve their attitudes toward and tools for success in STEM more than their nonconnected peers (Allen et al., 2020). Importantly, purposeful STEM alliances have been found to be helpful in increasing the number of underrepresented STEM learners by fostering peer mentorship and opportunities for research and collaboration with STEM educators (Rodriguez et al., 2016).

What are features of and considerations within STEM ecosystems?

STEM ecosystems have many features that are intended to benefit learners in a specific geographic area. For example, STEM ecosystems, as with DSEC’s hubs, are “anchored by strong leaders” who collaborate on a common vision and method of practice (Traphagen & Traill, 2014). These types of intentionally designed STEM ecosystems are “force multipliers,” in which the efforts of individual partners reinforce each other and thus are amplified within the ecosystem (Stevens Institute of Technology, 2022, pp. 80-81; Traphagen & Traill, 2014). Additionally, STEM ecosystems ideally provide a “continuum of STEM exposure” from childhood to early adulthood (Stevens Institute of Technology, 2022, p. 80), providing participants with numerous opportunities to immerse themselves in STEM. Within STEM ecosystems, flexibility and resourcefulness

LITERATURE SCAN

Each year, the Consortium Management Committee (CMC) and DoD STEM select several emerging areas of importance for DSEC. The Element 2 team then completes a literature review to inform the evolution of the consortium’s strategy around these topics. This year, the selected topics were STEM ecosystems and early (prekindergarten-grade 6) interventions in STEM education. STEM ecosystems are relevant as the DSEC hubs connect multiple partners within their regions and as DSEC explores locations for an additional hub. Information on early STEM interventions, which are currently limited within the DSEC portfolio, can be useful in determining which partners to consider in the future as the DSEC portfolio continues to expand and evolve.
are key; ecosystem participants must change plans for the benefit of their fellow participants (Traphagen & Traill, 2014), such as implementing distance learning as a response to the COVID-19 pandemic (Stevens Institute of Technology, 2022).

How do STEM ecosystems advance equity?

Female students, racially and ethnically minoritized students, and students from economically marginalized communities have historically had unmet needs in terms of STEM learning (National Research Council, 2015). DoD STEM’s definition of “underrepresented populations” includes students with disabilities, English language learners, students in rural areas, military-connected students, and first-generation college students; and DSEC follows this widened definition.² Penuel et al. (2016) also suggested several principles to promote equity in STEM ecosystems; among these are the articulation of shared learning goals among community members and involving underrepresented populations (e.g., youth whose racial background is historically underrepresented in STEM) in ecosystem design. Penuel et al. also suggested intentionally brokering and making connections across settings, such as by creating ties among partners and between partners and participants, which is a crucial step toward promoting equity. Providing adequate material resources and support for parents is important for students’ equitable access to the benefits of STEM ecosystems (Penuel et al., 2016). Active efforts to recruit underrepresented populations in STEM for mentorship programs—such as educators or business employees regularly meeting with and serving as role models for students—should be considered as well (Dunn et al., 2018; National Academies of Sciences, Engineering, and Medicine [NASEM], 2016; Windchief, 2019). DSEC’s “Serve” fundamental actively attempts to engage and retain learners typically underrepresented in STEM.

How can the success of STEM ecosystems be measured?

Management and Collaboration

It has been suggested in the literature that (a) rigorous use of data and (b) constructive relationships between partners can be examined to understand success of the STEM ecosystem. Several studies have called for transparent and intentional data collection as well as subsequent evaluation of the data (Allen, Brown, & Noam, 2020; Allen, Lewis-Warner, & Noam, 2020; Allen & Peterman, 2019). Plus, prior studies have found that communication and strategic collaboration between partners, although rare, is vital for building strong, productive relationships (Allen, Lewis-Warner, & Noam, 2020; Liou & Daly, 2021). In line with the existing literature, DSEC’s Element 2 (Program Evaluation) not only assesses partners’ methods and understanding of data but also monitors the network and relationships among DSEC partners; both are crucial in determining needed supports.

Access to STEM Learning Opportunities

Ease of access to and involvement in STEM learning opportunities may be a measure of success for STEM ecosystems. In particular, STEM ecosystems’ (a) support for learners’ freedom of movement (i.e., providing accessible learning spaces and making available safe and affordable transportation to, from, and between these learning spaces; [Pinkard, 2019]) and (b) involvement of teachers (Tapprich et al., 2016) for the entire classroom’s access to STEM can be examined. Without support for freedom of movement, not all learners within the same STEM ecosystem can fully access STEM learning experiences, resulting in differing experiences (Shaby et al., 2021). The purposeful involvement of educators is also important and has been explored in the context of STEM ecosystems through the collaboration between teachers and researchers, a type of researcher–practitioner partnership (Farrell et al., 2021; Tapprich et al., 2016). Researcher–practitioner partnerships in science teaching have been found to increase teachers’ content knowledge and confidence in discussing science (Tapprich et al., 2016). Although DSEC is not a research–practitioner partnership, the purposeful involvement of teachers is present in the DoD STEM Ambassador program, where DSEC and DoD STEM connect with educators to create, curate, and share ways to engage learners. Furthermore, many DSEC partners, including the consortium’s largest investment (the National Math and Science Initiative [NMSI]), recognize the important roles that educators play in shaping the STEM aspirations of students and supporting them in meeting those goals.

Frameworks to Assess STEM Ecosystems

There is no agreed-on approach for assessing STEM ecosystems. The challenge with evaluation and assessment in this space is that the efficacy of various STEM education programs and interventions are locally focused, as metrics needed are typically aligned with the desired outcomes of individual stakeholders. However, characteristics can be used to inform the assessment frameworks. Some common features include leadership that prioritizes advocacy and administration; effective lines of communication for partners and stakeholders; low barriers to entry for partners and

²The official DoD STEM definition of underrepresented/underserved, including the definition of military-connected, appears in the appendix.
stakeholders (including industry); and a diverse mix of funding sources. Additionally, the Teaching Institute for Excellence in STEM ([TIES], a DSEC partner that created the STEM Learning Ecosystems Community of Practice) has also noted the following observations in the field as STEM ecosystems evolve:

1. Years 1-3 tend to be start-up phases, when leadership turnover is common;
2. Years 3 and beyond is when the STEM ecosystems evolve and adapt to a more established model that reflects their experiences and local conditions;
3. Progress is not typically linear, and trial and error is a part of the process;
4. The organizational models that thrive typically allow for change, are nimble, and can respond to dynamically changing conditions; and
5. Local design, priority, leadership, and control give agency and create more sustainability (Stolzer, 2022).

EARLY INTERVENTIONS (PREKINDERGARTEN - GRADE 6) IN STEM

Early positive STEM experiences can build strong stepping stones for students' future success in STEM. High-quality, early science experiences support the development of executive functioning skills, particularly the ability to revise predictions based on observations (Clements et al., 2016), sense-making, and individual risk-taking in learning (Bencze et al., 2020; Pedretti & Iannini, 2020). These skills are necessary for building competencies in other subjects, such as mathematics and English language arts (Bustamante et al., 2018; Cervetti et al., 2016; Pearson et al., 2010). Relatedly, research on early STEM education illuminates the importance of interdisciplinary, integrated STEM instruction, in which science, technology, engineering, and mathematics are taught in an interconnected manner (McClure et al., 2017). Such interdisciplinary instruction can inspire students' future interest and outcomes in STEM (Stohlman et al., 2012). Early STEM instruction also promotes learning by fostering science identities and positive attitudes toward STEM. In particular, out-of-school interventions may be instrumental because the average elementary classroom in the United States devoted less than 20 minutes per day to science instruction in 2019, which is substantially less time than that allocated to English language arts instruction per day (90 minutes; Horizon Research, Inc., 2019).

STEM Identity Development and STEM Attitudes

Early, hands-on STEM experiences can play a crucial role in fostering STEM values, motivation, and interest (Habashi et al., 2009; Rabenburg, 2013). These outcomes, in turn, contribute to children's positive identity formation as science learners (Lin & Schunn, 2016), which is then linked to students' engagement with STEM, STEM educational outcomes, and ultimately pursuit of STEM careers (Archer et al., 2012; Cech et al., 2011; Cole & Espinoza, 2008; Perez et al., 2014), creating a positive reciprocal cycle. Positive attitudes toward science predict a host of outcomes, including later science achievement (Bruce et al., 1997; Neathery, 1997; Osborne et al., 2003; Saçkes et al., 2011), participation in challenging STEM courses, pursuit of STEM degrees, and entrance into STEM careers (Cech et al., 2011; Correll, 2001; Lindahl, 2007; Maltese & Tai, 2011; Mau, 2003; Tai et al., 2006). Many DSEC partners focus on promoting not only STEM achievement but also motivation for and attitudes toward STEM, such as student interest in pursuing STEM careers and confidence toward STEM. DSEC increasingly recognizes the need to focus on STEM identity and attitude development in early years of schooling as well, as evidenced by the addition of the National Inventors Hall of Fame (NIHF) Camp Invention program to the portfolio during Option Year Two. Camp Invention engages students in grades K-6 in learning experiences that develop their STEM skills and identities.
Why are out-of-school STEM interventions in prekindergarten-grade 6 important?

STEM interventions, in this review, refer to out-of-school programs designed to augment children's STEM learning through authentic, hands-on experiences with STEM tools and practices (Hite & Taylor, 2021). Strategies include supplemental education programs, research opportunities for students, after-school programs, mentorship interventions, competitions, camps, and hybrids of multiple intervention components (Rincon & George-Jackson, 2016).

Out-of-school STEM experiences are key to enhancing students' interest in STEM (Afterschool Alliance, 2015; National Research Council, 2009, 2015; Sahin et al., 2014; Young et al., 2017) and science careers (Tucker et al., 2008), promoting advanced communication and collaboration skills (Sahin et al., 2014), and encouraging selection of a postsecondary STEM major (Sahin, 2013). Out-of-school STEM experiences have been found to be related to high levels of intrinsic motivation for STEM, additional involvement in other out-of-school STEM activities (Hite & Taylor, 2021), STEM identity, career knowledge and interest in STEM, critical thinking skills, and perseverance in STEM, especially if students were engaged with STEM activities for 4 or more weeks and in higher quality programs (Allen et al., 2019).

What are strategies to advance STEM equity in prekindergarten – grade 6?

There are still significant opportunity gaps in accessing STEM interventions, which are driven by socioeconomic, racial/ethnic, and gender inequities (DePass & Chubin, 2008). To address these inequities, DSEC supports partners, such as Arizona State University (ASU) Center for Gender Equity in Science and Technology (CGEST) and National Center for Women & Information Technology (NCWIT), that strive to remove systematic barriers to engagement by these populations of students. For example, these partners coordinated an event for students to meet STEM professionals who are representative of students' own identities.

Racial/Ethnic Equity

Early STEM interventions play a critical role in providing targeted support for achievement and access for learners with racial/ethnic backgrounds historically underrepresented in STEM (Museus et al., 2011; Riegle-Crumb & King, 2010; Xie & Killewald, 2012). One strategy is to diversify the STEM teacher workforce (NASEM, 2021). Research has demonstrated that elementary school students gain significant education and motivation benefits when they are paired with a teacher who matches their racial/ethnic identity (Egalite & Kisida, 2018). In addition, culturally responsive programs can be beneficial. For example, an after-school STEM program for elementary Latinx children used culturally relevant content developed and taught by Spanish-speaking bilingual teachers and involved mentors who demonstrated hands-on STEM experiences. The program led to a significant increase in STEM career interest after the program (Roncoroni et al., 2021). An in-school elementary engineering curriculum (Engineering is Elementary) provides additional resources for multilingual learners and multiple opportunities for students to communicate what they know about engineering. It has proven to be effective in increasing Latinx and Black students' engineering and science learning (Cunningham et al., 2020).

Gender Equity

STEM interventions focusing on serving women and girls seek to alleviate gender gaps in STEM confidence and interest and expand exposure to extracurricular science experiences (Catsambis, 1995; Greenfield, 1996, 1997; Jones et al., 2000). Evidence has suggested that elementary school girls who engage in hands-on science projects are more likely to perform well in science and engage in science fields at the collegiate level (Brotman & Moore, 2008) and have a heightened knowledge of STEM careers (Emembolu et al., 2020). Engineering is Elementary provides students with opportunities to express their engineering ideas and think critically in diverse ways benefited female students' learning more so than male students' (Cunningham et al., 2020). Strategies to close gaps include increasing teacher awareness of gender-sensitive education (Scantlebury, 1995), creating additional opportunities for girls to engage with science (Brotman & Moore, 2008), and meeting representative women in the field (Arnold, 1993). Incorporating gender-inclusive curriculum is another strategy for supporting girls in STEM (Brotman & Moore, 2008). One program allowed girls to interview women in STEM and emphasized women scientists in the curriculum (Nation et al., 2019). The program was associated with an increased recognition of a STEM career as a possible trajectory, and it helped students feel more confident in their ability to become scientists (Nation et al., 2019).
CONCLUSION

The results of this Option Year Two literature review reinforced the importance of the hubs in developing a deep understanding of STEM education and outreach efforts in their communities and using that knowledge to coordinate STEM efforts. DSEC continues to support the hubs in developing their own local strategies and pursuing their individual scopes of work through the hub professional learning community. The findings from the literature review informed the areas of focus for the professional learning community. Additionally, as the CMC reviewed applications for a fourth hub, the key themes from the literature review informed the questions posed to the hub candidates, as well as the evaluation of their potential to strengthen the consortium. Additionally, as noted above, Option Year Two represented the addition of the first DSEC STEM education and outreach partner focused solely on early STEM interventions (NIHF). The review of the literature on early STEM intervention reinforces the importance of NIHF’s membership in DSEC, as well as an area of potential growth for the consortium in the future.
PORTFOLIO AND OPERATIONAL STRUCTURE

DSEC comprises organizations and institutions in partnership with DoD STEM. Each entity focuses on supporting or delivering unique STEM engagement opportunities for K-16 students or teachers, which align to the five DSEC fundamentals, as shown in Exhibit 5.

Exhibit 5: DSEC Option Year Two Management and STEM Education and Outreach Partners

**Innovation Bloc**: The DSEC Innovation Bloc is a flexible allotment of DSEC funds to be periodically allocated to new STEM education and outreach partners. This vehicle is used to strategically address programming gaps, expand reach, and strengthen DSEC’s alignment to evolving DoD priorities.
A key component of the DSEC strategy is the emphasis on targeted, place-based programming. The hub approach emphasizes expanding the pool of traditionally underrepresented and military-connected students who are aware of, equipped for, and interested in STEM careers in the national security sector. DSEC has adopted the STEM learning ecosystem approach, which functions as a force multiplier in the STEM landscape. Each hub actively develops STEM ecosystems in their respective region by growing deep partnerships and leveraging efficiencies of scale with multisector partners. This allows hubs to broaden participation and enrich accessible, inclusive outreach activities in regions with high concentrations of DoD installations. As in STEM learning ecosystems, each hub has a designated lead who advocates for the community and leads coordination and collaboration efforts. The hubs also welcome all partners to join in their place-based efforts to improve STEM opportunities, just as effective STEM learning ecosystems do.

By cultivating deep local collaboration among diverse stakeholders engaged in STEM and leveraging existing networks, the hubs expand the reach and impact of all DSEC partners while fostering a community of practice mindset.

DoD STEM outreach success in every hub relies upon the collaborative engagement of DSEC partners, DoD installations, educators, and community-based programs. DSEC partners provide high-quality STEM programs, support networks of educators, and build brand awareness of DoD STEM as a trusted resource for advancing STEM for all learners. Hub leadership partners with DoD STEM outreach coordinators at installations to build and sustain relationships with local school districts and to provide authentic connections to DoD STEM professionals and awareness of DoD STEM careers (e.g., volunteers, speakers, role models, internship programs, onsite learning opportunities) in higher education settings.

As in previous years, the hubs continued to meet in a professional learning community to share best practices and collaborate to solve shared challenges. During Option Year Two, the community began by setting a shared vision for its success before discussing shifting programming from in-person to virtual delivery and back to in-person or hybrid programming; engaging DoD laboratories and installations; evolving the overall DSEC hub strategy and individual hub plans based on data; and considering how to engage meaningfully with DSEC STEM education and outreach partners.

The three DSEC regional hubs are located in San Diego, California (led by the University of California [UC] San Diego Center for Research on Educational Equity, Assessment, and Teaching Excellence [CREATE]); Dayton, Ohio (led by the Dayton Regional STEM Center [DRSC]); and the DMV area.
(led by the Morgan State University [MSU] Center for Excellence in Mathematics and Science Education [CEMSE]).

**PLANNING FOR HUB EXPANSION**

In Option Year Two, the CMC began an exploration of possible communities to serve as a fourth hub for DSEC. TIES used a variety of data sources (including the TIES STEM Learning Ecosystems Community of Practice database and locations of DoD laboratories, installations, and facilities) to assess the readiness of each existing ecosystem to become a DSEC hub. Each ecosystem received a STEM learning ecosystem score, which included assessments of its collaborative nature, how it welcomes all stakeholder groups, its level of self-organization, its administrative capacity, its approach to sustainability, and its current/future champions and leaders. Each ecosystem also received a DSEC score, which included the number of DoD installations, laboratories, and facilities in the ecosystem; the number of ecosystems operating in the community; the percentage of the population in the ecosystem that is military-connected; the extent to which the ecosystem had expressed interest in becoming a DSEC hub; and the ecosystem’s engagement with DSEC partners. Based on these two scores, the CMC recommended four ecosystems for additional consideration by the CMC.

As Option Year Two ended, TIES launched a survey to the leaders of these four ecosystems to gather more information on their potential to align with and enhance the DSEC hub strategy. In Option Year Three, the Consortium Chair, along with any interested members of the CMC, will interview the leadership team in each hub. After the interviews, the CMC will vote on an ecosystem to become the fourth DSEC hub.
OPERATIONAL STRUCTURE

DSEC is managed through a five-part organizational structure as shown in Exhibit 6.

Exhibit 6. DSEC Structure

**DEPARTMENT OF DEFENSE STAKEHOLDERS**

- **Cooperative Agreement Manager (CAM) / *CMC**
  - DoD STEM
  - LOUIE LOPEZ
- **Alternate CAM**
  - TYLAR TEMPLE

**Consortium Chair (CC) / *CMC**
- RTI INTERNATIONAL (LEAD ORGANIZATION)
  - REBECCA STANLEY, PhD

**Project Management and Integration (PMI)**
- RTI INTERNATIONAL

**Element 1: Consortium Management**
- Individual Program Administrator (IPA) / *CMC
  - RTI: JENNIFER PRESTON, PhD

**Element 2: Program Evaluation**
- Individual Program Administrator (IPA) / *CMC
  - AIR: JOSEPH WILSON, PhD

**Element 3: Outreach and Communications**
- Individual Program Administrator (IPA) / *CMC
  - RTI: JANELL KOCHERAV

**Element 4: STEM Alumni Management**
- Individual Program Administrator (IPA) / *CMC
  - RTI: KATHERINE MCKNIGHT, PhD

**Element 5: Strategic Outreach Initiatives**
- Individual Program Administrator (IPA) / *CMC
  - BEST: JOHN YOCHelson

**STEM EDUCATION AND OUTREACH PARTNERS**

- For Inspiration and Recognition of Science and Technology (FIRST) *CMC
- National Math and Science Initiative (NMSI) *CMC
- Dayton Regional STEM Center (Regional Hub)
- Morgan State University, Center for Excellence in Mathematics and Science Education (Regional Hub)
- University of California San Diego CREATE (Regional Hub)
- Center for Excellence in Education

**STEM EDUCATION AND OUTREACH PARTNERS - INNOVATION BLOC**

- Arizona State University Center for Gender Equity in Science and Technology (CGEST)
- Bowie State University
- Central State University
- Citizen Schools
- CYBER.ORG
- Learning Undefeated
- National Inventors Hall of Fame
- RoboNation
- Robotics Education and Competition Foundation
- Prince George’s Community College
- San Diego Miramar College
- Sinclair College
- St. Petersburg College

*MCM: Consortium Management Committee Member
DSEC outcomes are summarized in this section. Information is organized around the five DSEC fundamentals, the Option Year Two continuous improvement concepts, and the Option Year Two budget summary. Additionally, this section highlights the work of the 2021-2022 DoD STEM Ambassadors and the STEM Advisory.

The program years for DSEC are:

- **Base Year:** March 2019 through August 2020
- **Option Year One:** September 2020 through August 2021
- **Option Year Two:** September 2021 through August 2022

The data related to the five DSEC fundamentals includes historical data from prior program years, when possible. Please note:

- In the original reporting on the Base Year, students taught by educators who were engaged in NMSI’s programming were included in the count of student participants. Since that time, the consortium has shifted its data reporting process to only include educators engaged in NMSI programming as they are the direct recipients of services.

- During Option Year One, DSEC partner USA Science & Engineering Festival served approximately 25,000 students in short-duration STEM experiences. This partner exited the consortium for Option Year Two.

- In the original reporting on the Base Year and Option Year One, the consortium highlighted the number of teachers engaged in DSEC programming and considered school administrators and counselors to be “other participants.” Since that time, the consortium has shifted its data reporting process to include teachers, administrators, and counselors in an “educators” group. The educator data reported in this report represent the sum of the separate groups as displayed in Base Year and Option Year One reporting.

- In the Base Year, DSEC STEM education and outreach partners only reported a range of the percentage of the students (i.e., between 25 to 50%) they served who were military-connected. As a result, it is not possible to provide a count of the number of military-connected students served.

- Percentages may not add to 100 due to rounding.

A separate data chapter accompanying this report provides full evaluation details and is publicly available at [https://dodstem.us/about/partners/](https://dodstem.us/about/partners/).
Engage students and educators in meaningful STEM experiences

DSEC will engage K-16 students and educators in meaningful formal and informal DoD STEM learning experiences.

**Students**

<table>
<thead>
<tr>
<th>Grade Band</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grades K-5</td>
<td>4,853</td>
</tr>
<tr>
<td>Grades 6-8</td>
<td>19,371</td>
</tr>
<tr>
<td>Grades 9-12</td>
<td>11,472</td>
</tr>
<tr>
<td>2-Year</td>
<td>191</td>
</tr>
<tr>
<td>4-Year</td>
<td>191</td>
</tr>
<tr>
<td>Graduate</td>
<td>6</td>
</tr>
</tbody>
</table>

Not in School - 11 Not Reported - 12,712

DSEC partners engaged students and educators in

50 STATES AND THE DISTRICT OF COLUMBIA, PUERTO RICO, THE U.S. VIRGIN ISLANDS, AND GUAM.

Several programs also reached students and educators in international locations.
HISTORICAL DATA ON STUDENT AND EDUCATOR ENGAGEMENT

As DSEC completes its third year of serving students and educators, it is important to consider trends over time. The data below represent the best attempt to allow for year-over-year comparisons given the changing nature of the consortium, the refinement of data collection and reporting processes over time, and the effects of the COVID-19 pandemic on partner programming.

The pandemic (which affected programming in the second half of the Base Year and during Option Year One) resulted in challenges related to student and educator recruitment for STEM programming and, in some cases, decreased engagement. However, the shift to virtual programming also allowed some programs to reach outside of their own communities to engage larger groups of students and educators than they would have served during in-person events.

<table>
<thead>
<tr>
<th></th>
<th>Students</th>
<th>Educators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BASE YEAR</strong></td>
<td>25,664</td>
<td>2,291</td>
</tr>
<tr>
<td><strong>OPTION YEAR ONE</strong></td>
<td>107,586</td>
<td>4,172</td>
</tr>
<tr>
<td><strong>OPTION YEAR TWO</strong></td>
<td>48,801</td>
<td>2,784</td>
</tr>
</tbody>
</table>

ASSESSING DSEC IMPACT THROUGH THE OPTION YEAR TWO ALUMNI SURVEYS

As part of DSEC’s longitudinal studies, Option Year Two alumni surveys provide continuing evidence of the impact that DSEC-funded programs have on educators and students, building on what was learned from Option Year One.

For educators, DSEC-funded programs had a positive impact on their STEM awareness, self-efficacy, and interest in the STEM content they teach, all of which are related to positive student STEM outcomes according to research on STEM education. Additionally, overall, DSEC programs provided educators with strategies, knowledge, and skills to help engage historically underrepresented students in STEM. This is an important outcome related to broadening participation in STEM.

Educators who worked directly with students during DSEC program participation reported positive impact on students’ interest and engagement in STEM and awareness of STEM research and careers, although they reported less student awareness of STEM opportunities in the DoD. As in Option Year One, educators reported positive beliefs about DoD STEM overall, yet they were only somewhat aware of DoD STEM career opportunities.

For students, survey results also continued the positive trends observed in Option Year One. Overall, students report a strong impact on their interest in STEM topics, in wanting a STEM career, in gaining new knowledge and skills, and
feeling prepared for more challenging STEM activities. On average, they indicated that the DSEC program in which they participated influenced their education plans “somewhat.” About 55% reported applying for STEM-focused internships, apprenticeships, fellowships, or job positions, and almost 70% indicated plans to seek a STEM-focused career in the future. Far fewer (about 10%) indicated plans to seek a DoD STEM-focused career.

