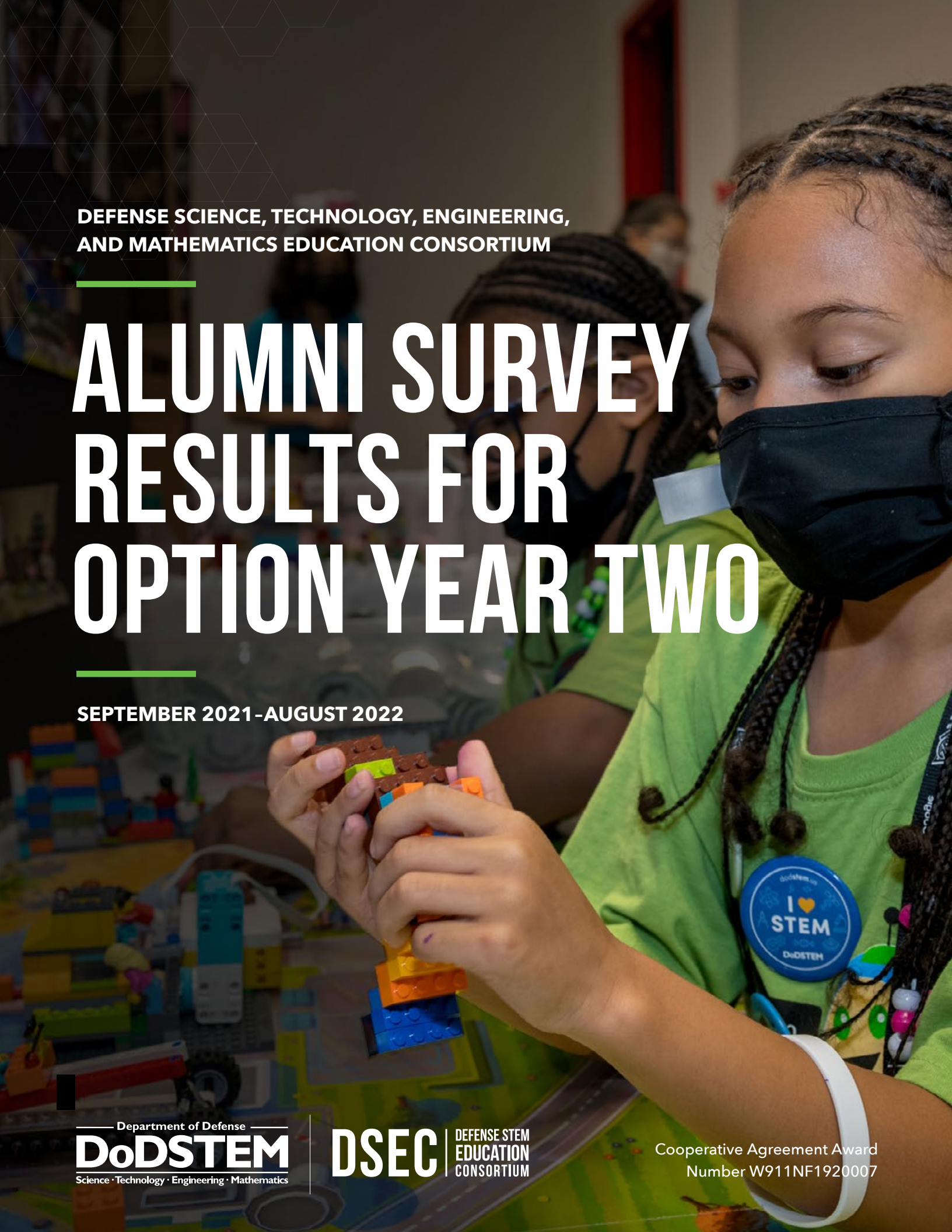

DEFENSE SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS EDUCATION CONSORTIUM

ALUMNI SURVEY RESULTS FOR OPTION YEAR TWO

SEPTEMBER 2021–AUGUST 2022

Department of Defense DoDSTEM
Science · Technology · Engineering · Mathematics

DSEC DEFENSE STEM EDUCATION CONSORTIUM

Cooperative Agreement Award
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CONTENTS

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.

ABBREVIATIONS AND ACRONYMS

AEOP	Army Educational Outreach Program
ASU CGEST	Arizona State University's Center for Gender Equity in Science and Technology
CEE	Center for Excellence in Education
DSEC	Defense STEM Education Consortium
FIRST	For Inspiration and Recognition of Science and Technology
MSRTC	Middle School Research Teachers Conference
MSU	Morgan State University
NCWIT	National Center for Women and Information
NMSI	National Math and Science Initiative
OY	Option Year
PD	Professional development
RTI	RTI International, a trade name of Research Triangle Institute
STEM	Science, technology, engineering, and mathematics
The Society	Society for Science
TIES	Teaching Institute for Excellence in STEM

EXECUTIVE SUMMARY

For the Defense STEM Education Consortium (DSEC) Option Year Two, Alumni Surveys continue to provide evidence of the impact that DSEC-funded programs have on educators and students. This evidence has some limitations: about half (51.2%) of the educators and 84% of the students who were eligible to be surveyed responded to the survey, and there were missing data from the surveys indicating that not all respondents provided complete data. However, the survey response rates improved from 45% for educators and only 4% for students in Option Year One. For Option Year Two, data collection processes helped to improve response rates, especially for students, where the largest programs targeted their surveys to a sub-sample to make data collection more manageable and representative of the students they served.

Building on results from Option Year One, educators continued to report improved STEM self efficacy and interest while also feeling supported in learning how to support students traditionally underrepresented in STEM, all of which have a positive impact on student learning as reflected in STEM education research. **Students reported gains in new STEM knowledge and skills, in their sense of preparedness for more advanced STEM, and in their interest in STEM degrees and careers** as a result of participating in DSEC. Moreover, for these important STEM-related outcomes, **male and female students did not differ**, whereas in Option Year One, significantly more male students planned on pursuing a STEM degree compared to females.

The type of STEM program helped to determine the strength of the impact on STEM outcomes. For educators, fellowship programs and activity-based professional learning showed the greatest positive impacts. For students, programs that were more selective about who participated showed the strongest impacts. Notably, the more selective programs tended to serve more students who are traditionally represented in STEM (male, White, Asian, with parents who attended college) than the programs open to all.

Regarding interest in STEM-related degrees and careers, we found about the same proportions of students interested in STEM-related degrees (about 70%) and careers (about 70%, and about 10% in the DoD) as reported in Option Year One. Overall, students felt that participating in a DSEC-funded program had "somewhat" impacted these outcomes. **Students of racial/ethnic groups traditionally represented in STEM were more likely to plan on pursuing a STEM degree/career, whereas male students and students of underrepresented racial/ethnic groups were significantly more interested in DoD STEM careers**. Notably, there were no differences between genders interested in STEM degrees/careers outside the DoD.

DSEC is broadening participation in STEM, primarily through programs that are open to all students. DSEC STEM education and outreach programs support multiple pathways to a STEM career these programs range from raising STEM awareness, to inspiring interest and engagement in STEM, to honing more advanced skills and preparing students for STEM careers. The latter focus areas tend to be the domain of the more selective programs—which, for DSEC, tend to serve students who are traditionally represented in STEM. Moving forward, a key consideration for DSEC is to determine how to be more inclusive in programming that is designed to provide challenging STEM to broader groups of students, including more female students, students of racial and ethnic groups traditionally underrepresented in STEM, and those facing socioeconomic challenges.

WHY CONTINUE TO SURVEY DSEC PROGRAM PARTICIPANTS?

The Defense STEM Education Consortium, or DSEC, is a collaborative partnership aimed at broadening STEM literacy and developing a diverse and agile workforce through evidence-based approaches.