For Option Year Two, the Element 4 team compared outcomes based on three variables: gender, race/ethnicity, and selectivity of the DSEC program. For the latter, the research team categorized programs as “open” if they were open or available to all interested students, and “selective” if students had to qualify to participate (e.g., through competitions, interviews, etc.). Notably, programs that were categorized as open had more females, students of color, and students from lower socioeconomic households. By disaggregating the data and comparing them by gender, race/ethnicity, and selectivity, interesting differences were observed:

- On average, White and Asian students reported stronger STEM identity than students of color, as did students in selective vs. open programs, both before and after participating in the DSEC programs. Notably, there were no meaningful gender differences in STEM identity.
- On average, students in selective programs reported doing more STEM activities in their free time than those in open programs. White and Asian students reported more compared to students of color, as did males compared to females.
- Students in selective programs were more likely than those in open programs to plan on going to a 4-year college (87% and 71%, respectively) and far more likely to plan on earning a degree in STEM (82% and 56%, respectively).
- White and Asian students were far more likely to plan on seeking a STEM career than students of color (76% and 54%, respectively), as were those in selective programs when compared to students in open programs (81% vs. 46%).

Given the focus of DSEC on broadening participation in STEM, it is important to monitor the perceptions of the students who participate in these programs regarding the impact of the DSEC portfolio of programs on historically underrepresented and underserved students in STEM. It is important to have an array of programs that are open and selective to encourage students to engage and persist in multiple STEM pathways. Evidence from the surveys suggests that, overall, educators believe they are getting supports they need to engage historically underrepresented students, and encouragingly, historically underrepresented students are reporting an increased interest in STEM, STEM education, and STEM careers. It is not surprising that students who participate in more selective STEM programs show even stronger interest in these areas. However, DSEC programs may need to improve in who is recruited into these more selective programs. From the survey data, student demographics show a greater number of males, White and Asian students, and students with fewer indicators of low socioeconomic status participating in the selective programs (i.e., not historically underrepresented students). It is important to note that these demographics reflect the characteristics of survey respondents, not all program participants.
Serve students who are military-connected and underrepresented in STEM

DSEC will focus on serving students who are underrepresented in STEM (as defined by DoD STEM).³

³The official DoD STEM definition of underrepresented/underserved, including the definition of military-connected, appears in the appendix.

(*) Multi-racial was not a reporting category in Option Year One.
With the support of Innovation Bloc funding in Option Year Two, four institutions of higher education joined DSEC through the HBCU/MI Pathways Network. During Option Year One, these partners received support from MSU and Building Engineering and Science Talent (BEST) as they designed their pathways and crafted their applications for DSEC funding. In Option Year Two, the institutions became formal DSEC partners, and they continued to receive coaching and implementation guidance through MSU and BEST.

As HBCUs/MIs, these institutions enhance DSEC’s efforts to align with the fundamental focused on serving students who are underrepresented in STEM.

<table>
<thead>
<tr>
<th>OPTION YEAR TWO</th>
<th>OPTION YEAR ONE</th>
<th>OPTION YEAR TWO</th>
<th>OPTION YEAR ONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,021</td>
<td>26,534</td>
<td>6,730</td>
<td>16,361</td>
</tr>
</tbody>
</table>

Number of underrepresented students DSEC served.

Number of military-connected students DSEC served.
Connect to the DoD STEM workforce

DSEC will ensure STEM experiences are connected to the DoD STEM workforce and DoD careers.

During Option Year Two, DSEC engaged:

1,468 volunteers

44% of volunteers were DoD affiliated

643 DOD volunteers

72 PROGRAM ALUMNI

59 OTHER ADULT VOLUNTEERS

694 VOLUNTEERS FROM EDUCATION PARTNERS

During Option Year One, DSEC engaged:

1,211 volunteers

78% of volunteers were DoD affiliated

942 DOD volunteers

67 PROGRAM ALUMNI

129 OTHER ADULT VOLUNTEERS

32 TEACHER VOLUNTEERS

41 OTHER STUDENT VOLUNTEERS
PARTNER SPOTLIGHTS

DoD STEM Ambassadors

After identifying barriers to students’ pursuit of internships in the DoD, DoD STEM Ambassadors Leo Ulloa-Higuera, Brett Doudican, and Nancy Rowland set out to understand the opportunities available across multiple components and develop a resource to help students navigate the application processes. They designed a collaborative website to consolidate timelines and requirements for various internship opportunities, as well as offer tips and advice to student applicants.

Learning Undefeated

Learning Undefeated’s 5-month Emerging Leaders in Biotechnology program supports young women by cultivating and reinforcing their STEM identity and developing their interest in joining the STEM workforce. The program exposes the students to DoD STEM careers and professionals through site visits and opportunities for program participants to interact with the professionals virtually and in person. During Option Year Two, participants spent a day at the Walter Reed Army Institute of Research and learned about different projects underway at the Institute, including those in the fields of viral diseases and biosystematics. Additionally, Captain Charmagne Beckett, a doctor and clinical researcher at the Navy Medical Research Center, spoke with the young women during the program’s opening session and shared information about her career path.

FIRST

All FIRST teams funded by DoD STEM (1,486) must have a DoD- or DoD Education Activity (DoDEA)-affiliated mentor. These mentors work with teams as they participate in the program challenge and serve as role models who bring careers and professions in STEM to life. Because of their firsthand experience working in the DoD, these mentors are uniquely positioned to share information about the many STEM careers that are available and the various pathways that students can follow in pursuit of one of those careers.
Leverage the network as a force multiplier

DSEC will leverage the consortium as a force multiplier to amplify the reach, visibility, and outcomes of DoD STEM.
Network connectivity:

- On average, each STEM education and outreach partner reported connecting to 10 other partners, which represented an increase from Option Year One.
- The network has a density of 43%, meaning that slightly less than half of all possible connections occur in the network. This density is consistent with the connectivity of the network in Option Year One and lower than the density in the Base Year (75%), when there were fewer partners in the consortium.
- Of the 118 reported connections, 109 (92%) included a focus on serving or connecting to at least one of the following focal populations: students who are historically underrepresented in STEM, military-connected students, and the DoD STEM workforce. Of those connections, STEM education and outreach partners and hub leads reported most frequently connecting to other DSEC organizations about serving students who are historically underrepresented in STEM.

81% of connections (95) were networking and sharing expertise or lessons learned.

19% of connections (22) were coordinating or collaborating.

Types of network connections:

- **Networked** means that partners networked (e.g., exchanged basic information about their organizations or programs) during group meetings, e-mail exchanges, or conversations about DSEC programs and activities.

- **Shared** expertise or lessons learned means partners shared expertise or lessons learned in one-on-one or small-group settings about program effectiveness, common challenges, promising practices, or engagement with DSEC beneficiaries.

- **Coordinated** programming means one partner consulted with another partner to implement programming in a coordinated way.

- **Collaborated** on joint programming means that one partner collaborated with another partner in a sustained way to design, deliver, and/or expand joint programming.

As focal points for collaboration, the DSEC regional hubs bring together DSEC partners and other key stakeholders in their local communities, including DoD personnel.

- MSU CEMSE hosted its STEM Expo in a platform that encouraged over 3,000 students to engage with DoD STEM professionals and careers virtually.
- DRSC continued to hold regular DO (Dayton, OH) STEM ecosystem convenings to spur new collaboration among local ecosystem partners, including Wright-Patterson Air Force Base (AFB).
- UC San Diego CREATE brought together DSEC partners with programming in San Diego to collaborate around how to expand STEM opportunities to specific geographic areas in the city in need of support.
Evolve the approach based on data

DSEC will use a data-driven approach to evolve and evaluate how DSEC operates over time to ensure positive outcomes for students and educators.

DSEC includes two distinct efforts to collect data and use it to inform the strategic approach of the consortium:

- Program Evaluation (Element 2)
- STEM Alumni Studies (Element 4)

During Option Year Two,

- DSEC welcomed seven new STEM education and outreach partners to deepen the consortium’s engagement of K-5 students, align with the DoD critical technology area of autonomy, expose students to robotics, and support the development of meaningful STEM pathways from K-12 to community colleges to 4-year institutions.
- DSEC’s approach to consortium management and the regional hub strategy evolved based on key recommendations from the hub case studies and consortium management evaluation report provided by Element 2.
  - For example, in response to lessons from the consortium management report, the Element 1 team began assigning a partner liaison to each DSEC member. This individual serves as a single point of contact when partners have any questions about the consortium and provides support for partners to meet all consortium requirements.
- The consortium began to use the DSEC Event Tracker in Amaze to share information about upcoming events and provide post-event data needed to inform the work of Elements 2 and 4.
  - To accompany the release of this new system, the consortium management team produced a variety of resources, including cheat sheets and frequently asked questions.
- Based on challenges observed during Option Year One, AIR facilitated a session during the June 2022 quarterly meeting to deepen partner understanding of logic model data and how to write outcome statements.
- The February 2022 networking session built the capacity of partners to review their formative and summative outcome data and strengthen their programming based on results.
Evolution of Data Collection Methods

As DSEC has matured, the consortium’s approach to data collection has evolved. During the Base Year, STEM education and outreach partners were not required to collect demographic data for participants. As the consortium moved into Option Year One, the consortium management team began to require the collection of demographic data on participants; while partners generally did so, collection of some elements (for example, participant race/ethnicity data) varied. Additionally, some partners used estimation and other data collection methods that are not as reliable as collecting the data directly from participants or administrative datasets.

In Option Year Two, DSEC recommitted to the importance of participant demographic data and the role it plays in assessing the consortium’s progress toward its goals. Partners began to provide participant data through one, streamlined data collection tool: the DSEC Event Tracker, and many began to collect data directly from participants. As part of Option Year Three, partners will be meeting with members of the consortium management team, including the Consortium Chair and the IPAs for Elements 2 and 4, to discuss, among other topics, their progress toward collecting all required data elements through a reliable method. One of the partner work groups for Option Year Three is focusing its efforts on enhancing data collection processes and will be able to support the sharing of best practices around this important commitment.
OPTION YEAR TWO CONTINUOUS IMPROVEMENT CONCEPTS

In the Annual Program Plan (APP) for Option Year Two, the consortium management team for DSEC set out eight continuous improvement concepts. These improvement concepts reflect feedback from DSEC’s STEM education and outreach partners, STEM Advisory, the CMC evaluation completed by Element 2, and changes in the STEM environment. Progress toward these continuous improvement concepts represents deeper alignment with the DSEC fundamentals and strengthens the consortium as a network of partners sharing a single goal.

Continuous Improvement Concept:
Build on remote and virtual outreach strategies

Incorporate lessons learned from COVID-19 virtual pivots to ensure DSEC partners retain flexibility in programming and student outreach methodologies during Option Year Two.

Description of Progress Made:
- During 1:1 meetings with STEM education and outreach partners, the Consortium Chair asked probing questions about how partners were shifting from virtual to hybrid or in-person instruction and how they were retaining the strong elements of their virtual programming. The Consortium Chair would also recommend connections between partners to share specific lessons learned about intentional remote outreach strategies.
- During the March 2022 quarterly meeting, a panel of students and a panel of educators reflected on what they had learned about student learning and engagement during the past year and how to preserve valuable parts of remote outreach strategies. The student panelists shared specific strategies that have been effective in encouraging them to engage in STEM programming.
- ASU CGEST provided an excellent example of this continuous improvement concept in action. After shifting its CompuGirls program to virtual delivery during Option Year One and the beginning of Option Year Two, ASU CGEST brought young women in Arizona and the DMV together in person in those locations while also providing for virtual connections between the two communities.

Continuous Improvement Concept:
Develop intentional connections to promote the engagement of historically underrepresented populations in STEM

Directly engage with HBCUs/MIs to develop career pathways for underrepresented students in Option Year Two. Provide technical support to partners and leverage network collaboration to expand outreach to underserved populations.

Description of Progress Made:
- During Option Year Two, DSEC welcomed the four members of the HBCU/MI Pathways Network formed in Option Year One into the consortium as members of the Innovation Bloc. They continued to receive targeted technical assistance and support from MSU CEMSE and BEST as they transitioned into consortium membership. Their experiences with creating STEM pathways in their communities emphasized the importance of engaging students while simultaneously removing institutional barriers to students’ movement through a pathway. For example, students in Prince George’s County who developed their interest in computer science through DSEC-funded programming would still have faced challenges as the curricula used by the K-12 education system, the community college, and the four-year institution were not aligned. The scope of work for the two members of the HBCU/MI Pathways Network in the DMV region included efforts to align those curricula and ease transitions between systems. Their work was effective in enhancing student opportunity because it attended to student engagement and the removal of structural barriers at the same time.
leveraging partnerships to strengthen STEM engagement pathways, while DoD STEM Ambassadors hosted two sessions. In addition, DoD STEM engaged with conference attendees at a booth in the exhibit hall. Those who connected with DoD STEM on Twitter had the opportunity to win a prize. A networking session held in April 2022 provided an opportunity for STEM education and outreach partners to learn more about the CSTA.

- DoD STEM Ambassadors presented at a wide variety of professional convenings, including the Association for Career and Technical Education Leadership Conference, South by Southwest EDU, and the Smithsonian National Education Summit.

Continuous Improvement Concept:

Expand connections with other STEM networks to amplify awareness of DoD STEM

Focus development of DSEC hub ecosystems to expand DSEC programming and engagement. Include planning in Option Year Two for a STEM technical exchange that will be designed to connect DSEC to other DoD STEM partners and networks during Option Year Three. DoD STEM Ambassadors will present at local, regional, and national STEM education conferences to promote DoD STEM program awareness.

Description of Progress Made:

- During the December 2021 quarterly meeting, STEM education and outreach partners reflected on the strategies included in the Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies and how those best practices can translate into their engagement efforts.
- During the March 2022 quarterly meeting, partners learned about culturally relevant pedagogy from ASU CGEST and considered how to infuse its key practices into their support of populations historically underrepresented in STEM.

Continuous Improvement Concept:

Amplify approach to promote STEM careers within DoD

Increase partner inclusion of student experiences and exposure to DoD STEM careers. Specifically recruit three DoD STEM Ambassadors to focus on work-based learning, which will include the development of tools and resources for workforce development and the promotion of DoD STEM careers.

Description of Progress Made:

- During meetings of the hub professional learning community, hub leaders explored research-based best practices on organizational collaboration (including the literature that forms the basis for the STEM learning ecosystem model) and how to put these practices into action when building new relationships with DSEC STEM education and outreach partners or deepening existing ones.
- A cross-functional team, including representatives from the DoD STEM office, began planning for the STEM Technical Exchange, which will be held in February 2023. During the Exchange, participants will share innovative and positive practices for increasing STEM literacy and inspiring the next generation of STEM leaders and will build on existing and create new relationships to leverage the power of the network and amplify DoD STEM impact.
- DSEC strengthened relationships with both the National Science Teaching Association (NSTA) and Computer Science Teachers Association (CSTA). At the NSTA conference, the Consortium Chair led a session on leveraging partnerships to strengthen STEM engagement pathways, while DoD STEM Ambassadors hosted two sessions. In addition, DoD STEM engaged with conference attendees at a booth in the exhibit hall. Those who connected with DoD STEM on Twitter had the opportunity to win a prize. A networking session held in April 2022 provided an opportunity for STEM education and outreach partners to learn more about the CSTA.
- DoD STEM Ambassadors presented at a wide variety of professional convenings, including the Association for Career and Technical Education Leadership Conference, South by Southwest EDU, and the Smithsonian National Education Summit.

- DSEC was well-represented at the STEM learning ecosystems community of practice meeting in Bay City, Michigan. The DoD STEM Director, members of the DoD STEM team, several DoD STEM Ambassadors, the Consortium Chair, the Element 1 IPA, and representatives of some DSEC partners attended the convening to engage in meaningful conversations about how STEM learning ecosystems can enhance opportunities in communities across the nation.
Continuous Improvement Concept:

Improve two-way communication and feedback between the CMC and outreach partners

Establish opportunities for outreach partners to have 1:1 meetings with the Consortium Chair as well as partner-specific sessions with IPAs.

Description of Progress Made:

During Option Year Two, the Consortium Chair offered the opportunity for each partner to join a 1:1 meeting to discuss program successes and opportunities for growth, as well as areas of collaboration with other STEM education and outreach partners. These meetings also served as a way for the Consortium Chair to gather feedback on how the consortium management team can better support partners. In summer 2022, 14 partners took advantage of this opportunity, which represented a significant increase over the seven who chose to participate when the 1:1 meetings launched in fall 2021. The Consortium Chair is one component of the team of consortium managers, but the consortium management evaluation revealed that 11 of 13 partners reported that they were satisfied with feedback from this team. Additionally, the liaison assigned to each partner served as a conduit for information to flow between the consortium management team and each partner organization.

Continuous Improvement Concept:

Facilitate intentional collaboration opportunities within DSEC

Design sessions during DSEC meetings for purposeful collaboration and networking. Provide technical support for new partners to help form connections with the hubs and other partners doing similar work.

Description of Progress Made:

• New STEM education and outreach partners that joined DSEC through the HBCU/MI Pathways Network engaged in bimonthly professional learning sessions. One of these sessions focused exclusively on leveraging the DSEC network. During this meeting, representatives from two

Continuous Improvement Concept:

Increase engagement of military-connected students in DSEC programming

Identify resources and methodologies in Option Year Two to educate and support DSEC partners to increase outreach to and engagement of military-connected students.

Description of Progress Made:

In Option Year Two, the consortium management team launched the Military-Connected Resource Toolkit as an optional tool for partners to pilot as they worked to identify and engage military-connected students. The toolkit centralizes resources and methodologies that inform and support the consortium’s STEM education and outreach partners to increase outreach to and engagement of military-connected students. It also represents considerable collaboration between DSEC, DoD (i.e., the Office of Military Community and Family Policy and DoDEA), and the Military Child Education Coalition. To accompany the toolkit’s initial release, a networking session in October 2021 provided an overview of the resource and opportunity to engage with two panels of subject matter experts. One panel focused on programming to support and engage military-connected students, while a second panel focused on how to navigate school systems with military-connected schools.

Continuous Improvement Concept:

Facilitate intentional collaboration opportunities within DSEC

Design sessions during DSEC meetings for purposeful collaboration and networking. Provide technical support for new partners to help form connections with the hubs and other partners doing similar work.

Description of Progress Made:

• New STEM education and outreach partners that joined DSEC through the HBCU/MI Pathways Network engaged in bimonthly professional learning sessions. One of these sessions focused exclusively on leveraging the DSEC network. During this meeting, representatives from two
Continuous Improvement Concept:

Tighten connection to DoD critical technology areas

Design networking sessions for partners to learn about DoD critical technology areas. Pursue avenues for strengthening alignment between current outreach and education partners’ programming and DoD critical technology areas.

Description of Progress Made:

In Option Year Two, DSEC added several new partners, two of which offer programming that is directly aligned with the critical technology areas. The Robotics Education & Competition (REC) Foundation’s Aerial Drone Competition engages student teams in the design and flight of aerial drones. RoboNation’s SeaPerch underwater robotics program teaches students basic engineering, design, and science concepts as they design remotely operated vehicles. Both STEM education and outreach partners support the critical technology area of trusted artificial intelligence (AI) and autonomy.

DSEC convenings also provided opportunities for consortium members to learn more about work underway on the critical technology areas and how they can be infused into STEM education. During the December 2021 quarterly meeting, participants learned about educational and community outreach underway at the Lincoln Laboratory at the Massachusetts Institute of Technology (MIT), a federally funded research and development center for the DoD.
The DoD STEM Ambassador program was a cohort of 16 educators who partnered with DSEC to advance STEM outreach throughout the 2021-2022 school year. The educators serving in the second cohort of Ambassadors were carefully chosen by DSEC partners to represent their respective organizations and DoD STEM. DoD STEM Ambassadors were selected based on their demonstrated history of outstanding commitment to the DSEC fundamentals, particularly for working with students who have been historically underrepresented in STEM and/or are military-connected.

In addition to the numerous resources created, each DoD STEM Ambassador authored a blog post that will be featured on the DoD STEM website. They also presented at national, state, and/or local conferences to share DoD STEM resources, with some Ambassadors sharing at more than one conference. Together, they formed a community of practice that met monthly to network, learn from each other, and develop meaningful partnerships that supported students.

In alignment with the DSEC fundamentals, the DoD STEM Ambassador program has evolved based on data from Ambassadors, their host organizations, and program managers. The candidate pool expanded beyond K-12 classroom teachers to include education professionals working at the district level, as well as faculty and staff from institutions of higher education. DoD STEM Ambassadors from the first cohort focused on the creation of classroom resources to support their fellow educators during the shift to virtual instruction in spring 2020. The resources created by the second cohort were more expansive and included websites, reports, and resources for use by students, families, teachers, school administrators, and community members.

Objectives:

• Provide resources to teachers who specifically serve targeted student populations.
• Enhance exposure of DoD STEM resources and programs.
• Recognize outstanding educators and promote deep STEM learning across the nation.
• Collaborate and strengthen relationships across DSEC.

“I am passionate about creating rich STEM learning opportunities that bring joy to learning and empower all students to develop skills for success beyond high school. In addition to skills, I believe in equipping all students from the earliest grades with knowledge and experience to solve big problems in our world and open their minds to becoming members of a dynamic STEM workforce of the future.”

– Lisa Blank, Director of STEM Programs, New York

“Students have changed a lot since I began my career in education. So has my approach. I’ve found effective ways to teach scientific concepts to students with learning difficulties that work well for all students. Inclusivity is so important! I’ve also found that when students are encouraged to chat amongst themselves, they do a really good job teaching each other.”

– Patty Brunet, High School Science Teacher, California

“My students are high needs and have many different learning styles. They have taught me that every student can learn and bring joy into the classroom. I am a firm believer that experiential hands-on activities combined with community mentorship is the spark that improves the educational landscape for my students. My classroom motto is ‘Never quit’.”

– Tiara Davis, Middle School Science Teacher, North Carolina
<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitney Aragaki</td>
<td>High School Science Teacher, ‘Hawai’‘i</td>
</tr>
<tr>
<td>Patty Brunet</td>
<td>High School Science Teacher, California</td>
</tr>
<tr>
<td>Brett Doudican</td>
<td>Curriculum Specialist, Ohio</td>
</tr>
<tr>
<td>Priscilla Lumbreras</td>
<td>High School Science Teacher, Texas</td>
</tr>
<tr>
<td>Kristy McDowell</td>
<td>College Professor and Scientist, Virginia</td>
</tr>
<tr>
<td>Heather Overkamp</td>
<td>High School STEM Teacher, Virginia</td>
</tr>
<tr>
<td>Jenn Stormer</td>
<td>Elementary School Science Teacher, Ohio</td>
</tr>
<tr>
<td>Melanie Villanueva</td>
<td>Middle School Science Teacher, California</td>
</tr>
<tr>
<td>Lisa Blank</td>
<td>Director of STEM Programs, New York</td>
</tr>
<tr>
<td>Tiara Davis</td>
<td>Middle School Science Teacher, North Carolina</td>
</tr>
<tr>
<td>Tyler Erb</td>
<td>Middle School Math Teacher, North Carolina</td>
</tr>
<tr>
<td>Kirsten Manning</td>
<td>High School Physics and Engineering Teacher, Virginia</td>
</tr>
<tr>
<td>Melissa Moser</td>
<td>Elementary and Middle School Teacher, Environmental Education and Robotics, California</td>
</tr>
<tr>
<td>Nancy Rowland</td>
<td>STEAM Outreach Specialist, Virginia</td>
</tr>
<tr>
<td>Leo Ulloa-Higuera</td>
<td>School Principal, California</td>
</tr>
<tr>
<td>Shelly Waller</td>
<td>Instructional Technology Coach, Virginia</td>
</tr>
</tbody>
</table>
The DSEC STEM Advisory provides external perspectives on emerging trends in STEM, content expertise, outreach strategy vetting, and outreach support. The invited members of the Advisory serve as critical friends to test ideas, identify gaps, and prioritize areas of focus. The group consists of volunteer members who meet virtually at least twice each year. Members represent a mix of STEM content experts, military-connected professionals, and civilians in STEM roles or organizations. Advisory members have no consortium management responsibilities or voting privileges.

During Option Year Two, the STEM Advisory met in December 2021 to review Option Year One data and assess alignment between those outcomes and the Option Year Two improvement concepts and DSEC strategy. The group met again in June 2022 to consider the past, present, and future of DSEC’s regional hub strategy and assess alignment between that strategy and DoD STEM’s vision for STEM learning ecosystems. In particular, the insights gleaned during the session on regional hubs informed the analysis used to identify potential sites for DSEC’s fourth hub, as well as the questions posed to these STEM learning ecosystems during the application process.