With 24 partners offering multiple programs in Option Year Two, DSEC provides a wide range of meaningful STEM experiences to students and educators—from internships, to competitions and workshops, to interactions with technology via STEM-on-the-Go vans. The **DSEC Alumni Surveys** were designed to describe and document key DSEC outcomes that apply across the range of programs offered in DSEC starting in Option Year One. Option Year Two, which spanned September 2021 through August 2022, marks the second year of the Alumni Surveys Study.

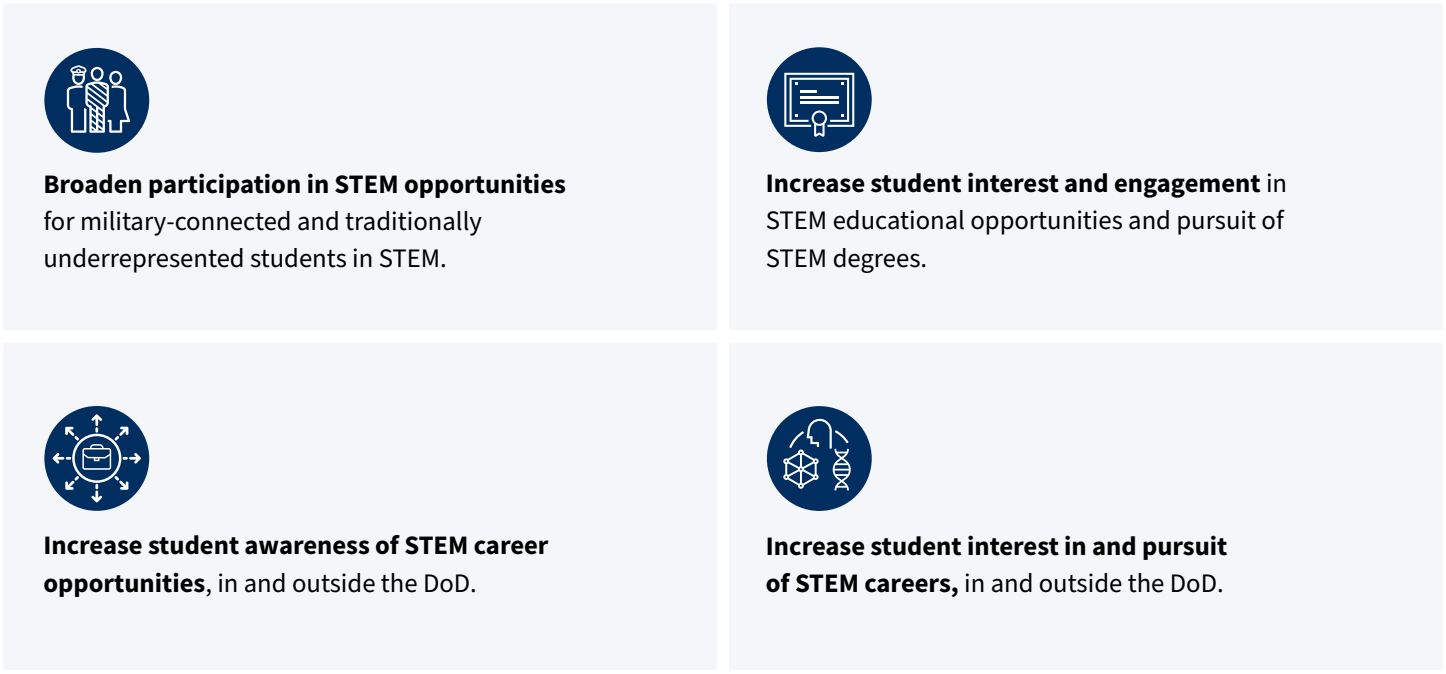
The DSEC Alumni Surveys study aligns with four of the five DSEC fundamentals, as shown in **Figure 1**.

Figure 1. The DSEC Alumni Surveys Study Aligns with Four of the Five DSEC Fundamentals

Engage students and educators in meaningful STEM experiences.	The surveys measured the extent to which educators and students were engaged.
Serve students who are military-connected and underrepresented in STEM.	The surveys documented participants' military connectedness and demographic characteristics, including gender and race/ethnicity.
Connect to the DoD STEM workforce.	The surveys measured the extent to which participants were made aware of DoD STEM careers and their level of interest in those careers.
Evolve the approach based on data.	By measuring the intended impacts of providing meaningful STEM experiences and serving military-connected and underrepresented students, the Alumni Surveys provide data-based insights to help DSEC to adjust in areas that need attention.

The DSEC outcomes on which the Alumni Surveys focus are highlighted in **Figure 2** below.

Figure 2. DSEC Outcomes for Providing Meaningful STEM Experiences



DSEC ALUMNI STUDIES DESIGN

The DSEC Alumni Studies are a set of studies designed to capture information about the four key DSEC outcomes shown in Figure 2 over the period of the project. We are currently in our second year of data collection. The studies are primarily focused on a **survey study design**, which carries over from the previous year, focusing on alumni of DSEC-funded programs that provide meaningful STEM experiences for educators and for students. Alumni are educators and/or students who participated in or were directly served by these programs. Eligible educators are any adults who serve in a STEM education capacity who participated in programs designed to support them in providing meaningful STEM experiences for students. These include but are not limited to classroom teachers, other school or district staff, industry partners, college students, and staff from nonprofit partners. For the student survey, only those who were 13 or older could participate.[1] In most cases, we surveyed participants within 2 weeks after program conclusion.

The study design also involves collecting interview data from a small sample of participants from each DSEC program that is participating in the surveys. As noted in the Option Year One Alumni Survey Results, the survey study design was reviewed by RTI's Internal Review Board to ensure the safety and well-being of research participants, including their ethical treatment and data security. RTI's Office of Risk Management also reviewed the study design to ensure compliance with RTI protocols for research with human subjects.

The Alumni Studies also leverage longitudinal data collected by some of the DSEC STEM education and outreach partners, to complement the Alumni Surveys results and inform the project about longer-term outcomes for participants in DSEC-funded programs. For Option Years One and Two, the two programs supplying longitudinal data for their students are For Inspiration and Recognition of Science and Technology (*FIRST*) and the National Math and Science Initiative (NMSI). Several other programs are planning longitudinal data collection for their participants in Option Year Three.

[1] To comply with the Children's Online Privacy Protection Act (COPPA) the Federal Trade Commission requires parents to be in control of what information is collected online from children under 13 years old (see https://www.ftc.gov/business-guidance/privacy-security/childrens-privacy).

WHAT WE INTEND TO LEARN FROM THE ALUMNI SURVEYS IN OPTION YEAR TWO

Although the survey study collects the same outcome data from participants from DSEC programs annually, it does not collect **longitudinal data** on previous program participants for each of those programs. RTI cannot collect personally identifiable information from program participants due to data use agreements between the DSEC programs and the organizations and/or participants they serve, and therefore cannot connect data points over time across the same individuals. Moreover, many DSEC programs are not allowed to continue to contact participants after their engagement in the program ends, as part of their data use agreement. Therefore, the Alumni Surveys Study can only document trends in outcomes over time, across groups of programs in DSEC serving primarily different participants each year. **Because they are not the same participants over time, and because a small number of programs change, are added to, or leave DSEC, the trends must be interpreted carefully and with caution**. It may be that any changes that are observed over time are due to the variance in participants, in programs, or an outside force such as the COVID-19 pandemic.

Aligned with the outcomes shown in **Figure 2**, we designed the Alumni Survey to address the evaluation questions for students and for educators shown in **Table 1**. **These questions are based on a review of research on STEM education, and are a continuation of those designed in Option Year One, so we can document trends in responses.** The reviewed research is addressed in more detail in the results sections of this report.