**Option Year Two 2021-2022 DSEC STEM Advisory Members**

- Elizabeth Allan, PhD, University of Central Oklahoma
- Robert Berry, PhD, University of Virginia
- Chantel Dooley, PhD, Tragedy Assistance Program for Survivors
- Daniel Kelly, PhD, Texas Tech University
- Tim McClees, Aerospace Industries Association
- Linda Rosen, PhD, Retired, Change the Equation
- Shane Shaneman, Carnegie Mellon University
- Ivory Toldson, PhD, NAACP
- Eric Wiebe, PhD, Friday Institute for Educational Innovation, North Carolina State University
- Brenda Darden Wilkerson, AnitaB.org
- Travis York, PhD, American Association for the Advancement of Science
BUDGET SUMMARY

DSEC operates on an annual program calendar of September 1 to August 31. The summary presented in Exhibit 7 represents the DSEC budget that guided operations for Option Year Two.

The budget structure for Element 5, which primarily supports STEM education and outreach partners, is organized into four categories (see Exhibit 8). Each partner’s Option Year Two activities are detailed in the next section of the report.

Exhibit 7: 2021-2022 Option Year Two Budget

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>Amount</th>
<th>%</th>
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<tbody>
<tr>
<td>ELEMENT 1</td>
<td>$1,191,524</td>
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<tr>
<td>ELEMENT 2</td>
<td>$1,063,474</td>
<td>5.4%</td>
</tr>
<tr>
<td>ELEMENT 3</td>
<td>$1,255,983</td>
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</tr>
<tr>
<td>ELEMENT 4</td>
<td>$632,822</td>
<td>3.2%</td>
</tr>
<tr>
<td>ELEMENT 5</td>
<td>$15,665,666</td>
<td>79.1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$19,809,469</td>
<td></td>
</tr>
</tbody>
</table>

Exhibit 8: Option Year Two STEM Education and Outreach Partner Structure

<table>
<thead>
<tr>
<th>PARTNER FUNDING CATEGORY</th>
<th>DSEC CMC MEMBER</th>
<th>DSEC REGIONAL HUB</th>
<th>STEM EDUCATION AND OUTREACH PARTNER</th>
<th>INNOVATION BLOC PARTNER</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNDING LEVEL</td>
<td>FIRST NMSI</td>
<td>$200,000-$250,000</td>
<td>$300,000-$500,000</td>
<td>$125,000-$500,000</td>
</tr>
<tr>
<td></td>
<td>DRSC</td>
<td></td>
<td>CEE</td>
<td>ASU CGEST</td>
</tr>
<tr>
<td></td>
<td>MSU CEMSE</td>
<td></td>
<td>MATHCOUNTS</td>
<td>Bowie State University (BSU)</td>
</tr>
<tr>
<td></td>
<td>UC San Diego CREATE</td>
<td></td>
<td>NCWIT</td>
<td>Central State University (CSU)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Society for Science</td>
<td>Citizen Schools</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TGR Foundation</td>
<td>CYBER.ORG</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TIES</td>
<td>Learning Undefeated</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>NIHF</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Prince George’s Community College (PGCC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>REC Foundation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RoboNation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>San Diego Miramar College</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sinclair Community College (SCC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>St. Petersburg College</td>
</tr>
</tbody>
</table>
The future of STEM!

Department of Defense

DoDSTEM

Science · Technology · Engineering · Mathematics
STEM EDUCATION AND OUTREACH PARTNERS

During Option Year Two, DSEC included 24 STEM education and outreach partners, three of which were regional hubs. This section includes a brief overview of each partner’s DSEC-funded activities, a summary of their outreach approach, and an analysis of their alignment with the goals in the DoD STEM Strategic Plan.

A separate data chapter accompanying this report provides full evaluation details and is publicly available at dodstem.us/about/partners.
Arizona State University Center for Gender Equity in Science and Technology (ASU CGEST)

SCOPE SUMMARY

ASU CGEST developed and delivered CompuGirls: Phoenix, a culturally responsive curriculum in information technology and cybersecurity for 65 girls from underanticipated/underrepresented/underserved communities (e.g., low-income, military families, rural, urban) to promote interest in pursuing a degree in computer science and/or cybersecurity. ASU CGEST focused on preparing and training participants about information technology/cybersecurity career options through industry mentors and guest speakers; a 5-week cybersecurity and cyber ethics explorations fall camp; exploration of technology programs via a 4-week spring camp; and enrollment in a summer online “Introduction to Information Technology” or similar course through ASU Prep Digital, where participants could receive college credit. This project allowed ASU CGEST to revise the culturally responsive professional development for mentor teachers that equips them to be successful mentors for student participants in the program. Additionally, the summer camp paired students with successful local college students who served as peer mentors in STEM and allowed them to explore beginning concepts in building computer programs and other related research.

In Option Year Two, CGEST also partnered with MSU to offer CompuGirls with a focus on cybersecurity to high school girls in the DMV community. This partnership addressed a gap identified by the landscape analysis of the HBCU/MI Pathways Network to support engagement of girls of color in computer science. The identified gaps that were addressed by CGEST staff included professional development on culturally responsive curriculum writing and teacher implementation of culturally responsive practices. CGEST expanded CompuGirls in Maryland to prepare the MSU mentors from computer science programs to deliver a culturally responsive computing curriculum that nurtures the development of participating students as techno-social change agents.

OPTION YEAR TWO FUNDING CATEGORY

Innovation Bloc: $125,000 - $500,000

49 girls were served through the CompuGirls program

43% of the female students served were military-connected
DSEC FOOTPRINT

Arizona

Maryland

RATIONALE FOR APPROACH

CGEST prepares young girls of color to develop not just a stronger identity as an emerging computer scientist but also one that is intersectional and does not separate community, academic, professional, and science identity into separate categories. The CompuGirls program encourages girls to apply computer science learning to solve modern community challenges that matter to them, which improves retention.

The literature describes the benefits to culturally and linguistically diverse learners in STEM education through pedagogical techniques that promote student-centered learning (Scott, 2021; Stewart et al., 2022). Culturally relevant STEM experiences support girls of color in the development of positive STEM identity, as their backgrounds and identities are an integral part of the learning process (Hughes et al., 2020). Girls who participate in out-of-school-time STEM programs feel more confident trying new activities and struggling through difficult concepts in ways they are not able to in the traditional classroom setting (Hughes et al., 2019).

ALIGNMENT TO DOD STEM STRATEGIC PLAN

01. Inspire

- Facilitate CompuGirls camps and recruit girls of color to gain access to STEM

02. Attract

- Create opportunities for girls of color to access industry mentors in STEM fields

03. Increase

- Provide girls with a dynamic, fun learning environment that nurtures the development of a positive self-concept

04. Advance

- Use data to advance equity in STEM and provide professional development for mentor teachers who present culturally responsive programming
## Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CompuGirls Fall/Winter/Summer</strong></td>
<td><strong>Engage</strong></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about cybersecurity as a field</td>
<td>• Gain knowledge of the cyber needs of their communities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Students learn how to communicate with different community members</td>
<td>• Learn to present findings/work to a variety of communities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Become aware that cybersecurity is a component/division of military installations</td>
<td>• Learn advocacy skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn how to build a coalition</td>
<td>• Understand the role of identity in individual success in STEM education and careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Become more critical about engagement in online settings (digital footprint)</td>
<td>• Increase understanding of equity in STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better understand what data is and how this relates to their daily actions</td>
<td>• Increase awareness of STEM careers in cybersecurity/STEM</td>
</tr>
<tr>
<td></td>
<td><strong>Serve</strong></td>
<td><strong>Parents learn about cybersecurity and how it applies to the real world (community, careers).</strong></td>
<td>• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td><strong>Connect</strong></td>
<td></td>
<td>• Increase awareness of career pathways in cybersecurity/STEM</td>
</tr>
<tr>
<td></td>
<td><strong>Online Courses</strong></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understand the ethics of cybersecurity and its impact on their community</td>
<td>• Become part of a community made up of STEM professionals, mentors, and/or program alumni; peers; parents; and community and cultural advisors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can identify data forms</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Understand how a networked society functions</td>
<td>• Increase knowledge of their technosocial change agency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understand critical media literacy and how it relates to cybersecurity</td>
<td>• Increase knowledge of their self-regulatory learning for cybersecurity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understand computer-mediated communication (CMC) effects</td>
<td>• Gain knowledge of the ethics of data collection and data dissemination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Understand the difference between security and privacy</td>
<td>• Learn presentation skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about cybersecurity as a field</td>
<td>• Become part of a community made up of STEM professionals, mentors, and/or program alumni; peers; parents; and community and cultural advisors</td>
</tr>
<tr>
<td></td>
<td><strong>Participants...</strong></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Develop self-regulatory learning skills</td>
<td>• Increase knowledge of their technosocial change agency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Develop technosocial change agency</td>
<td>• Increase knowledge of their self-regulatory learning for cybersecurity</td>
</tr>
</tbody>
</table>
Bowie State University (BSU) and Prince George’s Community College (PGCC)

SCOPE SUMMARY
This pathway initiative integrated and connected several student groups from Prince George’s County Public Schools (PGCPS) high schools, BSU, and PGCC. This group of students became a STEM student learning community. Learning community events (called STEM-ist sessions) occurred at BSU and PGCC, as well as virtually. The BSU and PGCC partnership further developed the STEM ecosystem in Prince George’s County through the development of a STEM professional learning community for educators. Like the STEM student learning community, the STEM professional learning community integrated and connected STEM teachers and faculty from PGCPS high schools, BSU, and PGCC. The final element of this partnership was the alignment of the computer sciences program between PGCPS, BSU, and PGCC. Aligning the curricula is intended to allow students from PGCPS to start computer science courses while in high school, then choose whether to continue their academic career at BSU or PGCC.

During Option Year Two, BSU and PGCC updated their scope of work to include greater collaboration and use DSEC partners’ strengths to provide programming for students. In lieu of hosting their own Education Hackathon, BSU and PGCC partnered with ASU CGEST to offer a CompuGirls summer session in Prince George’s County. The rationale for this change was threefold: the CompuGirls program could better meet the needs of students in Prince George’s County; it was an opportunity to build connections between BSU and PGCC and ASU CGEST; the programming provided networking opportunities between the communities of young women engaged in simultaneous programming in Arizona and Maryland.

DSEC FOOTPRINT

19 educators attended a professional development session on how to respond to students with empathy

15 students engaged in STEMist sessions

OPTION YEAR TWO FUNDING CATEGORY
Innovation Bloc: $125,000 - $500,000
RATIONALE FOR APPROACH

The creation of a STEM student learning community that includes students from PGCPS, BSU, and PGCC was a novel idea. Many of the participants in the STEM student learning community were underrepresented students as defined by DSEC. Research shows that learning communities offer a positive academic experience for the student participants (Bonilla, 2013; Rocconi, 2011; Virtue et al., 2019). Definitive characteristics of student learning communities are that they have (1) shared knowledge, (2) shared knowing, and (3) shared responsibility (Tinto, 2000). These learning communities are a high-impact practice, which is recognized as having positive effects on the student experience, especially for students from underserved communities (Goodlad, 2019). Zhao and Kuh (2004) show that learning communities are an effective educational practice both at the 2-year and 4-year level, while Winborne (2008) demonstrates the positive impacts of student learning communities at HBCUs. Due to COVID-19 restrictions during Option Year Two, most of the STEM student learning community programs were virtual. However, Goodlad (2019) demonstrates that a virtual learning community still offers the same positive impacts as traditional in-person learning communities.

Although professional learning communities are not new, the STEM professional learning community is innovative because it encompasses STEM educators from PGCPS, BSU, and PGCC. The purpose of the STEM professional learning community is to offer professional development for current STEM educators to prepare them to teach, mentor, and support current and future STEM students. Currently, the community exists virtually; however, Carpenter and Munshower (2020) show that integrating technology as a collaborative tool within a professional learning community enables educators to go beyond geographic boundaries to participate in professional development with educators who teach the same content area. Educators have a positive perception of virtual professional learning communities. Looking specifically at communities focused on STEM, Glaze-Crampes (2020) shows that leveraging these communities can impact retention and engagement in STEM and lead to larger scale reform across STEM education.

Overall, the literature supports the theory of action that student learning communities and professional learning communities are beneficial for all individuals involved. As the ideology behind the DSEC HBCU/MI Pathways Network is to engage, serve, and connect underrepresented students to STEM activities and support them as they prepare for STEM and/or DoD STEM careers, the expansion of the STEM student learning community and professional learning community fits this mission well.
<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEM Student Learning Community</strong></td>
<td></td>
<td></td>
<td><strong>Students</strong>...</td>
</tr>
<tr>
<td>Engage</td>
<td></td>
<td>Undergraduate students persist in pursuing a degree in STEM.</td>
<td>• Increase awareness of STEM careers</td>
</tr>
<tr>
<td>Serve</td>
<td></td>
<td>High school students...</td>
<td>• Increase awareness of STEM career pathways</td>
</tr>
<tr>
<td></td>
<td>• Enroll as STEM majors</td>
<td></td>
<td>• Gain knowledge of experiential learning</td>
</tr>
<tr>
<td></td>
<td>• Gain awareness of STEM careers</td>
<td></td>
<td>• Become part of the shared identity of the school community</td>
</tr>
<tr>
<td></td>
<td>• Gain awareness of pathways toward STEM careers</td>
<td></td>
<td>• Become part of the community made up of STEM professionals, mentors, and school alumni</td>
</tr>
<tr>
<td></td>
<td>• Experience experiential learning</td>
<td></td>
<td>• Understand the role of identity in individual success in STEM education and careers</td>
</tr>
<tr>
<td></td>
<td>• Gain the opportunity to network with peers and near-peers (e.g., undergraduate/graduate students)</td>
<td></td>
<td><strong>Bowie State University (BSU) and Prince George’s Community College (PGCC)...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increase retention of students in STEM degrees</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increase transfer rate of students from PGCC to Bowie State</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increase enrollment of Prince George’s Public Schools students in both PGCC and BSU</td>
</tr>
<tr>
<td><strong>STEM Professional Learning Community</strong></td>
<td></td>
<td></td>
<td><strong>Educators</strong>...</td>
</tr>
<tr>
<td>Engage</td>
<td></td>
<td>Students retain motivation in pursuing a STEM degree</td>
<td>• Develop an empathetic mindset and behavior toward students</td>
</tr>
<tr>
<td>Serve</td>
<td></td>
<td>Students and teachers...</td>
<td>• Gain knowledge of social-emotional learning</td>
</tr>
<tr>
<td></td>
<td>• Develop empathy (behaviors) toward students (e.g., time management)</td>
<td></td>
<td>• Become part of a professional learning community of grades 9-16 educators</td>
</tr>
<tr>
<td></td>
<td>• Gain social-emotional learning skills</td>
<td></td>
<td><strong>Educators</strong>...</td>
</tr>
<tr>
<td></td>
<td>• Gain a professional learning community of grades 9-16 educator peers</td>
<td></td>
<td>• Develop empathy (behaviors) toward students (e.g., time management)</td>
</tr>
</tbody>
</table>

**LOGIC MODEL**
## LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science Curricula Alignment</td>
<td>Engage</td>
<td>PGCC students...</td>
<td>Students...</td>
</tr>
<tr>
<td>Serve</td>
<td>• Gain conceptual understanding of programming languages</td>
<td>• Improve skills in computer science</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Experience an easier transition to BSU</td>
<td>• Earn certification via IBM in Cybersecurity, AI, or Cloud Computing at BSU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Persist in pursuing a degree in computer science major(s)</td>
<td>• Increase awareness of STEM careers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Get connected to career-related networks (e.g., computer science industries and professional associations)</td>
<td>• Increase awareness of STEM career pathways</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BSU and PGCC…</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase overall number of incoming students in computer science degree programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase retention of students in computer science degree programs</td>
<td></td>
</tr>
</tbody>
</table>
Center for Excellence in Education (CEE)

**SCOPE SUMMARY**

CEE was founded by Admiral H.G. Rickover in 1983 to nurture the development of gifted and talented students in the STEM disciplines. CEE facilitates the Research Science Institute (RSI) each summer for academically talented high school and college students to nurture careers of excellence and leadership in STEM. RSI is a 6-week residential program that brings high-caliber high school seniors and international counterparts to MIT to conduct mentored research.

During Option Year Two, RSI programming supported 92 high school students, of which 15 were considered DoD Scholars as DSEC funding supports their engagement in the program. For Option Year Two, CEE focused on building a partnership with DoDEA schools, specifically to recruit and place DoDEA students as DoD Scholars, in an intentional effort to increase the engagement of military-connected students. As a result of these efforts, the RSI 2022 cohort included a DoDEA student based in Germany.

Additionally, the DoD Summer Lab Research Intern Program paired college students with DoD laboratory internships for 10 students to nurture careers of excellence and leadership in STEM for academically talented students. The interns were undergraduate students from institutions such as Stanford University, MIT, and Harvard University. During Option Year Two, many interns expressed an interest in knowing more about the DoD research to determine if DoD was a fit for their future research career. The DoD internships provided opportunities for the interns as they engaged in real-world research and interacted with a DoD research mentor on a regular basis for support, guidance, and a firm foundation in the sciences related to their research interests. Interns were able to access and use research-level equipment and to see the potential of their own ideas come to fruition.

**OPTION YEAR TWO FUNDING CATEGORY**

Innovation Bloc: $125,000 - $500,000

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15
DoD-sponsored students participated in the RSI program (more than 1,700 student applicants)

10
students received internships in DoD laboratories
DSEC FOOTPRINT

Programming Includes a National Reach

RATIONALE FOR APPROACH

CEE, through the RSI program, nurtures high school and university scholars to pursue careers of excellence and leadership in STEM and encourages collaboration between and among scientific and technological leaders in the global community. During a time when employers, including the DoD, continue to identify a shortage of STEM personnel (Schulenberger & Olsonbaker, 2009), it is critical to provide students and educators with the opportunity to increase their STEM skill set.

The ongoing shortage of STEM professionals is attributed to a “leaky STEM pipeline.” This “leaky pipeline” entails the progressive loss of competent individuals, including underrepresented, gifted, and female students, throughout their career (Liu et al., 2019). To address the shortage of STEM workers, especially those from historically underrepresented groups, research indicates a need to address leaks in every stage of the STEM pipeline, including enrollment, retention, completion of educational opportunities, and subsequent employment in STEM occupations (Toven-Lindsey et al., 2017). CEE’s RSI program addresses the “leaky STEM pipeline” by engaging students in hands-on STEM research, which studies show improves motivation and attitudes toward STEM (Osborne et al., 2003).

CEE’s focus on partnering with MIT to place students in mentored research programs helps gifted students develop a clear vision of their “future academic selves” that includes an enriched understanding of their talents and skills and how to achieve their future goals (Gotlieb et al., 2016). Gifted high school students have opportunities to explore broader experiences that further develop academic excellence in STEM disciplines, thus preparing them for successful transitions to higher education (Wu et al., 2019).
<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Science Institute (RSI)</strong></td>
<td><strong>Engage</strong></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Connect</strong></td>
<td>• Understand scientific disciplines (working conditions, professional considerations)</td>
<td>• Increase knowledge of scientific disciplines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase knowledge of their STEM area of interest</td>
<td>• Improve skills, such as programming, report writing, and communication, that are essential to STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn more about the college application process and available scholarships</td>
<td>• Increase confidence in writing and oral presentation skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have increased confidence in writing skills, oral presentations, and laboratory protocols/techniques</td>
<td>• Increase awareness of STEM career pathways</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain greater awareness of career goals/available careers and what it means to be a researcher</td>
<td>• Become part of a community made up of STEM professionals, mentors, and program alumni</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain insight into specific STEM careers</td>
<td>• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Continue to participate as staff/mentors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are more aware of and have greater access to the larger STEM network that CEE represents</td>
<td></td>
</tr>
<tr>
<td><strong>RSI/CEE Internship Program</strong></td>
<td><strong>Engage</strong></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Connect</strong></td>
<td>• Understand scientific disciplines (working conditions, professional considerations)</td>
<td>• Increase knowledge of STEM disciplines within DoD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase knowledge of their STEM area of interest</td>
<td>• Increase confidence in writing and presentation of DoD scientific research at DoD and at scientific conferences</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have increased confidence in writing skills and oral presentations</td>
<td>• Improve communication skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve their laboratory skills, protocols, and techniques</td>
<td>• Improve laboratory skills, protocols, and techniques</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve their communication skills</td>
<td>• Improve report development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are more aware of and have greater access to the larger STEM network that CEE represents</td>
<td>• Gain real-world (work-based) experience in a STEM career</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Become part of a community made up of STEM professionals, mentors, and program alumni</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increase awareness of DoD STEM careers</td>
</tr>
</tbody>
</table>
Central State University (CSU) and Sinclair Community College (SCC)

SCOPE SUMMARY
CSU and SCC created a combined STEM Academy program that defined pathways and provided wraparound services for targeted students in middle and high schools to progress through high school graduation. Participating students then have an opportunity to enter SCC and graduate with an associate degree in a STEM-related field before continuing to CSU to graduate with a baccalaureate degree in one of 15 STEM fields. For Option Year Two, the initial pilot of this program involved schools in Dayton Public Schools and surrounding areas, as well as informal learning environments within the Dayton community. The program provided high school enrichment, a summer bridge program to SCC, a program of comprehensive services at SCC, and a summer bridge to CSU. This program was structured to allow the program to continue and expand in future years to include students graduating from CSU. There are also opportunities for students to exit the pathways directly to the workforce.

SCC also brought the TIES STEM-on-the-Go van to Ohio to support STEM enrichment activities and expanded their programmatic reach to students from the larger Dayton area through broadly distributed invitations for visits.

OPTION YEAR TWO FUNDING CATEGORY

_Innovation Bloc: $125,000 - $500,000_

19 students attended one of the summer bridge programs

22 students engaged in STEM enrichment activities during the school year
RATIONALE FOR APPROACH

While finding opportunities for STEM enrichment inside of classrooms remains important for students and educators, the current barriers that exist to get into the classroom, especially at the high school level, can be subverted by focusing attention on informal learning environments (out-of-school environments) such as community centers, YMCAs, Boys and Girls Clubs, and after-school clubs (Anthony & Morra, 2016; Penuel et al., 2016). A wealth of research exists on the positive effects of informal learning environments on student achievement (Holmes, 2011). This underscores the effort to provide STEM enrichment, awareness workshops, and activities in informal learning environments, which continue to benefit the STEM Academy program. It is estimated that, during the school year, 85% of a student’s time will be spent outside of a classroom (Gerber et al., 2001). This illustrates the importance of providing opportunities for learning that are outside of the traditional classroom environment. Informal learning environments provide these opportunities and have been an integral part of education for years (Martin, 2004). Continuing study of informal learning environments may provide insight into ways to attract a more diverse STEM workforce (Denson et al., 2015).

Adjusting the timeline to reach out to schools for enrichment programming in the late summer and early fall, instead of late winter, will simply allow for an earlier start to planning and more time to gain access to classrooms and network with appropriate organizations and individuals. With both institutions’ access to quality faculty and facilities, including a STEM Ambassador in the STEM Academy program, the revised timeline will allow further collaboration among CSU, SCC, and the Dayton community, as well as provide more meaningful opportunities to connect with local educators and school districts about the STEM Academy program and what both institutions have to offer students (Allen, Lewis-Warner, & Noam, 2020; Mendez, 2021).
## LOGIC MODEL - DAYTON HBCU/MI PATHWAYS NETWORK

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
</table>
| Central State University (CSU) and Sinclair College (SCC) STEM Academy | Connect Engage Serve | Undergraduate students...  
• Experience increased success in their respective program.  
• Remain motivated to pursue a STEM degree.  
• Complete STEM degree programs  
• Identify career opportunities within the STEM field  
• Mentors gain satisfaction from working with students  | Students...  
• Understand the role of identity in individual success in STEM education and careers  
• Increase confidence in making the transition from a 2-year to a 4-year program  
• Increase awareness of STEM careers  
• Increase awareness of STEM career pathways  |
| CSU-SCC STEM Academy | | Incoming and undergraduate students...  
• Are prepared to enter SCC/CSU and workforce.  
• Gain awareness of bachelor’s degree programs at CSU  
• Become more comfortable with their new learning environment  
• Complete pathway courses  | CSU and SCC...  
• Increase retention of students in STEM degree programs  
• Increase workforce readiness of students (transition from degree program to the workforce or simultaneously working and attending schools)  |
| CSU Residential Summer Bridge  
SCC Residential Summer Bridge  
SCC Weekday Summer Bridge | | Incoming students...  
• Are acclimated to college life  
• Gain an understanding of the skills required to be successful in college  
• Gain an understanding of the support services available on campus  
• Develop an increased capacity in math (e.g., skills) at the college level  
• Are introduced to the STEM workforce (professional and technical skills development – skills needed for the workforce)  
• Are prepared to transfer to CSU or enter the workforce  | Students...  
• Become a part of the shared identity of the school community  
• Gain an understanding of the skills required to be successful in college  
• Gain an understanding of workforce readiness skills  
• Increase knowledge of the role civic engagement plays in leadership roles  
• Improve math and/or English skills at the college level  
• Increase awareness of STEM careers  
• Increase awareness of STEM career pathways  |

**CSU and SCC increase the overall number of incoming students in STEM degree programs**
<table>
<thead>
<tr>
<th>CSU-SCC STEM Academy</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect</td>
<td>High school students...</td>
<td>• Gain an increased awareness (among students, parents, educators) of STEM education opportunities</td>
<td>Students...</td>
</tr>
<tr>
<td>Engage</td>
<td>• Gain an increased awareness of STEM careers</td>
<td>• Increase awareness of STEM careers</td>
<td></td>
</tr>
<tr>
<td>Serve</td>
<td>• Gain an increased awareness of available college STEM opportunities</td>
<td>• Increase awareness of STEM careers pathways</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Are motivated to complete their degree</td>
<td>• Understand the role of identity in individual success in STEM education and careers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transition from Sinclair to CSS</td>
<td>CSU and SCC...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Experience increased academic success</td>
<td>• Increase interest in STEM degree programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Associate STEM with fun and enjoyment</td>
<td>• Increase the number of incoming students in STEM degree programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Middle school students and their parents gain an increased awareness of STEM education and career opportunities</strong></td>
<td>• Increase interest of middle school students in completing STEM-focused coursework in high school</td>
<td></td>
</tr>
</tbody>
</table>
In Option Year Two, the Maker Fellows program deployed six AmeriCorps service members in DSEC communities in Maryland, North Carolina, Ohio, and Washington, DC. These Fellows built local capacity for STEM programming by connecting community colleges and Makers to middle and high school youth in their communities and positioning maker-centered learning as a key component of career and technical education in the 21st-century economy.