Table 1. Learning Questions Addressed by the Alumni Surveys for Option Year Two

STEM AWARENESS, ATTITUDES, AND IDENTITY/SELF-EFFICACY

Student Alumni Study Questions	Educator Alumni Study Questions
As a result of participating in DSEC programs....	
To what extent do student alumni report awareness of STEM opportunities, including internships and careers, in and outside the DoD?	To what extent are alumni educators aware of STEM career opportunities, in and outside the DoD? What are their attitudes about DoD research and researchers?
To what extent do student alumni report STEM identity and self-efficacy?	To what extent are alumni educators confident in their ability to teach/coach STEM (i.e., have positive STEM self-efficacy) and have positive attitudes toward STEM?

Table 1. Learning Questions Addressed by the Alumni Surveys for Option Year Two (continued)

INTEREST & ENGAGEMENT IN STEM

Student Alumni Study Questions	Educator Alumni Study Questions
As a result of participating in DSEC programs....	
To what extent do alumni report interest or engagement in STEM activities? To what extent do STEM interests vary by gender, race/ethnicity, or program type?	To what extent do educators perceive an impact of the DSEC program on their students' and their own interest and engagement in STEM? Do these perceptions vary by type of program?
To what extent do alumni report pursuit of STEM courses in secondary school, postsecondary STEM degrees, STEM careers, and DoD STEM careers?	To what extent do educators perceive an impact of the DSEC program on their students' interest in STEM education and careers (including in the DoD)?

IMPACT OF PROGRAM TYPE, AND BROADENING PARTICIPATION AND EQUITY IN STEM EDUCATION

Student Alumni Study Questions	Educator Alumni Study Questions
As a result of participating in DSEC programs....	
To what extent do student gender, race/ethnicity, and socioeconomic status vary by type of program in which students participate (open to all vs. more selective)?	To what extent do educators believe that the DSEC program in which they participated provided them with strategies for engaging students who are historically underrepresented in STEM?
To what extent do STEM awareness, attitudes, identity, and self-efficacy vary by students' gender, race/ethnicity, and program type (open vs. more selective)?	To what extent do educators perceive that the DSEC program in which they participated had an impact on students who are traditionally underrepresented in STEM?
To what extent does interest in STEM course-taking, STEM degrees, and STEM careers (including in the DoD) differ by gender, race/ethnicity, and program type (open vs. more selective)?	To what extent are educator characteristics (e.g., STEM experience) and program type related to their interest and engagement in STEM and the perceived program impact on students?

We updated Option Year Two survey items to capture information that addresses the evaluation questions for students and educators detailed in **Table 1** based on feedback from DSEC partners and from Option Year One analyses.

INFORMATION FROM STUDENTS

- Student characteristics (gender, race/ethnicity, socioeconomic status, military connectedness)
- Interest in STEM topics
- STEM identity and self-efficacy, before and after participating in DSEC
- Engagement in STEM-related opportunities
- Perceived benefits of participating in a given DSEC-funded STEM program
- STEM course-taking (high school and postsecondary)
- Pursuit of a STEM degree
- Awareness of STEM career opportunities, in and outside the DoD
- Interest in or pursuit of a STEM career, in and outside the DoD

INFORMATION FROM EDUCATORS

- Educator's role (teacher or other) and teaching history, if relevant
- STEM background and experience
- STEM identity and self-efficacy
- Awareness of and attitudes toward STEM career opportunities, in and outside the DoD
- Perceptions of program impact on students' STEM interest and engagement
- Perceptions of program impact on educators' own STEM interest, awareness, knowledge, and skills
- Perceptions of program impact on broadening student participation in STEM

The **Appendix** includes results from our psychometric analyses of subsets of survey items, similar to the analyses we conducted in Option Year One.

HOW WE COLLECTED THE ALUMNI SURVEY DATA

DATA COLLECTION PROTOCOLS AND SURVEY RESPONSE RATES

Data collection protocols for Option Year Two were similar to those used for Option Year One. To protect confidentiality and increase the likelihood of survey responses, DSEC programs that participated in the Alumni Surveys Study (listed in **Table 2**) were responsible for contacting their respective eligible program participants about the survey. The RTI Alumni Studies team created a unique link for each program to help ensure we could link survey responses to each participating DSEC STEM education and outreach partner program. A subset of programs agreed to integrate the Alumni Survey items into their existing post-program surveys, to avoid burdening participants with two different surveys. Those programs shared their data with the RTI DSEC Alumni Studies research team without participant names and contact information, to protect participant confidentiality.

Figure 3. Tracking Sheet for DSEC Programs Participating in Alumni Surveys

	Partner Name	Name of individual program to be surveyed	Has the program been scheduled? (Select "Scheduled" or "TBD")	Date individual program began (if you know the month but not the specific date, enter the first date of the month. If you know the season/term but not the month, enter the first date of the first month in the season/term.)	Date individual program ended (if you know the month but not the specific date, enter the first date of the month. If you know the season/term but not the month, enter the first date of the first month in the season/term.)
2	ASU CGEST	CompuGirls Cybersecurity Warriors Program, Fall 2021	Scheduled	10/01/21	11/13/21
3	ASU CGEST	CompuGirls Cybersecurity Warriors Industry Mentors Fall 2021	Scheduled	10/01/21	11/13/21
4	ASU CGEST	CompuGirls Cybersecurity Warriors Program, Spring 2022	Scheduled	01/29/22	02/19/21
5	ASU CGEST	CompuGirls Cybersecurity Warriors Industry Mentors Spring 2022	Scheduled	01/29/22	02/19/21
6	ASU CGEST	CompuGirls Summer Camp	Scheduled	06/27/22	07/01/22
7	ASU CGEST	CompuGirls Summer Camp Educators	Scheduled	06/27/22	07/01/22

All programs that participated in the Alumni Surveys were asked to provide the RTI Alumni Studies team with data on their program's participants, including participant numbers and demographics (e.g., gender, race/ethnicity) by completing a Post Event Survey form in the AMAZE platform. We used these data to calculate survey response rates for each program, based on how many were eligible compared with how many responded to the survey. (See **Table 2**.) Several programs did not provide those numbers and therefore their data were not included in response rate calculations.

Educator and student survey response rates are shown in the results sections of this report. (See **Figures 4** and **13**.) It is important to note that, **similar to Option Year One results, the structure of the program had an impact on response rates for the Alumni Studies surveys**. In general, programs that were more intensive and focused on smaller numbers of participants, such as fellowship programs for educators and internships for students, had the highest response rates. **To increase student response rates for Option Year Two**, the RTI research team worked with the two largest student-serving programs (MATHCOUNTS and *FIRST*) to select a subset of students on which to focus their efforts for collecting survey responses. *FIRST* focused on Robotics and Tech Challenge teams that participated in the National Championship (n = 940 students). MATHCOUNTS selected a subset of districts and schools to represent different regions of the United States, focusing primarily on the three DSEC hubs (Dayton, Ohio; San Diego, California; and the DC/Maryland/Virginia area) and districts serving military-connected students in the Championship Series (n = 342) and their Video Challenge (n = 88). Although these numbers are much smaller than the total of the students both programs serve, these DSEC partners tried to select students that best represented those served by DSEC funds.