Citizen Schools continued the implementation of its Catalyst program in partnership with Dayton-area public schools and expanded the program to the San Diego area. Challenges included tremendous teacher turnover in Dayton, capacity restrictions that came from substituting for colleagues who were ill with COVID-19, limited educator ability and willingness to take part in professional development, and teacher stipend and compensation expectations in San Diego. Despite barriers, Citizen Schools was able to work with one school in Ohio and two schools in San Diego. The Catalyst program built the capacity of teachers to implement STEM project-based learning in their classrooms and created opportunities for students to work collaboratively with volunteer career mentors to complete standards-aligned STEM projects over a term of 10 weeks. Additionally, in partnership with the DRSC and Greater Cincinnati STEM Collaborative, Citizen Schools further catalyzed the expansion of maker-centered learning opportunities for underserved Dayton youth through the Makers + Mentors Network Community of Practice.

Based on lessons learned during the Option Year One partnership with DSEC, Citizen Schools shifted its programming focus to expand the Makers + Mentors Network to include HBCUs as host sites. In Option Year Two, the organization partnered with HBCUs, including the University of the District of Columbia (DC) and MSU. Citizen Schools placed a Maker Fellow at the CEMSE at MSU to align with the DSEC hub efforts and provide opportunities for the Fellow to collaborate with various partners in the DMV region who work with military-connected and underserved students.

**OPTION YEAR TWO FUNDING CATEGORY**

Innovation Bloc: $125,000 - $500,000
By supporting a robust local hub of STEM professionals, teachers, community programs, and schools in communities of focus—which are linked to and supported by a national STEM network—Citizen Schools and other local agencies brought more STEM education opportunities to several states.

STEM integration in secondary schools has been shown to decrease achievement gaps involving underrepresented student populations (Bicer et al., 2018; Wiswall et al., 2014). Students experience increased academic achievement, engagement in school, and interest in pursuing STEM careers when instructional content is taught through the lens of real-world problems (Dorph et al., 2018; Guzey et al., 2016; Newman et al., 2015).

Experiential learning (inclusive of maker-centered learning) is an application-based approach to education focused on individualizing learning experiences to address unique learner needs. This type of pedagogy deviates from more traditional, teacher-centric models and prioritizes active engagement with relevant content and skills over knowledge transfer. Experience-based pedagogy seeks to enhance student engagement by focusing on content which is relevant to student interests, experiences, and the skills that they will need to succeed in higher education and the modern workforce. Further, maker-centered learning focuses on experiences that provide students with the opportunity to explore their world through designing, hacking, building, prototyping, and experimenting (Kim et al., 2019; Oswald & Zhao, 2021).

01. Inspire

• Engage the community directly through both the Catalyst program and AmeriCorps Maker Fellows

02. Attract

• Ground classroom projects in the “real world” and provide support from mentors

03. Increase

• Focus on underserved and underrepresented populations, including Black, Indigenous, and students of color, as well as their schools, and districts

04. Advance

• Embrace the role of evaluation and collaboration with DSEC, including actively investing in a data-to-action framework
## LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEM Catalyst Program</strong></td>
<td>Engage</td>
<td>Students...</td>
<td>Students...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>- Learn science and engineering design</td>
<td>- Increase awareness of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Learn about STEM careers</td>
<td>- Learn engineering skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Gain confidence and build a growth mindset through hands-on projects</td>
<td>- Increase knowledge of STEM concepts</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Teachers...</strong></td>
<td>- Increase self-efficacy, growth mindset, and social awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Deepen practice in implementing experiential learning in their classrooms</td>
<td><strong>Teachers...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Become aware of how to use trained volunteers to support science instruction and student engagement</td>
<td>- Gain knowledge of SEL instructional strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Learn social emotional learning (SEL) instructional strategies</td>
<td>- Increase awareness of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Become aware of STEM career pathways</td>
<td>- Increase self-efficacy in using experiential learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Citizen Schools...</strong></td>
<td><strong>Citizen Schools...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Expands the Catalyst program into the San Diego Hub region</td>
<td></td>
</tr>
<tr>
<td><strong>Maker Fellows</strong></td>
<td>Engage</td>
<td><strong>Maker Fellows...</strong></td>
<td><strong>Maker Fellows...</strong></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>- Design, support, and lead maker-centered programming at host sites.</td>
<td>- Increase self-efficacy in hands-on science and engineering instruction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Bridge connections between K-12 schools and higher education, focusing on redesigning career and technical education (CTE) curriculum, internships/apprenticeships, and industry mentoring/career connections.</td>
<td>- Gain real-world (work-based) experience in a STEM career (teaching)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Students have increased exposure to innovation and industry mentors</strong></td>
<td><strong>Students increase awareness of STEM careers</strong></td>
</tr>
<tr>
<td><strong>STEM Ecosystem/Community of Practice</strong></td>
<td>Engage</td>
<td>Students...</td>
<td>Students...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>- Gain confidence in creating and presenting projects</td>
<td>- Become part of a community of STEM professionals, mentors, and program alumni</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Gain confidence in working with a team</td>
<td>- Increase knowledge of career pathways in science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Make connections with community-level stakeholders</td>
<td>- Increase confidence in teamwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Increase their understanding of career pathways in science</td>
<td>- Increase confidence in creating and presenting projects</td>
</tr>
</tbody>
</table>
SCOPE SUMMARY

CYBER.ORG implemented a K-12 STEM/cyber-based education program to address both the challenges in providing military-connected children with a consistent STEM education as they migrate between school systems and the social and emotional changes that occur as they move. CYBER.ORG developed programmatic alignment among a limited set of on-base youth centers and the associated school districts that support their military-connected children. The collaboration between these on-base youth centers and schools is built on CYBER.ORG’s curriculum implementation and teacher training model that has been previously used across multiple states, school districts, and geographic communities.

For the first time, during Option Year Two, CYBER.ORG strategically implemented its educator training model to help teachers create educational pathways around STEM, cyber, and computer science that lead to future employment with the DoD. CYBER.ORG provided hands-on, professional development for educators to introduce curricular resources in coding, cybersecurity, engineering, virtual challenges, and resources for starting or enhancing a K-12 robotics program. CYBER.ORG also provided technical assistance and strategic support to teachers on best practices for implementing the curriculum within their classrooms and after-school programs. Lastly, CYBER.ORG launched virtual, interactive, cybersecurity content designed to engage students with standards-based, foundational cybersecurity skills and awareness.

OPTION YEAR TWO FUNDING CATEGORY

Innovation Bloc: $125,000 - $500,000
RATIONAL FOR APPROACH

Research has shown that extracurricular programming, including competitions, plays a pivotal role in helping students develop STEM career interest (Miller et al., 2017; Ozis et al., 2018). CYBER.ORG’s internal and external evaluation initiatives have supported this finding with specific regard for cybersecurity careers. A 2020 evaluation, for example, found that cyber-related extracurricular involvement was a strong predictor of cyber career aspirations (Dean, 2020).
# Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement cyber education curriculum</td>
<td>Engage</td>
<td>Provide professional development on cybersecurity curriculum:</td>
<td>Educators...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>- Educators learn how to integrate cybersecurity with other content.</td>
<td>• Increase ability to integrate cybersecurity and computer science with other content areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Educators learn how to integrate computer programming with other content.</td>
<td>• Increase confidence in implementing cybersecurity and computer science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Educators understand how cybersecurity applies to the subject matter that they teach.</td>
<td>• Increase awareness of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Educators feel more confident in introducing cyber education and/or computer science in their diverse learning environment.</td>
<td>Youth Center Administrators:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Educators have an increased awareness of cybersecurity careers.</td>
<td>• Expand the cyber education curriculum and teacher professional development from two bases to four</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Educators are equipped to provide remote learning using cybersecurity curriculum.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engage</td>
<td>Implement cyber education:</td>
<td>Students...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>- Students see the relevance of cybersecurity at an age-appropriate level</td>
<td>• Increase knowledge of cybersecurity and computer science programming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Students will know how to protect their devices at an age-appropriate level.</td>
<td>• Increase cybersecurity and computer science skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Students acquire 21st-century skills and soft skills related to cybersecurity.</td>
<td>• Increase knowledge of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Students have increased interest in cybersecurity-related coursework.</td>
<td>• Improve attitude toward cybersecurity and computer science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Students have increased interest in cybersecurity careers.</td>
<td>Students...</td>
</tr>
<tr>
<td>Conduct cyber competitions between schools/bases</td>
<td>Engage</td>
<td>• Students acquire 21st-century skills and soft skills related to cybersecurity.</td>
<td>• Increase ability to solve problems and work as team members</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Students have increased interest in cybersecurity-related coursework.</td>
<td>• Improve attitude toward cybersecurity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Students have increased interest in cybersecurity careers.</td>
<td></td>
</tr>
</tbody>
</table>
For Inspiration and Recognition of Science and Technology (FIRST)

SCOPE SUMMARY

FIRST leveraged DoD support to sponsor program registration, fees, and approved products and materials for 1,486 rookie, veteran, and championship competition teams in mentor-based research and robotics programs. FIRST programs included are FIRST LEGO League Discover (Class Pack only), FIRST LEGO League Explore, FIRST Lego League Challenge, FIRST Tech Challenge, and FIRST Robotics Competition. FIRST continued the Class Pack Grant program, targeting outreach to DoD sites. Class Pack implementation options provided educators with STEM learning experiences for PK-12 students for use in classrooms or for after-school programming to encourage connections to core curricular content in school and to increase participation of underserved communities during traditional school hours.

After receiving positive feedback from DoD coaches and mentors during Option Year One, FIRST worked closely with DoD STEM to further expand access to FIRST LEGO League Explore via Class Pack grants in Option Year Two. However, with more students returning to in-person learning during Option Year Two, fewer returning coaches and mentors expressed interest in Class Packs in the other programs for which Class Packs are available (FIRST LEGO League Explore, FIRST LEGO League Challenge, and FIRST Tech Challenge); therefore, Class Pack grants for those programs were not offered in Option Year Two.

In Option Year Two, FIRST returned to an in-person championship event in April 2022. As a result of this change, DoD STEM provided additional support in the form of registration grants to DoD STEM-sponsored FIRST teams that qualified for the Championship.

The FIRST Championship, which took place in Houston, Texas, was the culmination of the FIRST 2021-22 season’s programs. Forty-seven of the 454 championship qualifying teams were sponsored by DoD STEM, representing nineteen states. DSEC members, including representatives from Elements 1, 3, and 4, attended the FIRST Championship in support of DoD STEM-sponsored teams and, through a DoD STEM booth at the Innovation Faire, engaged with students, educators, coaches, mentors, volunteers, and parents to raise awareness of DoD STEM opportunities. Additionally, the DoD STEM Director announced the winners of various awards throughout the four-day event. FIRST also worked closely with DSEC partner organization TIES to bring their STEM-on-the-Go

16,648
students were served through DoD STEM investments

631
DoD-affiliated mentors supported robotics teams, volunteering an estimated 178,863 hours

OPTION YEAR TWO FUNDING CATEGORY

CMC (Partner Organization): >$1,500,000
van to the FIRST Championship. FIRST participants engaged in hands-on STEM activities on site, leveraging the opportunity to get TIES in front of the members of the FIRST community during the largest in-person event of the year.

RATIONALE FOR APPROACH

The goal of FIRST is to increase the STEM interest, knowledge, and skills of participating youth to increase the likelihood that they will pursue postsecondary education and training in STEM. A secondary goal of FIRST is to increase the holistic skills of participating youth (e.g., creativity, social, emotional, and cognitive skills). The FIRST theory of change suggests that providing engaging, relevant, and hands-on learning in STEM; teamwork and cooperative learning focused on a challenge; relevant and real-world challenges; career exposure; opportunities to build relationships with caring adults and mentors; and a culminating celebration to share outcomes and learnings will result in an increase in STEM awareness, interest, skills, and knowledge that will lead to awareness of and interest in STEM careers. At the same time, as youth participate in the program, they engage in problem-solving and team activities, improve communication, and develop social emotional skills, including building their confidence and a sense of belonging. FIRST believes that the combination of exposure to meaningful STEM experiences and teamwork opportunities will inspire students to consider postsecondary STEM education and training and gain work-life skills that will prepare them for their careers.

Each FIRST program provides opportunities for students to develop skills including teamwork, problem-solving, conflict resolution, persistence, time management, presentation skills, leadership, and self-confidence to prepare them to work in a STEM career (Center for Youth and Communities, 2011, 2013). By providing hands-on experiences during which students can apply concepts they have learned in their math and science classes, FIRST complements the learning that occurs in other classes and fills in the gaps of STEM education.

FIRST has developed several strategies to ensure that students have experiences that result in outcomes such as increased awareness of STEM, STEM interest,
knowledge, increased engagement in school, interest in STEM careers and gains in holistic skills. Programs incorporate best-practice strategies for engaging youth and cultivating interest in STEM such as the following:

- Relevant and real challenges (Jolly, 2017)
- Opportunities for hands-on experiences
  - In all programs, participants who engage in robot building and design learn how to develop strategy, test theories and approaches, troubleshoot, apply math and science concepts, and learn the engineering design process (Center for Youth and Communities, 2011). The majority of participants become inspired to learn more about robotics, science, and technology and to consider careers in STEM (Center for Youth and Communities, 2011; 2013).
- Engagement in STEM challenges through teamwork and group learning
  - Mentors and students indicate positive increases in areas of teamwork, solving disagreements, managing time, communication, and problem-solving (Center for Youth and Communities, 2011, 2013).
- Connections with experienced mentors
  - Preliminary results of a longitudinal study of FIRST demonstrate that mentors are critical in helping students prepare for college and careers in STEM (Center for Youth and Communities, 2015).
- Infusion of FIRST's unique set of values
  - A distinguishing factor that sets FIRST apart from other STEM programs is the organization's strong belief in the values of Gracious Professionalism® (demonstrating respect for others, being a good sport, and sharing what they learn) and Coopertition® (competing like crazy but also helping the other teams).
- Program culmination in high-energy tournaments (Kulturel-Konak, 2021)

Overall, recent formal evaluations of FIRST conducted by the Center for Youth and Communities at Brandeis University have found that, through participation in FIRST, youth are more likely to attend college full time, major in science or engineering, and pursue a STEM career than a national sample of students (Melchior et al., 2005). Youth participants in several FIRST programs noted that, as a result of participating in FIRST, they were more interested in learning about science and technology, more interested in going to college, and more interested in a career that uses science and technology (Center for Youth and Communities, 2011, 2013). The most recent study of FIRST alumni (completed in 2021) followed participants for seven years after their completion of a FIRST after-school program. This study found that “FIRST college students reported significantly higher rates of STEM interests, attitudes, and college level behaviors than comparison students” (Meschede et al., 2022).
## Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All FIRST programs</strong></td>
<td></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td><strong>FIRST LEGO League</strong> Grades PK-8</td>
<td><strong>Engage</strong></td>
<td>• Gain awareness of what coding is used for and what is needed to code</td>
<td>• Increase their knowledge in STEM</td>
</tr>
<tr>
<td><strong>FIRST Tech Challenge</strong> Grades 7-12</td>
<td><strong>Serve</strong></td>
<td>• Know more about engineering, technology, and computer science as a profession</td>
<td>• Increase their awareness of STEM careers</td>
</tr>
<tr>
<td><strong>FIRST Robotics Competition</strong> Grades 9-12</td>
<td><strong>Connect</strong></td>
<td>• Learn about and use an engineering design principles approach to problem-solving by understanding the scope of the problem, identifying an approach, and then working within parameters and constraints to find a viable solution</td>
<td>• Improve their critical thinking and problem-solving skills</td>
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<td></td>
<td></td>
<td>• Develop and apply creative problem-solving skills to solve a problem</td>
<td>• Improve their leadership skills</td>
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<td></td>
<td></td>
<td>• Enjoy engineering and feel capable as engineers</td>
<td>• Increase their computer science (coding and programming) skills</td>
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<tr>
<td></td>
<td></td>
<td>• Persevere in problem-solving to complete their projects</td>
<td>• Increase their skills and abilities in engineering</td>
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<td></td>
<td></td>
<td>• Have an emerging interest in STEM and see themselves as pursuing a STEM career</td>
<td>• Increase their teamwork skills (collaboration, communication, and innovation)</td>
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<td></td>
<td>• See the value in supporting others in STEM work</td>
<td>• Develop/change their attitudes toward STEM</td>
</tr>
<tr>
<td><strong>FIRST Tech Challenge</strong></td>
<td></td>
<td><strong>Students...</strong></td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td><strong>FIRST Robotics Competition</strong></td>
<td><strong>Engage</strong></td>
<td>• Learn to program their model/robot to perform a desired function</td>
<td>• Increase their knowledge of engineering principles</td>
</tr>
<tr>
<td></td>
<td><strong>Connect</strong></td>
<td>• Gain an understanding of engineering principles and how they are applied, particularly in mechanical and electrical engineering</td>
<td>• Gain knowledge of STEM career pathways</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Have an increased ability to complete basic engineering tasks</td>
<td>• Become part of a community made up of STEM professionals, mentors, and program alumni</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Network with other FIRST participants, mentors, and/or coaches during the season’s design process and at the events</td>
<td><strong>FIRST</strong> will increase in the overall number of volunteers.</td>
</tr>
</tbody>
</table>
Learning Undefeated

SCOPE SUMMARY

Learning Undefeated established the Emerging Leaders in Biotechnology program to foster long-term mentor relationships between high school and college students, specifically Black, Latino, and/or American Indian or Alaska Native females. The program aims to build and reinforce participant STEM identity, develop student interest in joining the STEM workforce, and support underrepresented groups in STEM careers. The program provides meaningful educational experiences to participants to facilitate authentic laboratory investigation, develop career readiness skills, and connect students with DoD STEM professionals.

Using information from Option Year One, in Option Year Two, organizers prioritized student recruitment to reach more military-connected students, recruited additional speakers from DoD biotechnology roles, and held a DoD laboratory tour.

OPTION YEAR TWO FUNDING CATEGORY

Innovation Bloc: $125,000 - $500,000

64 students engaged in the virtual Emerging Leaders in Biotechnology program

100% of participants were female
DSEC FOOTPRINT

MARYLAND

RATIONALE FOR APPROACH

The Emerging Leaders in Biotechnology program is based on the hypothesis that student engagement in authentic learning experiences, combined with access to STEM professionals, will further student persistence and interest in the field of biotechnology and STEM in general. The program is designed to provide students with the science capital that helps students succeed in STEM. The Emerging Leaders program aims to increase student science capital by addressing the four basic aspects of science capital: knowledge, attitude, experiences, and social contacts and networks. The idea of science capital was developed by Dr. Louis Archer as a theoretical framework to understand student success and self-identity in the science fields. Science capital can be seen as the sum of science knowledge, engagement, attitude, and resources an individual has in their life. It includes not only what a person knows but also who they know and if they feel they belong. Studies have shown that science capital is a much better indicator of student pursuit of science as a career as compared to interest (Archer et al., 2013, 2016) as students with low science capital tend to have lower science career aspirations (Archer et al., 2013).

ALIGNMENT TO DOD STEM STRATEGIC PLAN

01. Inspire

• Foster long-term mentor relationships between high school and college students

02. Attract

• Recruit additional speakers from DoD biotechnology roles and hold a DoD laboratory tour

03. Increase

• 100% of participants in the Emerging Leaders in Biotechnology program are female

04. Advance

• Reflect on student recruitment strategies through the use of data
<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerging Leaders in Biotechnology Program</td>
<td>Engage</td>
<td>Students will...</td>
<td>Students (including mentors) will...</td>
</tr>
<tr>
<td>Job shadowing</td>
<td>Serve</td>
<td>• Report an increase in knowledge about STEM for corresponding items in survey</td>
<td>• Learn biotechnology lab techniques</td>
</tr>
<tr>
<td>Industry exposure</td>
<td></td>
<td>• Increase their confidence in a STEM topic</td>
<td>• Increase self-efficacy in biotechnology and STEM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain comfort with skills related to a STEM career</td>
<td>• Increase confidence in pursuing coursework or careers in biotechnology and STEM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Be trained in biotechnology techniques</td>
<td>• Increase awareness of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Want to become mentors</td>
<td>• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn of DoD biotechnology-related careers and programs and pathways to a STEM profession</td>
<td>• Increase awareness of STEM career pathways and on-ramps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain an understanding that there are many different careers in STEM and within the DoD</td>
<td>• Become part of a community made up of STEM professionals, mentors, and program alumni</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn firsthand from volunteers about their professional work at DoD in STEM and biotechnology, specifically</td>
<td>• Develop ability to self-advocate and navigate support systems in the biotechnology field</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Become aware of alternative pathways to a STEM career that are not part of a traditional 4-year degree path</td>
<td>• Gain career and workforce readiness in the biotech field</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gain real-world/work-based experience in a STEM career</td>
</tr>
</tbody>
</table>
MATHCOUNTS

SCOPE SUMMARY
MATHCOUNTS provides middle school students the opportunity to engage and grow in mathematics through the National Math Club, Math Video Challenge, and MATHCOUNTS Competition Series. In Option Year Two, MATHCOUNTS provided math programming for students in grades 6-8, providing extra support and conducting outreach to new coaches and teachers working in low-income schools. This focus included sponsoring MATHCOUNTS programming in DoDEA schools and the Math Video Challenge national program. In addition, MATHCOUNTS engaged with its program alumni in high school and college to provide support and resources and to share information about STEM career opportunities. DSEC funding also supported at least 125 OPLET (an online problem database) subscriptions for new coaches and coaches at Title I schools, four scholarships for the Math Video Challenge award winners, and one alumni scholarship.

OPTION YEAR TWO FUNDING CATEGORY
STEM Education and Outreach Partner: $300,000 - $500,000

RATIONALE FOR APPROACH
Students participating in MATHCOUNTS programming increase their interest and confidence in mathematics. Through individual and team activities, students strengthen their math skills and learn collaboration and communication skills. Teachers who work with MATHCOUNTS gain valuable resources for their classrooms, particularly those who teach students from low-income communities.

MATHCOUNTS student participants reported that engagement in the program supported their mastery of math and STEM concepts, and 82% of student participants planned to take more math courses than required in high school. Additionally, more years of experience in MATHCOUNTS lead to an increased probability of taking more math classes (Reid et al., 2017). When asked about their career interests, student participants were most likely to report that they were interested in becoming an engineer, and 80% of all students reported an interest in pursuing a STEM-related career (Reid et al., 2017). MATHCOUNTS also has a positive impact on teacher coaches, as 88% reported that the program improved their ability to teach mathematics (Reid et al., 2017).

Strengthening math in middle school—the focus of MATHCOUNTS programs—is of particular importance because middle school is when students forge their
“math identities,” which both support and are supported by a student’s mathematical learning (National Council of Teachers of Mathematics [NCTM], 2020). Middle school students benefit from authentic, student-driven learning experiences that enable them to engage with math in ways that are interesting and relevant to their lives (NCTM, 2020). Among MATHCOUNTS student participants, 84% reported that their excitement for math and STEM grew after participating (Reid et al., 2017).

When students believe their skills and intelligence can be developed, they are more likely to embrace challenges and see failures as temporary and helpful, rather than self-defining and discouraging (Dweck, 2016). MATHCOUNTS is unique among math competitions for its emphasis on preparation, productive struggle, and team practices, a difference that makes competition both extrinsically and intrinsically motivating (Ozturk & Debelak, 2008). Among MATHCOUNTS student participants, 93% reported having a positive perception of their math and STEM abilities, and 87% reported that their confidence in math and STEM grew after participating in the program (Reid et al., 2017). Data from teacher coaches supported this finding, with 97% reporting that after participating, their MATHCOUNTS students could more successfully tackle and solve problems they had never seen before (Reid et al., 2017).
## LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Math Club</td>
<td>Engage</td>
<td>Students...</td>
<td></td>
</tr>
<tr>
<td>National Math Competition</td>
<td></td>
<td>• Learn how to approach non-routine problems with confidence</td>
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<td></td>
<td></td>
<td>• Develop increased interest in “doing math,” demonstrated by consistent attendance at MATHCOUNTS practices and events</td>
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<td></td>
<td></td>
<td>• See themselves as “math people“ and enjoy doing math</td>
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<tr>
<td></td>
<td>Teachers receive high-quality materials to use in their classrooms.</td>
<td>Students...</td>
<td></td>
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<tr>
<td>Math Video Challenge</td>
<td>Engage</td>
<td>Students...</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Develop increased interest in “doing math,” demonstrated by consistent effort to complete video project and participation in video team meetings</td>
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<tr>
<td></td>
<td></td>
<td>• See themselves as “math people“ and enjoy doing math</td>
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<tr>
<td></td>
<td>Students...</td>
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</tr>
<tr>
<td></td>
<td>• Improve teamwork and collaboration skills</td>
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<td></td>
<td>• Improve problem-solving and critical thinking skills</td>
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<tr>
<td></td>
<td>• Increase confidence and interest in doing math</td>
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<td></td>
<td>• Increase motivation to take math classes beyond the minimum high school requirements</td>
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<tr>
<td></td>
<td>• Have increased positive attitudes toward math</td>
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National Center for Women & Information Technology (NCWIT)

SCOPE SUMMARY

During Option Year Two, NCWIT expanded programming to include hosting Counselors for Computing (C4C) workshops in target regions; programming reached over 300 counselors. The attendees learned strategies and received resources that help them give all students access to transformative computing careers. Additionally, 15 counselor champions (among others) participated in a C4C Leadership Institute, which equipped them with the resources and tools they need to support other counselors in their communities with engaging students around the benefits of computing as a career.

The AspireIT program piloted a new toolkit in Option Year Two. Through surveys, NCWIT learned that after attending C4C workshops, counselors wanted ways to further engage their students but were not sure how to proceed. NCWIT created the AspireIT toolkit to provide them with an inclusive way to introduce and engage their students in computing experiences. The toolkit also leveraged the growing C4C community. Additionally, NCWIT celebrated 50 women through the AspireIT Impact Award, honoring their dedication to diversifying the computing industry and helping to introduce computing to underrepresented students. The AspireIT Impact Award was the result of survey data indicating the local Aspirations in Computing (AiC) communities wanted to be recognized for the invaluable work they do to introduce computing to underrepresented students.

NCWIT also hosted virtual webinars for counselors, educators, and others in advising roles in collaboration with other DSEC partners, which highlighted DoD professionals and career opportunities.

RATIONALE FOR APPROACH

NCWIT’s C4C is the only nationally recognized program that helps school counselors learn about computing careers in ways that enable them to explicitly guide and encourage girls and other students from historically underrepresented groups to pursue computing. School counselors are an important source of career information for students in K-12 settings and are well-positioned to have a positive impact on students’ STEM engagement and success (Studer, 2015). For girls and underrepresented racial minorities, the role of school counselors is especially critical. To provide equitable school counseling services, professional school counselors must be knowledgeable and aware of the factors perpetuating the opportunity gaps in STEM for girls and underrepresented minorities (Cabell et al., 2021).

313 counselors and educators engaged in the C4C program

36 counselors and educators participated in the C4C Leadership Development Institute

OPTION YEAR TWO FUNDING CATEGORY

STEM Education and Outreach Partner: $300,000 - $500,000
NCWIT’s three-pronged approach to instigating individual and organizational change includes convening, equipping, and uniting program participants. This three-pronged approach is intended to increase the knowledge, awareness, and skills of counselors so that their advising practices change, their confidence in addressing sustainable careers in computer science increases, and their perceptions/biases about who is right for computer science change. Finally, the ultimate impact is that counselors/educators are empowered to develop more pathways for historically underrepresented students to explore computer science learning opportunities, educational pathways, and careers in computing. In focus groups held by NCWIT’s evaluation team in 2020-21, participants indicated that C4C has provided them with strategies to encourage historically underrepresented students to explore computer science education and career opportunities. In particular, the evaluation team found that C4C has empowered counselors/educators to:

- encourage students to pursue computing, for example, “I really encouraged [girls] to look at going into a computer science field... [as they] don’t necessarily think about computer science as a career;”
- disrupt stereotypes that “you have to be smart or a certain ethnicity or gender” to pursue computer science;
- share resources with students, especially ones that showcase women and minorities in computer science, so “girls and minorities... could see themselves on the posters in the hallways and in my room to make them a little less intimidated;”
- discuss with parents and school colleagues, for example, “I asked all of our female math and science teachers to [encourage] females in their classes that they thought would be interested in computer science;” and
- change school systems and structures to allow all students to take computer science, for example, “I took out any of the honors requirements,” “[changed] language in our course description book to be more inclusive.”
In addition, Google (2014) and Sharma et al. (2021) identified four factors that greatly influenced a girl’s perception and interest in computer science: social encouragement, self-perception, academic exposure, and career perception. Each of these factors interweave with the role of the school counselor and the mindsets and behaviors present in a full comprehensive school counseling program. With the professional learning and resources C4C provides, and the school counselor’s unique position in the K-12 ecosystem, they are able to greatly influence each of these four factors, thereby increasing the interest of CS in historically underrepresented student groups.

### LOGIC MODEL – ASPIREIT

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pilot program with AspireIT toolkit</strong></td>
<td>Engage</td>
<td>Participants...&lt;br&gt;- Become more comfortable and confident in computational thinking work&lt;br&gt;- Better understand the possible pathways for women into computing careers&lt;br&gt;- Express interest in considering a career in computing&lt;br&gt;Facilitators...&lt;br&gt;- Become more comfortable and confident in creating computing experiences in their community&lt;br&gt;- Learn how to use various tools and resources to broaden participation in computing&lt;br&gt;- Learn how to engage various groups through activities in their community&lt;br&gt;- Understand the various elements that go into creating computing experiences from planning, to facilitation, to reflection&lt;br&gt;- Become equipped to advocate for computing activities and programs within their district</td>
<td>Participants...&lt;br&gt;- Increase confidence in pursuing computational coursework&lt;br&gt;- Develop a positive attitude toward pursuing a computing career&lt;br&gt;Facilitators...&lt;br&gt;- Increase confidence in planning and implementing computing programs or computing learning experiences&lt;br&gt;- Increase knowledge of computing resources and opportunities</td>
</tr>
<tr>
<td><strong>DoD opportunity webinar for women STEM professionals</strong></td>
<td>Engage</td>
<td>Participants (high school, college, workforce women) learn about career opportunities in computational science with DoD.</td>
<td>Participants...&lt;br&gt;- Increase awareness of DoD STEM careers&lt;br&gt;- Increase awareness of STEM career pathways (DoD specific)</td>
</tr>
</tbody>
</table>
# Logic Model – Counselors for Computing (C4C)

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C4C workshops</strong></td>
<td>Engage</td>
<td>Educators/Counselors...&lt;br&gt;- Increase their understanding of computer science opportunities, resources, gender issues, and where change needs to begin&lt;br&gt;- Know how to integrate computer science career paths with routine counseling (counselors)&lt;br&gt;- Learn how to use tools for counseling&lt;br&gt;- Learn of career pathways and scholarships for those engaged in computer science&lt;br&gt;- Learn of DoD STEM careers&lt;br&gt;- Learn how to engage a community of CS advocates (allies among school personnel, others)&lt;br&gt;- Change attitude toward advising students underrepresented in STEM in relation to computer science</td>
<td>Educators/Counselors...&lt;br&gt;- Increase knowledge of computer science resources and opportunities&lt;br&gt;- Increase ability to recognize and talk about equity and access issues in computer science&lt;br&gt;- Increase ability to use STEM counseling tools&lt;br&gt;- Increase ability to advocate for student work in computing, particularly for students underrepresented in STEM&lt;br&gt;- Increase awareness of DoD STEM careers&lt;br&gt;- Increase awareness of STEM career pathways, including STEM scholarships and awards</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>C4C Leadership Development Institute</td>
<td>Educators and counselors engage in the immediate changes seen in C4C workshops, with the addition of…&lt;br&gt;- Equip those in advising roles to become part of a community of STEM professionals advocating for computer science at the state level</td>
</tr>
<tr>
<td>C4C Leadership Development Institute</td>
<td>Engage</td>
<td>Educators, parents, and students...&lt;br&gt;- Learn of professions stemming from a computer science degree/background, especially those within DoD&lt;br&gt;- Learn of educational pipelines to computer science careers&lt;br&gt;- Learn of computer science opportunities, resources, gender issues, and where change needs to begin&lt;br&gt;- Change attitude toward advising students underrepresented in STEM in relation to computer science</td>
<td>Educators, parents, and students...&lt;br&gt;- Gain knowledge of computer science resources&lt;br&gt;- Gain knowledge of equity and access issues in computer science&lt;br&gt;- Increase awareness of STEM careers, focusing on computational science&lt;br&gt;- Increase awareness of DoD STEM careers&lt;br&gt;- Increase awareness of STEM career pathways</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>C4C virtual webinars</td>
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</table>
National Inventors Hall of Fame (NIHF)

SCOPE SUMMARY
NIHF’s nationally accredited, standards-aligned STEM summer program, Camp Invention, engaged 1,061 students during Option Year Two. Camp Invention participants created, collaborated, and gained confidence by engaging in entrepreneurship-based activities involving building prototypes and solving real-world problems. For example, students designed and built their own miniature skate parks, as well as personalized skateboards and riders. In the design process, they incorporated key principles from physics, design engineering, and art. Camp Invention experiences develop an innovation mindset, including nine key skills and traits (collaboration, confidence, creative problem-solving, design thinking, entrepreneurship, innovation, intellectual property, persistence, and STEM).

OPTION YEAR TWO FUNDING CATEGORY
*Innovation Bloc:* $125,000 - $500,000

RATIONALE FOR APPROACH
Two decades ago, Camp Invention began formally measuring its impact. During this time, multiple independent evaluations have confirmed both the short- and long-term benefits of the program. NIHF has completed evaluations of impact that meet Every Student Succeeds Act’s Tier 3 Level of Evidence (Promising Evidence) (Falk & Meyer, 2018; Garner et al., 2021; Garner & Kuhn, 2022; Summit Education Initiative, 2018, 2019). This level indicates a study has met several key criteria related to quality but does not include the recommended sample size or match requirements for analysis.

Collectively, these evaluations have reported short- and long-term improvements in creativity, STEM interest, and problem-solving skills; improved in-school attendance; and increased median grade point averages (GPAs) and average and median scores on standardized assessments (Bell et al., 2017; Changemaker Consulting, 2014; Institute for Learning Innovation, 2018; Ortega & Shama-Davis, 2007; Saxon et al., 2003; Scarisbrick-Hauser and Hauser, 2010).

Research tells us that, when children are exposed to innovation early in life, they are more likely to become innovative adults (NIHF, 2022). The education staff at NIHF works closely with inductees, a diverse array of the world’s greatest inventors, to develop new curriculum. While NIHF’s program offers different activities and challenges each summer, the commitment to offering tailored content for grades K-6 remains the same.
NIHF’s Camp Invention Connect program removes geographic barriers for military-connected students as it is designed for those who are on the go, working from home, or far from a local camp, and for students who thrive in at-home, self-paced settings.

**01. Inspire**

- Spark imagination through open-ended engagement in creative problem-solving at Camp Invention

**02. Attract**

- Empower participants by providing real-world challenges and hands-on activities that show children a career in STEM is an attainable and exciting possibility

**03. Increase**

- Serve underrepresented students at Camp Invention

**04. Advance**

- Conduct independent evaluations indicating significant short-term and long-term improvements in creativity, STEM interest, collaboration, and problem-solving skills

[https://www.invent.org/blog/behind-nihf-scenes/art-science-camp-invention](https://www.invent.org/blog/behind-nihf-scenes/art-science-camp-invention)
## LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camp Invention</td>
<td>Engage</td>
<td>Students in grades K-6...</td>
<td>Students...</td>
</tr>
<tr>
<td>Serve</td>
<td>Serve</td>
<td>• Have hands-on experiences with science</td>
<td>• Gain knowledge of science topics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about aquatic robots, space, chain reactions, physics, art, intellectual property, and invention</td>
<td>• Learn engineering design skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about STEM careers</td>
<td>• Develop critical thinking, collaboration, and creativity skills</td>
</tr>
<tr>
<td></td>
<td>Educators...</td>
<td></td>
<td>• Increase confidence in understanding STEM subjects</td>
</tr>
<tr>
<td></td>
<td>• Gain more in-depth understanding of science topics</td>
<td>• Develop a positive attitude toward STEM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Receive training on cutting-edge, inquiry-based learning</td>
<td>• Gain knowledge of social-emotional intelligence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Learn about STEM careers</td>
<td>• Increase awareness of STEM careers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Educators...</td>
<td></td>
<td>Educators...</td>
</tr>
<tr>
<td></td>
<td>• Increase knowledge of science topics</td>
<td>• Increase knowledge of science topics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Learn how to facilitate inquiry-based learning experiences</td>
<td>• Learn how to facilitate inquiry-based learning experiences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Increase confidence in giving students open-ended challenges</td>
<td>• Increase confidence in giving students open-ended challenges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Increase awareness of STEM careers</td>
<td>• Increase awareness of STEM careers</td>
<td></td>
</tr>
</tbody>
</table>
National Math and Science Initiative (NMSI)

SCOPE SUMMARY

NMSI focuses on providing military-connected students with access to rigorous and challenging Advanced Placement (AP) STEM education opportunities across the United States. Through NMSI’s two core programs, the College Readiness Program (CRP) and Laying the Foundation (LTF) Summer Academy, military-connected schools receive a host of teacher professional development opportunities, student support, and school supports. Specifically, NMSI’s CRP for Military Families provides military-connected students from coast to coast with well-trained teachers, challenging AP coursework, and a strong foundation in STEM subjects that prepares students for the rigors of college and careers, whether military or civilian.

In Option Year Two, NMSI provided its multiyear CRP and LTF program to about 30 additional schools that met the DoD threshold requirements for serving military-connected students, which included having sponsors serving on Active Duty and in the National Guard and Reserves. Teacher professional development opportunities provided training for approximately 594 AP teachers. NMSI also launched a DoD Virtual Safety Net pilot program focused on supporting military-connected students who do not have access to AP STEM courses either through their local schools or based on home schooling. The pilot program includes a broad selection of online AP courses, coaching, and data collection. NMSI offered online and on-demand teacher training and student study sessions.

OPTION YEAR TWO FUNDING CATEGORY

DSEC CMC Member: >$1,500,000

RATIONALE FOR APPROACH

Research completed with various methods has shown the CRP to be effective. Holtzman (2010) found that the CRP had a positive and statistically significant first-year impact on student enrollment in STEM-related AP courses. Likewise, significant effects were found on students attaining qualifying scores of 3 or better on STEM-related AP tests. This study employed a comparative interrupted time series design and found positive effects among the 64 program schools and 128 matched schools. In each analysis investigated, the CRP was associated with large and statistically significant increases in the percentages of students taking AP exams. Holtzman reported standardized effect sizes for percentage increase in the likelihood of students taking an AP test in excess of 1.0.

Similarly, CRP implementation increased the percentage of students earning qualifying scores, with effect sizes up to 0.5. Jackson (2010a, 2010b) examined the impact of the CRP on longer-term outcomes in addition to secondary outcomes, such as postsecondary success, using data...
from Texas. In these studies, Jackson found positive program effects on AP course enrollment, SAT/ACT scores, and college matriculation (Jackson, 2010a) and on college GPAs and college persistence (Jackson, 2010b). Jackson (2012, 2014) extended the 2010 studies by investigating the effect of the program on labor market outcomes such as wages. Using the same quasi-experimental difference-in-differences strategy, Jackson found a positive CRP effect on earnings, as well as a significant positive impact on college retention and college GPAs for students in schools implementing the NMSI program.

Brown and Choi’s (2015) potential outcomes modeling approach indicated substantial and significant increases in both AP exam-taking and qualifying score-earning for all students as a result of the CRP. In addition, significant first-year effects for AP exam-taking and qualifying score-earning were found for female students and traditionally underrepresented students when analyzed separately.

The analyses from a recently conducted randomized control trial of the CRP revealed that the probability of a student taking an AP exam in the treatment schools in the first year of implementation was higher than in the paired comparison schools, and the difference was statistically significant (Phelan et al., 2021). When looking at the probability of an exam yielding a qualifying score, exams taken at the treatment schools had a significantly higher overall probability of receiving a qualifying score than in the comparison schools in the second year of implementation.

In another study, teachers felt that the CRP contributed to improving recruitment of high-need and traditionally underrepresented students into AP courses (Brown & Phelan, 2021). They also saw open enrollment as having a positive impact on the AP program overall. All school coordinators and partner school directors felt that the CRP was an effective way to increase enrollment in AP courses, and most felt that opening enrollment had a positive impact on the AP program at their school. Student performance improved as the program implementation progressed. There was an increase in student performance on AP exams following participation in the CRP. Following the first year of implementation, the qualifying score rate for math, science, and English exams went from 8.44% to 9.65%, and the qualifying score rate for math and science exams went from 6.13% to 9.74%, a 59% increase in qualifying score rate after the first implementation year.
### Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College Readiness Program</strong></td>
<td></td>
<td><strong>Administrators/schools...</strong></td>
<td><strong>Educators...</strong></td>
</tr>
<tr>
<td>Engage</td>
<td></td>
<td>• Understand the gaps in their advanced STEM course offerings</td>
<td>• Increase their ability to teach advanced STEM courses</td>
</tr>
<tr>
<td>Serve</td>
<td></td>
<td>• Create action plans to offer more advanced STEM courses</td>
<td>• Increase confidence in engaging students in advanced-level STEM coursework</td>
</tr>
<tr>
<td>Connect</td>
<td></td>
<td><strong>Teachers are trained to deliver AP course offerings.</strong></td>
<td><strong>Administrators...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>More students sit for AP exams.</strong></td>
<td>• Increase their ability to plan for and provide advanced STEM courses at their school</td>
</tr>
<tr>
<td><strong>Laying the Foundation (Grades 3-12)</strong></td>
<td></td>
<td><strong>Educators...</strong></td>
<td><strong>NMSI...</strong></td>
</tr>
<tr>
<td>Engage</td>
<td></td>
<td>• Feel more confident in their ability to engage students in grades 3-12 and incorporate hands-on learning into their classrooms</td>
<td>• Increases the number of students in DSEC-sponsored schools who have access to advanced STEM classes</td>
</tr>
<tr>
<td>Serve</td>
<td></td>
<td>• Will implement hands-on practices taught in the trainings into their teaching</td>
<td>• Increases the number of students from DSEC-sponsored schools who complete advanced STEM exams</td>
</tr>
<tr>
<td>Connect</td>
<td></td>
<td></td>
<td>• Increases the number of students from DSEC-sponsored schools who achieve passing scores on AP exams</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Educators...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increase confidence in engaging students in hands-on learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Implement practices taught in the <em>Laying the Foundation</em> training</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><strong>NMSI...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Increases the number of teachers completing the <em>Laying the Foundation</em> training</td>
</tr>
</tbody>
</table>
RoboNation

SCOPE SUMMARY

RoboNation introduced its SeaPerch Remotely Operated Vehicle program in three military-connected communities across the Gulf Coast region, specifically in the school districts and communities surrounding Fort Polk, Fort Hood, and Joint Base San Antonio. Through outreach, educator training, and hands-on project support for students, SeaPerch reduced traditional barriers to participation in robotics programs; introduced students to basic engineering, design, and science concepts; and promoted opportunities to engage students and educators in inquiry-based learning with real-world applications.

During Option Year Two, RoboNation added a master trainer in Louisiana to allow for alignment to the training needs in that area. This increased capacity also enabled RoboNation to provide more SeaPerch kits and opportunities for students based on very high interest and engagement in Louisiana.

OPTION YEAR TWO FUNDING CATEGORY

Innovation Bloc: $125,000 - $500,000

RATIONALE FOR APPROACH

Significant research over the past few decades has focused on two things: (1) the STEM educational attainment of students ranging from prekindergarten through postsecondary school and (2) the career readiness of these students when they enter the workforce. Although the United States has generally remained constant in metrics related to STEM bachelor’s and graduate degree attainment, as well as K-12 math and science assessment scores (Gonzalez and Kuenzi, 2012), these broad trends shadow the growing disparity between various demographic groups. To address the disparities, particular effort has been made to identify STEM education approaches that enhance student engagement with real-world applications and promote student inquiry, innovation, and invention (Kennedy and Odell, 2014). These approaches endeavor to inspire students at all levels and empower students to explore STEM in ways that relate directly to their own lives and communities.

Barriers to engaging integrated STEM education exist at all levels of the educational system. Funding challenges at the institution level, lack of training and investment in professional development for teachers, and missed opportunities to inspire students through connections to the real world are obstacles that adversely impact the
implementation of successful STEM education efforts in schools. Educator preparation and confidence influence student engagement, attitudes, and feelings of self-efficacy (Stohlmann et al., 2012). This correlation highlights the imperative to provide ongoing support to STEM educators to make connections across the STEM disciplines and to real-world applications (Kelley & Knowles, 2016). RoboNation attends to this research through its focus on high-quality professional development for educators.

As educational ecosystems evolve across the United States, educational programming innovations both in and outside of the classroom are needed. Successful implementation of these innovations requires the engagement of students and educators as well as members of society across industry, government, and the general public. Within this approach, innovations should focus both on quality materials and resources and on opportunities to promote student learning of career-relevant 21st-century skills such as critical thinking, creativity, and collaboration. Projects that offer flexibility for implementation and consider various personal and societal factors that vary between communities are needed to offer students greater autonomy in navigating complex pathways and promoting pathway continuity for diverse groups of learners (Groark, 2019). The SeaPerch program aligns with this research by providing students with high-quality equipment needed to design their vehicles and by engaging students in design thinking.

01. Inspire

• Reduce traditional barriers to participation in robotics programs and promote opportunities to engage students and educators in inquiry-based learning with real-world applications

03. Increase

• Identify students in traditional and nontraditional educational settings and provide access to robotics education that helps students make the connection between academics and possible DoD, military, and civilian STEM career pathways
## LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SeaPerch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educator training sessions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connect</td>
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</tbody>
</table>

**Students...**
- Work in teams of 3-4 to collaboratively build an underwater robot
- Learn about electrical circuitry, buoyancy, and refraction
- Learn about careers that work with underwater robots

**Educators (both formal and informal)...**
- Connect what students are doing to DoD STEM careers
- Increase their level of confidence to do hands-on engineering design activities

**Students...**
- Learn engineering design
- Gain knowledge of science concepts
- Learn critical thinking, collaboration, and creativity
- Increase awareness of STEM careers
- Increase awareness of DoD STEM careers

**Educators...**
- Increase confidence in doing hands-on science and engineering in inquiry-based learning
- Increase awareness of STEM careers
- Increase awareness of DoD STEM careers
Robotics Education & Competition (REC) Foundation

SCOPE SUMMARY
The REC Foundation Aerial Drone Competition (RADC) offers students an opportunity to learn to safely operate a drone while working together as a team. Autonomous and driver skill competitions familiarize students with 3D printing and computer-aided design while they learn multiple coding platforms including Python, JavaScript, MATLAB, and more. DSEC-funded RADC programs prioritize female students to increase their access to and confidence in STEM careers. This project created 110 drone teams across schools in the Gulf Coast region (Alabama, Louisiana, Mississippi, and Texas), as well as the Midwest region (Illinois, Kansas, and Missouri). By accepting the terms and conditions of the team grants, teachers agreed to attempt to recruit female students so that at least 50% of each team is made up of females. This project provided four educator training sessions across the region on how to mentor an RADC team and implement associated lessons in the classroom. In addition to the technical skills needed to operate the drones, the student lessons are aligned to actual careers involving drone operation, allowing students to make the connection to future careers available to them.

Due to shipping and equipment procurement delays, the REC Foundation focused Option Year Two efforts on providing the needed equipment to schools and completing the educator training needed to allow for full use and program implementation during Option Year Three.

OPTION YEAR TWO FUNDING CATEGORY
Innovation Bloc: $125,000 - $500,000
RATIONALE FOR APPROACH

Evidence shows that, when school districts transform classrooms by linking independent research projects to real-life careers, students develop critical thinking skills by looking at the world through problem-solving and innovative lenses (Cai, 2019).

Additionally, research from Hoffman et al. (2002) defined sense of belonging as broadly the feeling of “fitting in” or being an integral part of an environment. Research has shown that a student’s sense of belonging is positively associated with student outcomes such as their motivation, grades, interest in a field, and the intent to pursue college or persist in a field (University College London, 2020). RADC fosters a sense of belonging by creating teams that work together to solve a challenging problem. Student satisfaction surveys from one DSEC event show that 72% students who participated in REC Foundation programs reported that they had a very positive experience, and had a lot of fun, while participating on their robotics team.
### LOGIC MODEL

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAD-C Aerial Drone Competition</td>
<td>Engage</td>
<td>Students...</td>
<td>Students...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Learn how to build, fly, and program drones to accomplish tasks on a field</td>
<td>• Gain knowledge of drone science</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td>• Develop computer science programming skills</td>
<td>• Learn engineering design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn to communicate and work with others</td>
<td>• Learn to work as a member of a team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about industries and careers involving drones</td>
<td>• Increase awareness of STEM careers that use drone technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Educators...</td>
<td>Educators...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about drone science (how to build, fly, and program a drone)</td>
<td>• Increase self-efficacy in inquiry-based, hands-on learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn to support students participating in drone competitions</td>
<td>• Increase self confidence in teaching about drone science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn of career opportunities using drone technology</td>
<td>• Increase awareness of STEM careers that include drone technology</td>
</tr>
</tbody>
</table>
SCOPE SUMMARY
During the spring and summer of 2022, San Diego Miramar College provided an additional Applied Biotechnology course each semester and accelerated 36 students in the training pipeline for entry level biotechnology industry employment. In addition to gaining hands-on lab skills, each student received one-on-one resume and job readiness assistance, as well as counseling to ensure that they have an updated education plan that fits their stated career goals. The College also ran the Quality and Regulatory Practices in Biotech online class in summer 2022 with 28 students completing the course. The College enhanced the program through 10 subsidized internships in partnership with the Biocom Institute and the Foundation for California Community Colleges. This 5-year partnership continues to deploy a successful internship model that is broadly supported by industry.

By offering the program’s capstone course, Biology 133, in spring 2022, the focus of programming for Option Year Two shifted to moving students who have taken Biology 132 through the biotechnology pipeline. With completion of both Biology 132 and 133 courses, students are eligible for a Certificate of Achievement in Biotechnology and are ready to work in industry. During Option Year Two, the College adjusted the internship hours to recruit and pay competitively. Internship hours decreased from 200 hours to 150 hours, allowing the hourly wage to increase from $15 to $20 an hour.

OPTION YEAR TWO FUNDING CATEGORY
Innovation Bloc: $125,000 - $500,000

RATIONALE FOR APPROACH
Biotechnology instruction is driven by the labor market. According to the San Diego-Imperial Centers of Excellence for Labor Market Research, the life sciences/biotechnology sector in San Diego County had over 1,500 businesses and over 50,000 employees in 2020 (2021). This sector analysis confirms that the growth of jobs in the life sciences/biotechnology industry increased by 18% from 2010 to 2020. The analysis also cited a labor gap of 1,142 workers needed to fill the labor market demand for middle skills jobs. The existing labor gap and steady growth support the program’s framework to meet the industry demand for completers. By participating in hands-on technical skills training and obtaining foundational skills based on industry needs in the biotechnology field, students in the College’s program can obtain stackable certificates, understand career pathways, and become work-ready, competitive candidates to fill the gap in these well-paying STEM careers.
While there is a huge demand for workers, industry still requires those entering the workforce in biotechnology to have hands-on experience. Jobs that the College’s biotechnology program trains for (i.e., laboratory assistant, laboratory technician, research assistant) are the positions that do most of the hands-on laboratory work (Frierman-Hunt & Solberg, 2008). Students gain that hands-on experience in the Applied Biotechnology courses, where they learn and practice necessary techniques and learn to operate equipment used in biotech laboratories. Having this hands-on experience increases their skills retention, gives them a safe place to practice and receive constructive feedback, and builds their confidence, all of which increase their success in finding and keeping a career in STEM-related careers (Shivdasani & Beatty, 2021). In a follow up survey of Option Year One participants (n = 50) in fall 2021 and through individual contact with students, 68% of respondents (n = 31) stated they were employed in a STEM-related field.

**01. Inspire**

- Engage students in the biotechnology courses with DoD scientists and civilian contractors through career panels

**02. Attract**

- Enhance participants’ knowledge and skills while increasing their awareness of biotechnology employment opportunities through coursework and internships

**03. Increase**

- Recruit students from underserved and military-connected communities directly

**04. Advance**

- Implement feedback surveys and program assessments
# Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coursework</strong></td>
<td>Engage</td>
<td>Students...</td>
<td>Students...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Earn credits toward biotechnology certification</td>
<td>• Learn biotechnology lab techniques</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prepare to take a third-party certification exam through the American Society for Quality (ASQ)</td>
<td>• Earn certification in biotechnology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase their job readiness</td>
<td>• Gain career readiness for biotechnology work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain resume-building experience</td>
<td></td>
</tr>
<tr>
<td><strong>Internships</strong></td>
<td>Engage</td>
<td>Students...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Gain real world experience through internships</td>
<td>• Gain career readiness for biotechnology work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Learn about work culture</td>
<td>• Gain real-world/work-based experience in a STEM career (biotechnology)</td>
</tr>
</tbody>
</table>
The Society for Science has been a champion for science since 1921—dedicated to expanding scientific literacy, effective STEM education, and scientific research. The Society is known for its award-winning science journalism, world-class science research competitions, and outreach and equity STEM education programming. Through DSEC, the Society has enhanced Broadcom MASTERS, the premier middle school science research competition in the United States, with a suite of awards including an annual DoD STEM Top Talent Award, a semifinalist award for all 300 Broadcom MASTERS and Affiliated Fair awards for 30 local fairs that are close to military bases or are of a strategic priority to DSEC. In Option Year Two, the Society ran the Middle School Research Teachers Conference (MSRTC) in July 2022 as a weekend of peer-led professional development focused on leading students in research projects that can be entered in local science fairs and other STEM research competitions. The Society continued its multiyear marketing plan to bring cutting-edge science journalism to middle schools with military-impacted families through Science News for Students. In addition, 400 military-impacted high schools received the Science News in High Schools program, which highlights the cross-curricular nature of STEM, provides connections to current STEM applications and careers, and links directly to primary research.

OPTION YEAR ONE FUNDING CATEGORY

STEM Education and Outreach Partner: $300,000 - $500,000
DSEC FOOTPRINT

Programming Includes a National Reach

RATIONALE FOR APPROACH

Research indicates that grades 7-9 is the key age range for influencing STEM career interest and for building self-efficacy with respect to mathematics and science (Blotnicky et al., 2018), and the Society’s DSEC projects center on this critical age range. Teacher training programs like MSRTC are effective at increasing the number and diversity of students participating in science fairs, as well as positively impacting students’ attitudes toward science and engineering (Lakin et al., 2021). Students who participate in STEM competitions are more likely to express interest in a STEM-related career at the end of high school than students who do not participate, even when students’ prior career interest in STEM is considered. Further, the impact of competition participation on the pursuit of a STEM career was found to be three times stronger when students compete in more than one competition (Miller et al., 2018). Awards for students competing at middle school science fairs and through the Broadcom MASTERS competition incentivize students to continue their scientific research efforts.

Strong preparation in secondary science was found to be significant to retention, persistence, and success among college students of color pursuing degrees in STEM fields (Palmer et al., 2011). One major obstacle to high-quality STEM education is unequal access to up-to-date STEM content and resources (Smith et al., 2016). Increasing educator awareness of the Science News for Students site and access to the Science News in High Schools program fills this content and resource gap, thereby increasing equitable access to high-quality science content and resources.

ALIGNMENT TO DOD STEM STRATEGIC PLAN

01. Inspire

- Increase awareness and visibility for DoD STEM via awards for middle school students participating in local fairs and the Broadcom MASTERS national competition, as well as educators attending MSRTC

02. Attract

- Share DoD workforce and career resources with educators through MSRTC

03. Increase

- Provide STEM literacy resources (through Science News for Students and Science News in High Schools) to schools selected specifically for being military-connected
### Logic Model

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<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcom MASTERS Competition&lt;br&gt;Mini-awards at local fairs&lt;br&gt;Semi-final awards&lt;br&gt;Top awards</td>
<td>Engage</td>
<td>• Increased engagement with a broader science community.&lt;br&gt;Students gain confidence in STEM ability and are likely to continue in competitions.</td>
<td>Students...&lt;br&gt;• Increase confidence in STEM&lt;br&gt;• Increase persistence in STEM</td>
</tr>
<tr>
<td>Middle School Research Teachers Conference (MSRTC)</td>
<td>Engage Serve</td>
<td>Teachers...&lt;br&gt;• Learn STEM pedagogy and ways to help their students complete scientific research&lt;br&gt;• Gain knowledge about science competitions&lt;br&gt;• Learn about STEM military careers that their students could pursue&lt;br&gt;• Learn about professional development opportunities with DoD labs</td>
<td>Teachers...&lt;br&gt;• Increase knowledge of STEM pedagogy&lt;br&gt;• Increase ability to teach STEM subjects&lt;br&gt;• Develop/change attitudes toward STEM&lt;br&gt;• Become part of a STEM-focused professional learning community</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td>Students...&lt;br&gt;• Increase/increases engagement with a broader science community&lt;br&gt;• Increase/increases confidence for students in presenting their work</td>
<td></td>
</tr>
<tr>
<td>Science News for Students</td>
<td>Engage</td>
<td>• Increased awareness of current, real-world science topics.&lt;br&gt;Increased awareness of current science news resources to bring into the classroom.</td>
<td>Students...&lt;br&gt;• Increase knowledge of current, real-world science topics&lt;br&gt;• Develop/change attitude toward science</td>
</tr>
<tr>
<td>Science News in High Schools</td>
<td>Engage Connect</td>
<td>Teachers and Students...&lt;br&gt;• Increase knowledge of current, real-world science topics&lt;br&gt;• Develop/change attitudes toward science&lt;br&gt;Teachers...&lt;br&gt;• Gain knowledge of STEM pedagogy&lt;br&gt;• Become part of a STEM-focused professional learning community</td>
<td></td>
</tr>
</tbody>
</table>

ANNUAL PROGRAM REVIEW • 97
SCOPE SUMMARY

St. Petersburg College leveraged the College’s robust work-based learning and career readiness programs, as well as established employer relationships, to provide targeted support to underrepresented and military-connected students through its STEM Work-Based Learning Experiences Expansion Initiative. Through the program, the College sought to increase the job readiness skills of participants and expose them to the region’s STEM opportunities. The College secured 51 work-based learning experiences for students in STEM-related sectors such as information technology, biotechnology, engineering/advanced manufacturing, health care, biology, and environmental science. These work experiences connected directly to the for-credit courses required in the College’s STEM pathways.

The program also offered career readiness workshops on topics such as workplace communication and interview skills to strengthen student readiness to pursue meaningful work with Tampa Bay STEM employers.

OPTION YEAR TWO FUNDING CATEGORY

Innovation Bloc: $125,000 - $500,000
RATIONAL FOR APPROACH

The College requires internships for most STEM degrees to ensure students have hands-on experience to extend their classroom knowledge into workplace environments. Students who engage in STEM internship opportunities will have an increased STEM skill set and will be more likely to choose and persist in a STEM career (National Research Council, 2011, 2013; National Science & Technology Council, 2018; U.S. Department of Education, 2016). Internships are particularly helpful for underrepresented populations in STEM occupations to gain experience in the field and for easier entrance into the workforce. Research by Lapan and Smith (2022) uses the concept of career self-management within social cognitive career theory as a theoretical framework to interview women in computer science majors to learn how internships impacted their career decisions. The internships helped affirm career interests in computer science careers, and the women frequently made career decisions based on experiences in their internships (Lapan & Smith, 2022). Students who engage in STEM internship opportunities will have an increased STEM skill set and will be more likely to choose and persist in a STEM career pathway. St. Petersburg College internships encourage student participation in STEM learning experiences within and beyond formal class time; student participation in work-based learning opportunities (workplace visits, apprenticeships, mentorship, research); student participation in applied and experiential STEM learning opportunities; and student pursuit of degrees and careers in STEM fields (National Research Council, 2011, 2013; National Science & Technology Council, 2018; U.S. Department of Education, 2016).
## Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career readiness workshops and internships</td>
<td>Engage</td>
<td>Students...&lt;br&gt;• Gain knowledge of career skills such as workplace communication, resume development, job search skills, interviewing skills, and personal branding&lt;br&gt;• Feel more confident to begin internships&lt;br&gt;• Participate in work-based learning experiences&lt;br&gt;• Gain real-world experience</td>
<td>Students...&lt;br&gt;• Gain career readiness for STEM careers&lt;br&gt;• Increase confidence in being ready to begin internships&lt;br&gt;• Gain real-world/work-based experience in a STEM career</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>Spcc...&lt;br&gt;• Develops or enhances partnerships with STEM industries&lt;br&gt;• Increases retention of students in STEM degree programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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100 • DEFENSE STEM EDUCATION CONSORTIUM (DSEC)
Teaching Institute for Excellence in STEM (TIES)

SCOPE SUMMARY

During Option Year Two, TIES focused on support of the DSEC hubs and operation of the STEM-on-the-Go van. Support of the hubs was customized to each hub to assist their efforts to cultivate a robust STEM ecosystem within their community and to align to and support their annual DSEC program plans. The STEM-on-the-Go van continued outreach to schools from Option Year One and reengaged with FIRST to support their spring 2022 FIRST robotics competitions in North Carolina and the FIRST National Championship in Texas. The van was available to travel to the DSEC hubs in Dayton and the DMV region to support their STEM programming and that of the DSEC partners.

In addition to ongoing work from Option Year One, during Option Year Two, TIES focused on conducting a feasibility study for establishing a new DSEC hub in Option Year Three. The feasibility study was based on TIES’ experience in launching and coaching STEM ecosystems into existence and identified and ranked candidate communities within the DoD STEM preferred geographic area. TIES developed and partnered with DoD STEM to administer a survey to STEM outreach coordinators; results are informing planning for a community of practice to bring these professionals together in a collaborative space. TIES also pivoted their STEM-on-the-Go van deployment due to continued COVID-19 restrictions in school districts during Option Year Two. This resulted in a change from longer duration visits to shorter engagements, including 2-day visits to support the DoD STEM-funded STARward STEM program in Cumberland County, North Carolina.

OPTION YEAR TWO FUNDING CATEGORY

STEM Education and Outreach Partner: $300,000 - $500,000

RATIONALE FOR APPROACH

Creation of a STEM ecosystem brings together the collective assets of community stakeholders to ensure that all K-12 students can engage in STEM experiences and acquire knowledge of STEM career pathways. Partnering across formal and informal institutions allows programs to leverage the expertise and resources of multiple institutions and have a collective impact that is larger than any one of the institutions would have individually (Harlow et al., 2020; Kania & Kramer, 2011). The paper “Assessing the Impacts of STEM Learning Ecosystems: Logic Model Template and Recommendations for Next Steps” offers a large body of evidence documenting the impact of cross-sector partnerships on young people; presents a logic model template for communities to advance opportunities for all young people to succeed; and shares a framework for ecosystem cultivation at a community, regional, or statewide level (Traill & Traphagen, 2015).
For its approach to the new hub feasibility study, TIES relied upon self-reported and firsthand observed evidence of localized deep STEM engagement and a track record of effective collaborations to rank potential sites on their readiness to engage as effective DSEC partners and leaders. According to the “Assessing the Impacts of STEM Learning Ecosystems” report, sites with evidence of existing cross-sector collaboration are more likely to have the existing conditions to be an effective hub site (Traill & Traphagen, 2015).

Additionally, TIES’ implementation of a mobile STEM-on-the-Go digital fabrication van is informed by the ongoing research of Paulo Blikstein. His paper, “Digital Fabrication and ‘Making’ in Education,” discusses the educational benefits of fabrication and shares best practices for designing and facilitating learning environments that incorporate these digital technologies and provide contextualized, interdisciplinary STEM learning for all students, not just those learners who see themselves as future engineers or scientists (Blikstein, 2013).

The STEM-on-the-Go van brings a dedicated, hands-on, facilitated learning environment to schools, engaging all students in a contextualized engineering design challenge, scaffolded by previsit activities. “Contextualized learning in STEM” is one of the key design principles that Blikstein highlights in his paper (2013). The evaluation data from the STEM-on-the-Go visits reinforces the power of “contextualized learning” as students reflected on their experiences: 65% of the students surveyed responded that they felt that they “had accomplished something in STEM” during the van’s visit, and 63% responded that they were “feeling prepared for more challenging STEM activities.”

---

01. Inspire

- Provide concrete, authentic STEM experiences to underrepresented communities, with a focus on inspiring STEM curiosity, competency, and career aspirations with the STEM-on-the-Go van

02. Attract

- Recruit, prepare, and support underrepresented students to apply for DoD STEM internships

03. Increase

- Prioritize engagements with underserved and underrepresented groups, especially high school, with the STEM-on-the-Go van

04. Advance

- Engage stakeholders in continuous improvement cycles using a wide array of datasets
### LOGIC MODEL – TIES ECOSYSTEMS

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop customized hub activities: Dayton Hub</td>
<td><strong>Engage</strong></td>
<td>• Continue to support Dayton’s STEM Ecosystem through coaching and contribution to the communications and governance committees</td>
<td>• Develop a sustainability plan for ecosystem programming (leadership)</td>
</tr>
<tr>
<td></td>
<td><strong>Serve</strong></td>
<td>• Develop a local funders collaborative to attract sustained funding and expand the influence of DSEC efforts within Dayton after the grant period ends</td>
<td>• Develop a blended portfolio of funding to sustain ecosystem work beyond the grant period</td>
</tr>
<tr>
<td></td>
<td><strong>Connect</strong></td>
<td></td>
<td>• Coordinate efforts with the DoD STEM Ambassador to launch the STEM IT! Internship Training Program in this region</td>
</tr>
<tr>
<td></td>
<td><strong>Leverage</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Develop customized hub activities: DMV Hub | **Engage** | • Grow and incubate the STEM Expo into a hybrid event that combines virtual and in-person programming and incorporates DSEC partners (In OY2 this remained a virtual only event due to Omicron spread in late 2020/early 2021) | • Develop or enhance partnerships with military installations, STEM industries, or community members in the DC and northern VA areas |
| | **Serve** | • Assist the DMV Hub with cultivating new connections in DC and Northern VA | • Coordinate efforts with the DoD STEM Ambassador to launch the STEM IT! Internship Training Program in this region. |
| | **Connect** | • Support capacity building for the DMV Ecosystem team to identify potential leaders to allow for easier expansion and scale | • Support the Hub Lead team in developing leadership for scalability within their region |
| | **Leverage** | | |

| Develop customized hub activities: San Diego Hub | **Engage** | Identify opportunities for greater collaboration in the San Diego STEM Ecosystem | Develop or enhance partnerships with military installations, STEM industries, or community members |
| | **Serve** | | |
| | **Connect** | | |
| | **Leverage** | | |

| Coordinating efforts with Hub leads: All Hubs | **Leverage** | Connect with each hub partner to formatively assess progress toward goals and outcomes | Continue to connect Hub leads to DSEC’s mission (Fundamentals) |
| | **Evolve** | | |

| STEM IT! Internship Training Program: All Hubs | **Engage** | Leverage the DoD STEM Ambassador to support and launch the STEM IT! Internship Training program in each region. | • Coordinate efforts with the DoD STEM Ambassador to launch the STEM IT! Internship Training in each Hub region. |
| | **Serve** | | |
| | **Connect** | | |
| | **Leverage** | | |
## LOGIC MODEL – STEM-ON-THE-GO VAN

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
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<th>Primary Outcomes</th>
</tr>
</thead>
</table>
| STEM-on-the-Go learning modules | Engage | Students in grades 3-12...  
• Engage in problem-based learning scenarios  
• Understand what a problem-based learning scenario is  
• Connect digital fabrication technologies and the engineering design process to open-ended tasks as grade appropriate | Students will...  
• Gain knowledge of the engineering design process  
• Learn to apply digital fabrication and design skills to open-ended tasks as grade appropriate  
• Increase awareness of STEM careers  
• Increase awareness of DoD STEM careers  
• Increase awareness of STEM career pathways (high school specific) |
| Serve | | Teachers in grades 3-12 learn to carry out standards-based transdisciplinary STEM projects. | Teachers increase confidence in teaching the engineering design process in problem-based learning scenarios with digital fabrication resources. |
TGR Foundation, A Tiger Woods Charity

SCOPE SUMMARY

TGR Foundation provided STEM teachers with professional development focused on underserved students and produced a STEM educator online training academy with reusable assets. TGR Foundation offered two forms of synchronous, professional development sessions for teachers, primarily in grades 4-12: workshops, which were 60- to 90-minute trainings that highlighted specific strategies for STEM teachers to implement in their work with students; and STEM Studios, TGR Foundation’s flagship teacher professional development program that provided teachers 12 hours of training in implementing inquiry-based tools and strategies to support students in developing critical STEM skills. TGR Foundation also produced an online training academy for STEM educators across the country where they received professional development that aided in implementing high-quality, integrated STEM teaching and learning in the classroom. This portal, in addition to strengthening and deepening future in-person TGR Foundation professional development trainings and seminars, provided teachers with easily accessible resources to improve practice, identify and implement new STEM content, and engage with a community of like-minded educators. TGR Foundation identified additional opportunities to engage with DSEC partners on new initiatives to deliver STEM professional development to teachers and STEM learning opportunities to students, with targeted emphasis on the DSEC hubs and military-connected students.

TGR Foundation assumed management of the DoD STEM Ambassador program for Option Year Two. Leveraging the experiences and outcomes from the first year and working with RTI and DoD STEM to understand program objectives, TGR Foundation worked with the cohort of new educators selected for the program to deliver impactful results.

OPTION YEAR TWO FUNDING CATEGORY

STEM Education and Outreach Partner: $300,000 - $500,000

RATIONALE FOR APPROACH

Improving the resources and support students receive before secondary education is critical to keeping them in the STEM pipeline and setting them up for success in STEM fields later in life (Sadler et al., 2012). Too often, students are unable to make connections between what they learn in academic settings and the future STEM workforce, while many, because of a lack of adequate representation at all levels, simply do not view STEM as a viable career path. This trend is born out in the data: Blacks and Hispanics combined make up just 16% of the STEM workforce, while females, who on average perform better on the National Assessment of Educational Progress than their male counterparts, constitute only 25% of workers in the computing field and 14% of employees in the engineering field (Funk & Parker, 2018). Other
underrepresented groups, including military-connected youth, experience similar discrepancies in outcomes.

Providing supports and programs for underrepresented students in later grades, and even in postsecondary education, is critical to ensuring they remain in the STEM pipeline; the disparities begin to manifest much earlier. For instance, students in high-poverty elementary schools are much less likely than their peers in wealthier ones to receive hands-on science education on a regular basis (Change the Equation, 2015). The academic achievement gap associated with family socioeconomic status widens considerably throughout secondary schooling (Caro et al., 2014). For this reason, it is critical that students from underrepresented communities and populations receive exposure to authentic and relevant STEM experiences in the middle grades (6-8) to account for previous opportunity gaps and to mitigate future achievement gaps.

Educator professional development and capacity is another critical piece of this puzzle. For instance, proven professional development programs demonstrate significant advances in student performance on standardized tests in math and science. Educators can also learn, for example, how to effectively integrate various disciplines and instructional approaches, including how to embed engineering design thinking and computational thinking into their practice (Avery & Reeve, 2013). By emphasizing inquiry-based teaching practices, which prioritize student-centered learning, questioning, exploration, collaboration, and reflection, teachers can facilitate activities that more authentically mimic the real world. In doing so, students can build essential skills such as collaboration, creativity, critical thinking, and communication. Inquiry-based learning practices—if done with the proper teacher support and guidance—demonstrate that students develop a deeper understanding of concepts and participate in more intellectually engaging learning experiences (Scott et al., 2018). Educators armed with these enhanced techniques and strategies will not only serve students in an expanded learning program but will also benefit students in traditional academic settings and help make direct connections between learning done in school and out of school.
# Logic Model

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Training Academy and STEM Studios</td>
<td>Engage</td>
<td>Teachers…&lt;br&gt;• Understand how to integrate STEM programming with other subjects&lt;br&gt;• Can identify high-quality materials&lt;br&gt;• Understand collaborative teaching strategies&lt;br&gt;• Make pedagogical changes following module interaction toward collaborative, student-centered teaching strategies&lt;br&gt;• Use project-based, inquiry-based, and transdisciplinary learning with students to highlight real-world problems and roles&lt;br&gt;• Have more confidence in ability to engage with students in STEM&lt;br&gt;• Gain confidence in talking to students about careers in STEM</td>
<td>Teachers will…&lt;br&gt;• Increase ability to recognize and implement STEM programming in the classroom&lt;br&gt;• Increase awareness of STEM careers&lt;br&gt;• Increase confidence in implementing STEM strategies within the classroom&lt;br&gt;• Become part of a STEM-focused professional learning community</td>
</tr>
</tbody>
</table>
The thing I most enjoyed about the program was how interactive it was and how much help I received from people. I knew for sure that I could interact with people or email them and receive a response really efficiently if I had questions…I had people I could rely on, and they would support me.

— Participant in NCWIT AiC Regional Awards
Regional Hubs

Three of the DSEC-funded STEM education and outreach partners serve as regional hubs supporting targeted, place-based programming. Hubs facilitate connections between DSEC outreach programs, DoD installations, and local schools through their deep understanding of the community context in which they are embedded. Hubs are accepted as trusted partners in their communities that speed up the implementation rate and sustainability of programs. Each of the three hubs prioritize building relationships with and creating opportunities for schools and districts within or near their surrounding counties. Hubs also function as STEM ecosystems in their regions. All three hubs set their goals and workplans to align to the DSEC fundamentals and also focused on meeting their unique community needs in Option Year Two.

A separate data chapter accompanying this report provides full evaluation details and is publicly available at https://dodstem.us/about/partners/.
Dayton, OH Hub: Dayton Regional STEM Center (DRSC)

SCOPE SUMMARY
The DRSC provided STEM teachers with professional development, offered improved access to DoD STEM experiences for students, and engaged in STEM workforce advocacy for students, including STEM career awareness activities, apprenticeships for students, and mentor meetings. The DRSC strengthened the STEM workforce pipeline in the Dayton region by engaging students in DoD, DSEC partner, and regional STEM outreach opportunities and programs. These experiences included: (1) Science Saturdays, a free STEM show for students in grades 2-6; (2) Future Fair, a convening of exhibitors from across the Dayton region who engaged students in grades 5-12 and their families in hands-on activities and demonstrations; (3) a collaboration with Air Camp, which provided students in grades 4-12 the opportunity to explore the history and evolution of aviation through immersive learning modules, mentorship from Wright-Patterson AFB scientists, and flight simulator experience; and (4) distribution of at-home and summer/after-school STEM supplies including hands-on, maker activities.

In Option Year Two, DRSC expanded participation in the STEM Fellows program and created a regional STEM event focused on underrepresented populations and providing opportunities for them to engage with local DoD laboratories, industry partners, school administration, teachers, and students. DRSC also focused on supporting the partnership with SCC and CSU (part of DSEC’s HBCU/MI Pathways Network) to provide STEM pathways for underserved populations.

As a hub, the DSRC provided organization, coordination, and communication across Dayton’s regional DoD-supported STEM outreach programming, providing opportunities for partners to share ideas and build off each other’s networks and program strengths.

OPTION YEAR TWO FUNDING CATEGORY
Regional Hub: $200,000 - $250,000
DSEC FOOTPRINT

Dayton, Ohio

RATIONALE FOR APPROACH

Research completed by the National Science and Technology Council (2018) found that high-quality, in-service professional development for STEM teachers improved access to high-quality STEM education for all students. DRSC’s nationally recognized professional development supports the evolution of educators’ classroom offerings with a focus on high-quality problem-based learning experiences rooted in career connections, 21st-century skills, and collaboration. STEM Fellows had unique transformational experiences, including building long-term relationships with local STEM industry professionals and university professors through a collaborative 15-session model. As a result, educators became members of a community of teacher-learners who share a common ambition to provide their students with rigorous and relevant classroom experiences that engage students’ minds and ignite their imaginations.

This same research offered that student engagement in multiple, connected, STEM opportunities within their communities strengthened the STEM pipeline and enhances the STEM workforce (Committee on STEM Education of the National Science and Technology Council, 2018). In facilitating student engagement in the 4 programs listed above, DSRC creates a pathway to allow continued engagement by students as they move through the K-12 education system.

Lastly, research on STEM learning ecosystems supports DRSC’s role as convenor and collaborator in the Dayton region. STEM learning ecosystems provided opportunities in STEM that strengthened the workforce and responded to employer needs (STEM Ecosystems, 2021).

01. Inspire

• The STEM Fellows program directly engaged teachers with volunteers from the Air Force Research Lab and Air Force Institute of Technology

02. Attract

• Air Camp highlights Air Force careers for participating students

03. Increase

• Programs focused on underserved and underrepresented groups

04. Advance

• STEM Fellows completed pre- and post-event surveys to evaluate effectiveness of programming
<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create and implement a regional STEM event</td>
<td>Engage</td>
<td>Teachers and school leaders attend a mini-STEM leadership event to learn about ecosystem work and local STEM partners.</td>
<td>Dayton Regional STEM Center...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td><strong>Educators...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gain knowledge of local STEM ecosystem and STEM learning opportunities</td>
</tr>
<tr>
<td>Grow and expand the impact of the DO STEM ecosystem community of practice</td>
<td>Leverage</td>
<td>• Conduct asset mapping of the Dayton region • Improve communication within the ecosystem • Better awareness of STEM opportunities in the region • Ensure that partners emphasize diversity and inclusion</td>
<td>Dayton Regional STEM Center...</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Dayton Regional STEM Center...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Develops a sustainability plan for ecosystem programming</td>
</tr>
<tr>
<td>Integrate HBCU/MSI Pathways institutions into the DO STEM Ecosystem</td>
<td>Leverage</td>
<td>• HBCU/MSI Pathways institutions become acquainted with other partners in the Dayton STEM ecosystem.</td>
<td>Dayton Regional STEM Center...</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Dayton Regional STEM Center...</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports regional STEM education opportunities</td>
</tr>
</tbody>
</table>
## Logic Model – Coordination with DSEC Partners

<table>
<thead>
<tr>
<th>Programming</th>
<th>Program Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen Schools</td>
<td>Programming did not occur in OY2 due to the pandemic</td>
</tr>
<tr>
<td>TGR Foundation</td>
<td>TGR’s change in programming focus led to a shift away from developing Master Teachers.</td>
</tr>
</tbody>
</table>

## Logic Model – STEM Outreach Programming

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Camp</td>
<td>Engage</td>
<td>• More STEM experiences are offered to military-connected students and students underrepresented in STEM via scholarships.</td>
<td>Students...&lt;br&gt;• Increase knowledge of STEM subjects&lt;br&gt;• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• High-quality STEM experiences are provided for students.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td>• Awareness of DoD STEM careers is increased.</td>
<td></td>
</tr>
<tr>
<td>STEM Fellows Program</td>
<td>Engage</td>
<td>Educators...&lt;br&gt;• Participate in a professional learning community focused on STEM education&lt;br&gt;• Plan lessons and units with their peers&lt;br&gt;• Learn STEM pedagogy techniques&lt;br&gt;• Learn about STEM and DoD STEM careers</td>
<td>Educators...&lt;br&gt;• Increase ability to teach STEM subjects&lt;br&gt;• Increase self-efficacy in teaching STEM subjects&lt;br&gt;• Become part of a community made up of STEM professionals, mentors, and/or program alumni&lt;br&gt;• Increase awareness of STEM careers&lt;br&gt;• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local STEM outreach programs</td>
<td>Engage</td>
<td>• Attendance at existing STEM opportunities in the area is promoted and supported.</td>
<td>Students...&lt;br&gt;• Gain knowledge of STEM topics</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Saturdays</td>
<td>Engage</td>
<td>• Local students engage in STEM learning.</td>
<td>Students...&lt;br&gt;• Gain knowledge of STEM topics</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
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</tbody>
</table>
Washington, DC; Maryland; and Northern Virginia Hub: Morgan State University (MSU) Center for Excellence in Mathematics and Science Education (CEMSE)

SCOPE SUMMARY
MSU’s CEMSE provided professional development to STEM teachers, supported a STEM mentor program, and focused on minority engagement in STEM in the DMV region. As a DSEC hub, CEMSE collaborated with DSEC STEM education and outreach partners to provide connections to students, lead programming, facilitate exposure to STEM careers, and design and implement professional development for pre-service and in-service educators. Programs included Saturday coding sessions for middle and high school students; professional development, including cybersecurity safety, for elementary to high school educators; a near-peer mentoring program; a rocketry club, and development of a Cyber-Bot training for in-service middle and high school teachers. In partnership with Citizen Schools, a Maker Fellow supported the development of programming at MSU for middle and high school students located within the community, including military-connected schools in the DMV region. MSU also continued to manage and support the HBCU/MI Pathways Network, with the selected institutions beginning their work in September 2021. MSU provided individual coaching to the Network members, specifically around how to navigate institutional systems to launch their programming and how to recruit program participants from within their student populations.

During Option Year Two, MSU CEMSE built on relationships with DSEC and other existing partners to promote connections between the partners and their programs to military-connected and underrepresented/underserved schools in the DMV region.

OPTION YEAR TWO FUNDING CATEGORY
Regional Hub: $200,000 - $250,000

3,332 students participated in the 2021 Virtual STEM Expo

94 students participated in Rocketry Club

15 undergraduate students served as near-peer mentors

5 programs were delivered in partnership with DSEC STEM education and outreach partners
RATIONALE FOR APPROACH

Research suggests that pre-service and in-service teachers need professional development involving project-based learning, as well as opportunities to increase their STEM content and pedagogy skills before their practice teaching. Many scholars argue that, for students to be fully prepared for careers in STEM, they should engage in pedagogical practices that reflect the interdisciplinary, ill-defined problems that scientists are attempting to solve. To mirror scientists’ problem-based work, a carefully crafted interdisciplinary approach to STEM teaching allows students to experience real-world problems and provides them with avenues to solve these problems through a variety of answers, as opposed to single-answer solutions that are more typical (Berisha & Vula, 2021).

Educators use project-based learning in STEM to encourage students to make sense of the STEM curriculum. This approach has particularly worked well for students who are not motivated in science (Han, Capraro, & Capraro, 2015). Slew, Amir, & Chong (2015) argue that, while the prescribed science experiments in laboratory manuals allow teachers to engage students in learning through a hands-on approach, many of these experiments provide little room to foster and reward students for being able to showcase their creativity through knowledge in STEM. To increase student engagement, professional development offered in the DMV region seeks to inspire pre-service teachers and in-service teachers and increase their skills in STEM, thereby fostering an increase in students’ interest in STEM jobs and careers.
## Logic Model – Regional Growth

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand partnerships between TIES ecosystems and DoD laboratories</td>
<td>Engage</td>
<td>Morgan State University (MSU) works with TIES and BMORE STEM to develop strategies for expanding the ecosystem.</td>
<td>MSU...</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>DoD labs are actively involved in the Morgan State University (MSU) STEM Expo.</td>
<td>Develops or enhances partnerships with military installations, STEM industries, and community members</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students complete internships with DoD labs (Walter Reed Medical Center).</td>
<td></td>
</tr>
<tr>
<td>Manage the HBCU/MSI Pathways project</td>
<td>Leverage</td>
<td>HBCU/MSI Pathways institutions...</td>
<td>MSU...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Receive technical help from MSU, RTI International, and BEST</td>
<td>Develops or enhances partnerships among the HBCU/MSI Pathways institutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop working relationships with each other</td>
<td>Supports the HBCU/MSI Pathways work through technical assistance</td>
</tr>
</tbody>
</table>

## Logic Model – Coordination with DSEC Partners

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Impacts for the Hub Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCWIT – Virtual Girls’ Coding Camp</td>
<td>Engage</td>
<td>Students</td>
<td>Middle and high school girls have the opportunity to participate in and learn computational and coding skills.</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Learn computational skills such as coding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gain knowledge of potential careers that use computer coding skills</td>
<td></td>
</tr>
<tr>
<td>TGR Foundation – PD and STEM Curricula</td>
<td>Engage</td>
<td>Pre-service teachers are paired with in-service teachers.</td>
<td>• Connections between pre-service and in-service teachers</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>TGR facilitates the course.</td>
<td>• Increase capacity of area teachers to use STEM pedagogy skills</td>
</tr>
<tr>
<td>CGEST – CompuGirls</td>
<td>Engage</td>
<td>Students gain knowledge of cybersecurity.</td>
<td>Middle and high school girls have the opportunity to participate in and learn about cybersecurity.</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## LOGIC MODEL – STEM OUTREACH PROGRAMMING

<table>
<thead>
<tr>
<th>Programming</th>
<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022 Virtual STEM Expo</td>
<td>Engage</td>
<td>Students participate in STEM activities linked to STEM jobs and careers</td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td>• Increase awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td></td>
<td>• Increase awareness of STEM career pathways</td>
</tr>
<tr>
<td>Rocketry Club for middle school and high school students</td>
<td>Engage</td>
<td>Students...</td>
<td><strong>Students...</strong></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Gain knowledge of rocket science</td>
<td>• Learn to build rockets</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td>• Learn about aerospace jobs and careers</td>
<td>• Increase awareness of STEM careers</td>
</tr>
<tr>
<td>Undergraduate Near-Peer Mentoring Program (virtual)</td>
<td>Engage</td>
<td>K-12 students gain knowledge of STEM topics.</td>
<td><strong>K-12 Students...</strong></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>Morgan State University students gain experience in mentoring.</td>
<td>• Increase knowledge of STEM topics</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td></td>
<td>• Gain awareness of STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gain awareness of STEM career pathways</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Become part of the shared identity of the school community</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Undergraduate students learn mentoring skills.</td>
</tr>
</tbody>
</table>
San Diego, CA Hub: University of California San Diego (UCSD) Center for Research on Educational Equity, Assessment, and Teaching Excellence (CREATE)

**SCOPE SUMMARY**

UC San Diego CREATE provided organization, coordination, and communication across San Diego’s regional DoD-supported STEM outreach programming, providing opportunities for partners to share ideas and build off each other’s networks and program strengths. UC San Diego CREATE helped DoD STEM outreach programs expand and/or deepen their reach for high-potential, traditionally underserved, and underrepresented students in San Diego. UC San Diego partnered with DSEC partners MATHCOUNTS, NCWIT’s AspireIT program, TGR Foundation, and Citizen Schools. The CREATE team led the summer math institute for educators and summer math academy for students and facilitated student experiences with the DoD, including internships, apprenticeships with the Naval Information Warfare Systems Command, and naval mentorships.

**OPTION YEAR TWO FUNDING CATEGORY**

Regional Hub: $200,000 - $250,000

**RATIONALE FOR APPROACH**

To accomplish the DSEC fundamentals, the UC San Diego CREATE theory of action recognizes that social interaction happens within specific local, regional, political, and cultural/structural contexts. Leveraging its social network (on behalf of DSEC partners and UC San Diego), therefore, requires the team to act as a “mediating institution” to push for greater equity-minded change (Oakes et al., 2005). A mediating institution is an organized social setting (e.g., school system, university, research center, nonprofit organization, etc.) that channels macropolitical, social, institutional, and/or economic forces in ways that help mediate (i.e., shape, structure, expand, and/or constrain) interactions among individuals within and across those sites. It is in the context of mediating institutions that larger social forces actually impact the lives of individuals (Lamphere, 1992).

Recognizing that the UC San Diego CREATE does not work in a vacuum, the team’s theory of action acknowledges that it is a mediating institution, and, in this role, staff mediate...
DSEC FOOTPRINT

among the regional K-16-serving community and organizations they work with under the DSEC umbrella (including other K-16 institutions). This theory of action sees all institutions (including UC San Diego) as situated in particular, local enactments of larger cultural norms, rules, values, and power relations, and these cultural forces promote either stability or change (McGivney & Moynihan, 1972). Furthermore, as a DSEC hub, UC San Diego CREATE recognizes that, in order to shift the context and the interactions within and among regional institutions, DSEC partners, and the various institutional actors (which includes students), they must employ persuasive and skillful public relations, deep content and pedagogical knowledge, and high levels of identity and cultural awareness to mediate effectively.

In addition to engaging as a hub, UC San Diego CREATE designed and implemented a summer math program that combines a professional development mathematics institute with student-learning summer programs. As a community, teachers and students work with clear goals, a common language, and an intellectual foundation for Common Core mathematical practices to deepen grades 6-12 Black, Latinx, low-income, and military-connected students’ mathematical knowledge in San Diego’s lowest income serving communities.

DNR, the design framework for the program, is an application of the constructivist theory of learning and teaching mathematics. DNR is founded on three basic principles. First, mathematics instruction connects concepts and skills to ways of thinking. By teaching mathematics conceptually, students learn to (1) understand math in different ways, and (2) recognize the importance of different interpretations to solve problems. Second, students must understand the need for what they learn. New concepts and skills should emerge from problems understood and appreciated by the students, and these problems should demonstrate to the student the intellectual benefit of the concept at the time of its introduction. Finally, a DNR-based approach focuses on reasoning. Students must practice reasoning to internalize, organize, and retain ways of understanding and ways of thinking. Research has shown that repeated experience is a critical factor in these processes (Harel, 2008a; Harel, 2008b).
## Logic Model — Regional Growth

<table>
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</tr>
</thead>
</table>
| Alumni engagement                    | Leverage          | • Develop and coordinate a DSEC alumni campaign with local high school districts.  
• Identify 2-3 individuals who are alumni of DSEC partners to launch a campaign to promote DoD programs and opportunities for students in grades 7-12. | UCSD CREATE supports the brand identity of DSEC partners in the region through a campaign to engage DSEC program alumni. |
| San Diego Hub meetings               | Leverage          | • Coordinate and lead four quarterly San Diego Hub meetings per year to leverage the resources of the ecosystem.  
• Bring partners together and help them understand what is going on in the region. | UCSD CREATE supports the development of connections between DSEC partners and local STEM ecosystem partners. |
| Program mapping and data collection  | Leverage          | • Coordinate data collection and mapping of DSEC programs across the San Diego region to further refine work for targeted populations.  
• Increase the number of engagement opportunities that are available in the region. | UCSD CREATE coordinates efforts for STEM programming in the region.                                         |
# Logic Model — Coordination with DSEC Partners

<table>
<thead>
<tr>
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<th>DSEC Fundamentals</th>
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<th>Primary Impacts for the Hub Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizen Schools &amp; San Diego Science Project</td>
<td>Engage</td>
<td>Citizen Schools and/or the San Diego Science Project work with UCSD CREATE to promote learning opportunities for teachers in high-need schools within the designated DSEC STEM deserts.</td>
<td>Together with DSEC partners, UCSD CREATE will pivot its DoD STEM Ambassadors efforts to expand the reach of associated programs to schools, teachers, and students in the region.</td>
</tr>
<tr>
<td></td>
<td>Leverage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGR Foundation</td>
<td>Engage</td>
<td>TGR works with UCSD CREATE to promote learning opportunities for teachers in high-need schools within the designated DSEC STEM deserts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leverage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATHCOUNTS</td>
<td>Engage</td>
<td>• MATHCOUNTS works with UCSD CREATE to provide learning opportunities for teachers and promoted Math Clubs in high-need schools within the designated DSEC STEM deserts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leverage</td>
<td>• The program/role provides and promotes a MATHCOUNTS End-of-the-Year Challenge for students to further promote, illustrate, and celebrate Math Clubs for students and teachers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCWIT</td>
<td>Engage</td>
<td>NCWIT implements programming for Aspire IT and C4C.</td>
<td>In partnership with NCWIT, UCSD CREATE will expand the reach of Inspire IT award programs and C4C workshops for local districts.</td>
</tr>
<tr>
<td></td>
<td>Leverage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Logic Model — STEM Outreach Programming

<table>
<thead>
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<th>DSEC Fundamentals</th>
<th>Immediate Changes</th>
<th>Primary Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barrio Logan Science &amp; Art Expo</strong></td>
<td>Engage</td>
<td>Community...</td>
<td>Community members (students, parents, others) will develop a positive attitude</td>
</tr>
<tr>
<td></td>
<td>Serve</td>
<td>• Participates in science performances and culturally</td>
<td>toward STEM.</td>
</tr>
<tr>
<td></td>
<td>Connect</td>
<td>relevant art and science demonstrations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leverage</td>
<td>• Attends a STEM-focused resource fair</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schools compete in science events.</td>
<td></td>
</tr>
<tr>
<td><strong>Summer Math Institute for Teachers</strong></td>
<td>Engage</td>
<td>Middle and high school teachers receive mathematics</td>
<td>Teachers will...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>professional development addressing the teachers’ knowledge</td>
<td>• Gain knowledge of math (inequalities)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>base: content, pedagogy, and student thinking.</td>
<td>• Increase their ability to teach math</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This work will prepare a subset to teach at the Summer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Math Academy for Students.</td>
<td></td>
</tr>
<tr>
<td><strong>Summer Math Academy for Students</strong></td>
<td>Engage</td>
<td>Middle and high school students receive mathematics</td>
<td>Students will...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>enrichment through attention to inequalities ranging from</td>
<td>• Improve their math skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fractions at the middle school level through linear</td>
<td>• Gain awareness of DoD STEM careers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inequalities for high school students.</td>
<td></td>
</tr>
</tbody>
</table>
It allowed people to get a glance at all the different opportunities there are. It really shows you that there are entire new places to go to, that there are new opportunities, and there’s new things coming up every day.

- Participant in CSU Summer Bridge Program
DSEC is arranged into five operational elements: (1) Consortium Management, (2) Program Evaluation, (3) Outreach and Communications, (4) STEM Alumni Management, and (5) Strategic Outreach Initiatives. This section describes key activities and highlights for each DSEC operational element.
ELEMENT 1:
CONSORTIUM MANAGEMENT

INDIVIDUAL PROGRAM ADMINISTRATOR (IPA)
Jennifer Preston, PhD (RTI International)

SCOPE SUMMARY IN OPTION YEAR TWO
The primary scope for Element 1: Consortium Management in Option Year Two was to provide leadership and coordination of DSEC. Element 1 ensured that all operational elements focused on planning and executing programs in alignment with DoD STEM priorities and goals. In addition, RTI planned and executed consortium-wide deliverables, facilitated consortium meetings, and completed overall consortium management efforts. RTI executed all tasks associated with Element 1, which included project management, logistics, status reporting, subcontracting, communications within DSEC, CMC management, annual planning, STEM Advisory management, and liaising with DoD STEM.

KEY ACTIVITIES
• Managed, coordinated, and updated overall DSEC operational project plan to ensure effective and efficient consortium activity.
• Managed intra-DSEC general communications and announcements to all partners to promote awareness and alignment.
• Planned and executed CMC coordination and strategy sessions, as well as ad hoc element planning sessions.
• Facilitated monthly IPA sessions to provide opportunities for element IPAs to share information on partner progress toward scopes of work and align partner support with partner needs.
• Planned and executed coordination meetings with the cooperative agreement manager to support the needs of the DoD STEM office, review plans and recommendations, and communicate needs of the consortium.
• Managed and executed DSEC business operations including subcontract initiation and modifications, invoice management, financial forecasting, and general budget oversight.
• Planned, managed, and executed four DSEC-wide meetings in collaboration with DoD STEM and the CMC to conduct consortium business, foster connectivity and collaboration, and advance the DSEC fundamentals.
• Planned, managed, and executed DoD STEM and IPA strategy sessions to reflect the consortium’s progress toward the DSEC fundamentals and shifts in approach that are required to advance that progress.
• Planned, managed, and executed regular networking sessions for DSEC partners to learn from each other about connecting with military-connected students, evolving programming based on data, and engaging with the CSTA.
• Planned, managed, and executed biannual STEM Advisory meetings to receive feedback on DSEC strategy and operations from the broader STEM community with representation from the military, private, public, and not-for-profit sectors.
• Provided technical assistance to each DSEC partner as needed for consortium operations and planning efforts by identifying an RTI liaison for each partner.
• Represented DoD STEM at DSEC partner events.
• Designed and facilitated sessions to create brand awareness of DoD STEM in STEM professional communities.
• Organized and coordinated the Innovation Bloc selection process and prioritization parameters in conjunction with DoD STEM and the CMC.
• Designed and launched four informational modules to present partners with key information in the areas of overview of DoD STEM and DSEC, subagreements and financial information, data collection, and outreach and communications.

• Attended and contributed to DSEC operational element meetings with DoD STEM.

• Hosted optional biannual meetings between each partner and the Consortium Chair.

• Provided technical assistance to hub ecosystems, the hub professional learning community, and the HBCU/MI Pathways Network.

• Prepared DSEC monthly status narrative and financial reports.

• Prepared DSEC quarterly financial reports.

• Prepared DSEC-wide reporting deliverables: Annual Program Review for Option Year One, midpoint Option Year Two adjustments and refreshed risk assessment in the APP, and APP for Option Year Three.

• Provided technical assistance to partners, resulting in all respondents in the consortium management evaluation indicating that the consortium management team provided supplemental supports to help them implement STEM programming.

• Facilitated opportunities for partner collaboration, leading to Element 2’s social networking analysis finding that, on average, each STEM education and outreach partner reported connecting to 10 other partners, which represented an increase from Option Year One. Of all reported connections, 109 (92%) included a focus on serving or connecting to at least one of the following focal populations: students who are historically underrepresented in STEM, military-connected students, and the DoD STEM workforce.

OUTCOME HIGHLIGHTS

• Launched the DSEC Event Tracker (designed and created by Element 3) to streamline and standardize pre-event requests for support from DoD STEM and the operational elements and post-event data submission. A session at the September 2021 quarterly meeting and multiple resources (including cheat sheets and a Frequently Asked Questions document) accompanied the release and provided clear support to partners. The launch of the DSEC Event Tracker accompanied a refresh of the process used to coordinate DoD STEM representation at and engagement in STEM education and outreach partner events.

• Instituted new IPA monthly meetings and a new change management process for ensuring that all operational elements are aware of partner changes to scopes of work and effects that the changes might have on each element’s key activities.

• Onboarded four HBCUs/MIs into DSEC through the Innovation Bloc, which deepens the consortium’s focus on serving students who are traditionally underrepresented in STEM.
ELEMENT 2: PROGRAM EVALUATION

INDIVIDUAL PROGRAM ADMINISTRATOR (IPA)
Joseph “Joey” Wilson, PhD (AIR)

SCOPE SUMMARY IN OPTION YEAR TWO
The primary scope for Element 2: Program Evaluation was to manage data collection, assessment/analysis, and reports for DSEC structured around four overall goals:

• Develop priority questions and evaluation agenda in collaboration with DoD and consortium members.
• Improve data availability, consistency, and quality for DoD STEM programs.
• Generate new evidence about the reach and impact of DoD STEM programs.
• Support learning and continuous improvement through the consortium.

KEY ACTIVITIES
Evaluation Coordination
• Updated a methodology brief for STEM education and outreach partners in coordination with Element 4 to distinguish the difference between each element’s collected data and addressed outcomes.
• Coordinated data collection with Element 4 to reduce the overall DSEC partner data burden.
• Held onboarding meetings with all Innovation Bloc partners.
• Delivered the Option Year One data chapter in an interactive, online platform version and Section 508-compliant PDF version.
• Created a data tool for DoD STEM focused on the executive summary and outreach partner data from the data chapter.
• Discussed Option Year One evaluation findings with the DSEC STEM Advisory.
• Co-presented with TIES to inform the DSEC STEM Advisory on STEM ecosystem and hub operating models.
• Producing a literature scan per DoD STEM’s suggestion that focused on STEM ecosystem functioning and early STEM experiences (kindergarten-grade 6).

• Collected and entered all DSEC data for the 2021 DoD STEM annual data call.

Partner and Hub Evaluation
• Provided partners and hubs with an Element 2 timeline and summary of data requests for Option Year Two during one-on-one meetings.
• Developed common logic model outcome language to use across all partners and hubs.
• Conducted individual meetings with partners and hubs to update their DSEC logic models.
• Met with new Innovation Bloc partners to develop initial logic models.
• Conducted interviews with partners and hubs to assist them in crafting evidence statements in support of selected logic model outcomes reported on in the data chapter.
• Conducted interviews and compiled artifacts to create the second hub case studies report.

Consortium Management Evaluation
• Conducted interviews and compiled artifacts to create the Option Year Two consortium management evaluation.
Network Connectivity
- Updated definitions and moved to a quarterly survey to collect partner and hub networking activity.
- Met quarterly with Element 5 and TIES to review social networking analysis data and refine understanding of networking connections.

Data Visualization
- Supported DSEC understanding and use of map visualizations by holding walk-through sessions, sharing video tutorials, and creating documentation on available map layers.
- Added additional data on military-connected schools and communities to the ArcGIS system to help partners and hubs focus on providing programming for military-connected students.
- Improved performance of all DSEC-related map renderings on ArcGIS.
- Created a dashboard in Tableau that incorporates the partner taxonomy, participation data, and location data into a data retrieval and analysis tool.

OUTCOME HIGHLIGHTS
- Continued support for STEM education and outreach partner and hub understanding of measurement to provide high-quality evidence in support of their program outcomes.
- Developed a data dashboard for use by DoD STEM and all DSEC members to create data visualizations that can be used to understand DSEC’s current work and potentially plan future endeavors.
- Produced the second hub case studies report and delivered a third consortium management evaluation.
- Delivered the Option Year One data chapter in an interactive, online format and received positive feedback on the new layout and structure.
ELEMENT 3: OUTREACH AND COMMUNICATIONS

INDIVIDUAL PROGRAM ADMINISTRATOR (IPA)
Janell Kochevar (RTI International)

SCOPE SUMMARY IN OPTION YEAR TWO

For Option Year Two, there were two primary objectives for Element 3: Outreach and Communications. The first was to continue to promote DoD STEM and DSEC as a coordinated and cohesive effort offering students and teachers a continuum of STEM educational opportunities. The second was to continue to plan, manage, and execute an elevated communication strategy supporting DoD STEM priorities and goals.

KEY ACTIVITIES

- Maintained and updated the dodstem.us website. Regularly updated the calendar of events, opportunities, blog posts, video library, and other sections of the website.

- Launched the “STEM Careers” section of the dodstem.us website to provide resources for students to explore careers in STEM fields, hear from DoD STEM professionals and near-peer scientists and engineers, and find DoD STEM programming opportunities for their STEM field of interest.

- Continued to develop and promote the “We are DoD STEM” awareness-raising campaign highlighting DoD STEM professionals, alumni, innovations, and opportunities.

- Highlighted DoD Innovator Spotlight awardees in the Meet DoD STEM section of the dodstem.us website and promoted the DoD Innovator webinar series.

- Added a “DoD STEM Ambassadors” page in the Meet DoD STEM section of the dodstem.us website and highlighted educators from the 2020-21 and 2021-22 school years.

- Maintained the DSEC Event Tracker and promoted partner events on the dodstem.us website and social media channels.

- Created and featured engaging blog posts that showcase a range of activities across DSEC and DoD STEM.

- Coordinated with the SMART Scholarship program office to cross-promote the “SMART Scholarship-for-Service” program application cycles on the dodstem.us website and social media channels.

- Highlighted the STEM education and outreach awardees and Manufacturing Engineering Education Program grantees on a feature page on the dodstem.us website.

- Added new partner resources to the online resources section of the dodstem.us website.

- Developed a “DoD STEM Impact” data story to promote the breadth, depth, and reach of the collaborative efforts across the DoD STEM education and workforce development programs.

- Enhanced search functionality on the “Opportunities” page to include location data, more filtering options, and a mapping feature.

- Managed the DoD STEM social media presence on Twitter, Facebook, Instagram, LinkedIn, and YouTube.

- Coordinated social media campaign schedules and content development protocols with the DoD STEM program office and trusted partners.

- Conducted an evaluation of DoD STEM social media strategy, content, and management to enhance amplification efforts.

- Coordinated outreach efforts with communication leads of DSEC partners.
• Supported DSEC partner outreach efforts with approved collateral and communications requests.

• Leveraged STEM conferences and special events to raise awareness of opportunities with DoD STEM and DSEC partners.

• Designed DoD STEM promotional items and educational collateral for DSEC partners to distribute at STEM education programs and outreach events.

• Developed the DoD STEM Digital Badges platform and conducted user testing of the platform.

• Used the FIRST grant portal for the third year running and incorporated improvements from lessons learned from prior years to improve user experience.

• Supported the DoD STEM Evaluation and Assessment Capability 2020 and 2021 data collection efforts.

• Refined the DSEC Event Tracker and associated surveys for use in Option Year Three.

• Updated interactive informational modules housed within the Amaze platform to aid in sharing information and expectations with all partners.

• Coordinated with Elements 2 and 4 to maintain and operate the DSEC data collection platform.

• Designed the Option Year One DSEC Annual Program Review.

• Designed the Option Year One Alumni Studies Report.

OUTCOME HIGHLIGHTS

• Maintained a cohesive brand identity for DoD STEM to embody and advance DoD STEM’s vision and mission through design and creative direction.

• Advanced brand authority and brand recognition across DoD STEM’s network through a multifaceted communications strategy.

• Sustained growth in monthly users of the dodstem.us website.

• Increased referral traffic from trusted partners by 6%.

• Received 60,000 page views of the “Opportunities” section of the dodstem.us website, a 32% increase from the prior year.

• Coordinated promotion of the “STEM Careers” section on the dodstem.us website with the DoD STEM program office and received 7,000 user visits and over 4,000 page views.

• Established baseline reporting metrics for conversion goals on the dodstem.us website. Achieved 25,000 goal completions.

• Promoted 55 DoD STEM partner events on the dodstem.us calendar.

• Grew social media following for DoD STEM across Twitter, Facebook, Instagram, and LinkedIn. Surpassed 1,000 followers on LinkedIn and Twitter and 500 followers on Facebook and Instagram.

• Received Verification checkmark on Facebook and Instagram in August 2022.

• Published over 1,000 social media posts for DoD STEM that reached over 135,000 users across Facebook, LinkedIn, and Instagram.

• Produced 11 “We are DoD STEM” spotlight videos featuring diverse DoD STEM professionals, scientists and engineers, and alumni.

• Increased awareness of DoD STEM by distributing educational promotional items at the NSTA National Conference, which received 500 attendees.

• Distributed educational promotional items and alumni survey incentives to 940 participants from DoD-sponsored teams at the FIRST Championship. Received a 45% response rate within 3 days of the event.

• Improved data quality and timeliness of responses for the 2021 DoD STEM data call.

• Collaborated across all elements to continue to improve the efficiency of event tracking and data collection.
ELEMENT 4: STEM ALUMNI MANAGEMENT

INDIVIDUAL PROGRAM ADMINISTRATOR (IPA)
Katherine McKnight, PhD (RTI International)

SCOPE SUMMARY IN OPTION YEAR TWO
The primary scope for Element 4: STEM Alumni Management included implementing the STEM alumni studies and developing the DoD STEM Digital Badges platform to prepare for a pilot test in Option Year Three. The alumni studies component focused on surveying students (ages 13+) and educators (e.g., teachers, counselors) who participated in DSEC-funded programs and were the primary beneficiaries of those programs. The surveys focus on targeted DSEC outcomes (i.e., building interest in and awareness of STEM careers in and outside of the DoD).

KEY ACTIVITIES
- Coordinated data collection efforts from program partners with Element 2.
- Updated the student and educator alumni surveys for Option Year Two data collection based on results from the Option Year One surveys (e.g., dropped items that showed little to no variability).
- Coordinated alumni survey protocols with each participating DSEC partner program to ensure that all programs (1) shared survey links with the targeted program participants, (2) followed up with participants to help ensure higher survey response rates, and (3) provided program participant counts and demographics using the post-event survey in the DSEC Event Tracker.
- Continued collecting alumni survey data for Option Year Two through the RTI-designed platform for online data collection.
- Interviewed and analyzed the data from 43 DSEC program alumni: 17 educators from five partner programs, and 26 students from eight partner programs.
- Analyzed survey response data for students and educators by program type and, for students, by gender and race/ethnicity to develop the annual report on key DSEC outcomes for DoD STEM.
- Supported each DSEC partner in entering program participant count and demographics in the DSEC Event Tracker to streamline data requests from Elements 2 and 4 and compare survey counts and demographics for estimating survey nonresponse bias.
- Implemented an onboarding process for DSEC partners for Option Year Two to help ensure a clear understanding of the alumni studies and what participation would entail.
- Developed the DoD STEM Digital Badges platform in collaboration with Element 3 and conducted user testing of the platform to improve user experience.
- Collaborated with Element 3 to interview alumni from eight partner programs for inclusion in the “We Are DoD STEM” campaign.
OUTCOME HIGHLIGHTS

• Co-designed a study protocol with ASU CGEST to measure CompuGirls participants longitudinally. The study started with the summer 2022 cohort and is intended to continue through Option Years Three and Four.

• Collected longitudinal data from NMSI and FIRST and included a summary report for each in the final version of the Option Year One Alumni Studies Report.

• Designed engaging data collection protocols for MATHCOUNTS and FIRST participants to improve survey response rates. In Option Year One, each STEM education and outreach partner had a response rate of below 10%. In Option Year Two, the response rate for both partners increased substantially, with a 100% response rate among MATHCOUNTS students targeted for survey participation.

• Collaborated with Elements 1 and 3 to distribute survey incentives to 940 participants from DoD-sponsored teams at the FIRST Championship. Received a 45% response rate within three days of the event.

• Developed an annual report summarizing the alumni survey results, limitations, and recommendations for improvements, focusing this year’s report on broadening participation and equity in STEM.

• Issued digital badges to the 2021-22 cohort of DoD STEM Ambassadors, in partnership with TGR Foundation, and collected feedback on the platform to improve user experience.

• Highlighted STEM education experiences of alumni from eight partner programs in the “We Are DoD STEM” campaign.
ELEMENT 5: STRATEGIC OUTREACH INITIATIVES

INDIVIDUAL PROGRAM ADMINISTRATOR (IPA)
John Yochelson (Building Engineering and Science Talent [BEST])

SCOPE SUMMARY IN OPTION YEAR TWO
The primary scope for Element 5: Strategic Outreach Initiatives is to ensure that STEM outreach activities are supported, are of high quality, and are coordinated across all partner programs and initiatives. Element 5 is accountable for managing the complex network of STEM education and outreach partners, including driving alignment to DSEC fundamentals, the DoD STEM Strategic Plan, and the Federal STEM Education Strategic Plan. Element 5 also provides quarterly status check-ins with each partner and regular reports to the CMC.

KEY ACTIVITIES

- Provided thought leadership to DSEC partners and monitored partner progress in reaching DSEC fundamentals.
- Engaged partners in reflective conversations to identify improvement opportunities based on programming in Option Year One and the first part of Option Year Two.
- Advanced progress toward the continuous improvement concept focused on building remote and virtual outreach strategies by exploring the effect of COVID-19 on partner programs, how they adjusted, and how they are building on successes.
- Monitored and supported partner scopes of work and briefed DoD STEM and the consortium management team on progress and challenges.
- Facilitated quarterly meetings with DoD STEM and RTI on findings from partner monitoring, which highlighted key themes in partner successes and challenges.
- Represented and promoted DSEC at local and national STEM partner events, including the MATHCOUNTS National Competition; CEE’s Research Science Institute; Learning Undefeated’s Emerging Leaders program; HBCU/MI Pathways CompuGirls program; MSU CEMSE’s STEM Expo and coding camps; RoboNation’s SeaPerch Challenge; the STEM-on-the-Go van visit to Dayton, Ohio; and the Society’s MSRTC.
- Convened quarterly professional learning community meetings with hub leads to discuss shared areas of interest and problems of practice, including how to evolve their approach based on data, strategies for overcoming challenges related to teacher engagement in professional development, and engaging DSEC partners in their local ecosystems.
- Authored a brief that distilled strategic insights gleaned from the hub professional learning community meetings.
- Coordinated and supported the onboarding of new Innovation Bloc partners (REC Foundation, RoboNation, and NIHF) and introduced them to consortium partners.
- In collaboration with MSU CEMSE, provided management oversight and technical assistance to the HBCU/MI Pathways Network partners (BSU, PGCC, SCC, and CSU).
- Convened quarterly meetings of the HBCU/MI Pathways Network partners to share best practices around how to leverage the DSEC network, project management, mentoring, and learning from successes and challenges in program implementation.
- Supported and reinforced requirements for data collection, specifically with the HBCU/MI Pathways Network partners.
- Provided input on quarterly meetings, including agenda items and speakers, and facilitated a session to encourage partner networking at the December 2021 meeting.
OUTCOME HIGHLIGHTS

• Supported the launch of DSEC’s HBCU/MI Pathways Network and the addition of new HBCU/MI STEM education and outreach partners.

• Fostered and monitored the collaboration with ASU CGEST, MSU CEMSE, BSU, and PGCC to expand the CompuGirls program as an initiative with the HBCU/MI Pathways Network.

• Facilitated professional learning within DSEC through convenings with hub leads and individual coaching to partners.

• Deepened knowledge about the consortium partners’ efforts to align with DSEC fundamentals, as well as challenges in reaching targeted underserved student populations.

• Implemented a structured process for monitoring partners’ progress toward their scopes of work and increased DoD STEM and consortium management visibility into partner successes and challenges.
UNDERREPRESENTED/UNDERSERVED

- Traditionally or historically underserved and underrepresented populations in STEM include the following:

- Military-connected, which may include:
  - Military children: dependents of members of the Active Duty Armed Forces.
  - Military-connected: military children plus the dependents of members of the National Guard and Reserves.

- Low-income (those whose family’s taxable income for the preceding year did not exceed 150 percent of the poverty level; those who qualify for free and reduced-price meals programs).

- Racial and ethnic minorities that are historically underrepresented in STEM (i.e., Alaskan Natives, Native Americans, Black or African Americans, Latinx/Hispanic Americans, and Native Hawaiians and other Pacific Islanders).

- Individuals with disabilities, as defined by the Americans with Disabilities Act.

- Individuals with English as a second language or English language learners.

- First-generation college students.

- Students in rural, frontier, or other federally targeted schools, such as Title 1 schools.

- Females in STEM fields where they remain underrepresented (physical science, computer science, mathematics, and engineering).

U.S. DEPARTMENT OF EDUCATION DEFINITIONS

HISTORICALLY BLACK COLLEGES AND UNIVERSITIES (HBCU)

The Higher Education Act of 1965, as amended, defines an HBCU as: “…any historically black college or university that was established prior to 1964, whose principal mission was, and is, the education of black Americans, and that is accredited by a nationally recognized accrediting agency or association determined by the Secretary [of Education] to be a reliable authority as to the quality of training offered or is, according to such an agency or association, making reasonable progress toward accreditation.”

MINORITY INSTITUTION (MI)

The term “minority institutions” (MIs) is defined by § 365(3) of the Higher Education Act (HEA) (20 U.S.C. § 1067k(3)). This definition of minority institutions applies only to the Minority Science and Engineering Improvement Program and other programs whose statutes or regulations reference the same MI definition. The term “minority institution” means an institution of higher education whose enrollment of a single minority or a combination of minorities exceeds 50% of the total enrollment.

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4The taxable income levels for the low-income designation can be found on the United States Department of Education website (https://www2.ed.gov/about/offices/list/ope/trio/incomelevels.html).

5Title I, Part A of the Elementary and Secondary Education Act, as amended by the Every Student Succeeds Act, provides financial assistance to local educational agencies and schools with high numbers or high percentages of children from low-income families to help ensure that all children meet challenging state academic standards. Federal funds are currently allocated through four statutory formulas that are based primarily on census poverty estimates and the cost of education in each state (https://www2.ed.gov/programs/titleiparta/index.html).
BIOTECHNOLOGY

Biotechnology is an emerging engineering discipline that uses living systems to produce a wide range of technologies and capabilities. From fighting global pandemics and avoiding surprises to reducing logistics and sustainment costs and increasing energy efficiency, biotechnology can help change the way the Department conducts missions, performs in contested logistics environments, and adapts to major global changes.

QUANTUM SCIENCE

Quantum Science is the study of physical properties at small, even atomic, scales. Defense applications include atomic clocks, quantum sensors, quantum computing, and quantum networks. Quantum science promises to enable leap-ahead capabilities. Quantum computing can provide unprecedented computational speeds and help solve the Department’s hardest analytical problems. Quantum sensors promise the ability to provide unprecedented accuracy in position, navigation, and timing. From more accurate information to faster decision making, to significantly stronger encryption capabilities, quantum science has the promise to deliver cutting-edge technology.

FUTURE GENERATION WIRELESS TECHNOLOGY (FUTUREG)

FutureG is a suite of emerging wireless network technologies enabled by DoD and commercial industry cooperation to enable military operations and ensure a free and open internet. As Fifth Generation (5G) wireless technology is adopted and provides building blocks for capability, the DoD will also look to FutureG for leap-ahead technologies to lead in creating future standards. The Department will invest in FutureG technology development to lay the groundwork for continued United States leadership in information technology, which is vital for maintaining our economic and national security.

ADVANCED MATERIALS

Advanced materials explore innovative new materials and novel manufacturing techniques that can dramatically improve many of the Department’s capabilities. Materials that have higher strength, lighter weight, higher efficiency, and can handle more extreme temperatures will have the potential to better protect our service members and enhance their ability to accomplish their missions.

TRUSTED ARTIFICIAL INTELLIGENCE (AI) AND AUTONOMY

AI is the software engineering discipline of expanding capabilities of software applications to perform tasks that currently require human intelligence. Machine learning is an engineering subfield of AI that trains software models using example data, simulations, or real-world experiences rather than by direct programming or coding. Autonomy is the engineering discipline that expands robots’ abilities to perform tasks while limiting the need for human interaction. AI holds tremendous promise to improve the ability and function of nearly all systems and operations. Trusted AI with trusted autonomous systems are imperative to dominate future conflicts. As AI, machine learning, and autonomous operations continue to mature, the DoD will focus on evidence-based AI-assurance and enabling operational effectiveness.

INTEGRATED NETWORK SYSTEMS-OF-SYSTEMS

Integrated Network Systems-of-Systems technology encompasses the capability to communicate, provide real-time dissemination of information across the Department, and effective command and control in a contested electromagnetic environment. Integrated Network Systems-of-Systems capability must enable engagements by any sensor and shooter, with the ability to integrate disparate systems. An interoperable network that leverages emerging capabilities across the electromagnetic spectrum such as 5G, software defined networking and radios, and modern information exchange techniques will allow the Department...
to better integrate many diverse mission systems and provide fully networked command, control, and communication that is capable, resilient, and secure.

MICROELECTRONICS
Microelectronics are circuits and components that serve as the “brain” to human-made electronic functional systems. Virtually every military and commercial system relies on microelectronics. Diminishing microelectronics manufacturing in the United States and supply chain concerns have highlighted national economic and security risks. Working closely with industry, academia, and across the Government, the Department is addressing the need for secure microelectronics sources and will leverage state-of-the-art commercial development and production for defense microelectronic solutions.

SPACE TECHNOLOGY
Space technologies include space flight, Space communication and other technologies needed to maintain space operations. With rising threats and increasing dependence on space-based systems, the Department’s space strategy must shift away from exquisite satellites to a more robust and proliferated architecture. Novel space technologies are necessary to enable resilient cross-domain operations. The space strategy must incorporate technologies that enhance the Department’s adaptive and reconfigurable capabilities in space situational awareness, space control, communication path diversity, on-orbit processing, and autonomy.

RENEWABLE ENERGY GENERATION AND STORAGE
Renewable energy generation and storage includes solar wind, bio-based and geothermal technologies, advanced energy storage, electronic engines, and power grid integration. Renewable energy generation and storage promises to decrease warfighter vulnerability and deliver new operational capabilities for the Department. From more efficient batteries to diversifying energy sources and reduced fuel transportation risks, renewable energy generation and storage will add resilience and flexibility in a contested logistics environment.

ADVANCED COMPUTING AND SOFTWARE
Advanced computing and software technologies include supercomputing, cloud computing, data storage, computing architectures, and data processing. Software is ubiquitous throughout the Department, but the speed at which software develops outpaces the Department’s ability to stay up to date. The Department must rapidly modernize its legacy software systems with resilient, affordable, and assured new software that has been designed, developed, and tested using processes that establish confidence in its performance. The Department must migrate to a Development-Security-Operations (DevSecOps) approach in its software development and evolve to a model of continuous development, continuous test, and continuous delivery. The Department must leverage modular open system architecture approaches to isolate hardware from software and enable rapid upgrades to secure processors.

HUMAN-MACHINE INTERFACES
Human-Machine Interface refers to technologies related to human-machine teaming and augmented and virtual reality. Rapid advancements in this technology will have a multitude of benefits for our service members. Highly immersive realistic training environments provide real-time feedback to enhance warfighter performance. Intuitive human-machine interfaces enable rapid mission planning and mission command by providing a common operational picture to geographically distributed operations.

DIRECTED ENERGY
Directed Energy Weapons utilize lasers, high power microwaves, and high energy particle beams to produce precision disruption, damage, or destruction of military targets at range. Directed energy systems will allow the Department to counter a wide variety of current and emerging threats with rapid responses and engagement at the speed of light. High-power lasers and high-power microwave technologies both offer new ways to counter diverse sets of threats.

HYPersonics
Hypersonic systems fly within the atmosphere for significant portions of their flight at or above 5 times the speed of sound, or approximately 3700 miles per hour. Hypersonics dramatically shorten the timeline to strike a target and increase unpredictability. While strategic competitors are pursuing and rapidly fielding advanced hypersonic missiles, the DoD will develop leap-ahead and cost-effective technologies for our air, land, and sea operational forces.
INTEGRATED SENSING AND CYBER

To provide advantage for the joint force in highly contested environments, the Department must develop wideband sensors to operate at the intersection of cyber space, electronic warfare, radar, and communications. Sensors must be able to counter advanced threats and can no longer be stove-piped and single function.
REFERENCES


Center for Youth and Communities. (2015). *FIRST longitudinal study: Year 2 findings*. Brandeis University.


Change the Equation (2015). *Analysis of results of the National Assessment of Educational Progress, 4th grade math and science* [Report].


Committee on STEM Education of the National Science and Technology Council. (2018). *Charting a course for success: America’s strategy for STEM education*. Committee on STEM Education of the National Science and Technology Council.


National Council of Teachers of Mathematics (NCTM). (2020). *Catalyzing change in middle school mathematics. NCTM.*


Tinto, V. (2000). What have we learned about the impact of learning communities on students? *Assessment Update* 12(2), 1-2, 12.


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