Table 2. DSEC Partner Programs Participating in the DSEC Alumni Surveys Study

EDUCATOR ALUMNI SURVEY PARTICIPANTS

DSEC Partner	DSEC-Funded Programs	Number of Participants Eligible To Be Surveyed
Arizona State University's Center for Gender Equity in Science and Technology (ASU CGEST)	CompuGirls educator professional development (PD)	15
Citizen Schools*	Catalyst for Educators	3
CYBER.ORG	Cybersecurity PD	18
Dayton Regional STEM Center	STEM Fellows	11
Morgan State University (MSU)	Micro:BIT PD	20
National Center for Women and Information Technology (NCWIT)*	Counselors for Computing (C4C)	217
	C4C Leadership	64
National Math and Science Initiative (NMSI)*	Laying the Foundation Summer Academy & College Readiness Program Summer Workshop	707
Prince George's Community College	STEM Educators Learning Community	17
RoboNation	SeaPerch PD	124
Sinclair Community College	Summer Bridge	8
Society for Science	Middle School Research Teachers Conference (MSRTC)	74
	Science News in High Schools	134
TGR Foundation, a Tiger Woods Charity*	STEM Studios	71
	DoD STEM Ambassadors program	16
Teaching Institute for Excellence in STEM (TIES)	STEM-on-the-Go van, Spring-Summer 2022	33
TOTAL: 13 DSEC PARTNERS providing 16 DSEC FUNDED PROGRAMS		1,532

*Program collected data using its own survey platform and provided them to RTI's Alumni Surveys Research Team.
**Program did not submit participant count data; these numbers instead reflect the number of survey responses.

Table 2. DSEC Partner Programs Participating in the DSEC Alumni Surveys Study (continued)

STUDENT ALUMNI SURVEY PARTICIPANTS

DSEC Partner	DSEC-Funded Programs	Number of Participants Eligible To Be Surveyed
ASU CGEST	CompuGirls, 2021 Spring and Summer cohorts	64
Center for Excellence in Education (CEE)	Research Science Institute	15
	DoD Lab internship	10
Central State University	Residential Summer Bridge Program**	10
Citizen Schools*	STEM Catalyst	125
CYBER.ORG	Capture the Flag Virtual Scavenger Hunt**	170
Dayton Regional STEM Center	Full Throttle**	75
	Air Camp	3
For Inspiration and Recognition of Science and Technology (*FIRST*)	Robotics Competition and Tech Challenge	940
Learning Undefeated	Emerging Leaders in Biotechnology internship	12
	Emerging Leaders in Biotechnology Mentorship Program (college mentors and high school mentees)	55
MATHCOUNTS	Competition Series	342
	Video Challenge	88
NCWIT	Aspirations in Computing Awards (National and San Diego area)	78
Prince George's Community College	STEM Student Learning Community	34
RoboNation	SeaPerch Student Camps	429
San Diego Miramar Community College	Life Sciences biotechnology internships	10
	BIO 132, 133, and 136 courses	45

Table 2. DSEC Partner Programs Participating in the DSEC Alumni Surveys Study (continued)

DSEC Partner	DSEC-Funded Programs	Number of Participants
Sinclair Community College	Summer Bridge Program	19
Society for Science	Broadcom MASTERS DoD prize, June 2022	28
	Broadcom MASTERS semi-finalists, Oct 2021	241
St. Petersburg College	Career readiness workshops	58
	Summer internship	49
TIES	STEM-on-the-Go van	59
TOTAL: 17 DSEC PARTNERS providing 24 DSEC FUNDED PROGRAMS		2,704

*Program collected data using its own survey platform and provided them to RTI's Alumni Surveys Research Team.
**Program did not submit participant count data; these numbers instead reflect the number of survey responses.

ONLINE SURVEY PROCESSES

Starting in the DSEC Base Year, RTI's DSEC Alumni Studies team created a platform and the survey for online data collection from DSEC program participants.[2] The survey indicated that participation was voluntary and asked program participants to indicate whether they wanted to participate. The RTI Alumni Studies team programmed the survey to close if the student indicated they were under 13 years old. DSEC STEM education and outreach partners were responsible for obtaining parental permission for students under 18 years old if their programs required such permissions.

[2] The design and development of the DSEC Alumni Surveys are described in a separate report, provided to DSEC in December 2020: "Development and Testing of the DSEC Student and Educator Alumni Surveys."

HOW DID OUR ALUMNI SURVEY ITEMS PERFORM?

Building on Option Year One results, we evaluated the extent to which a subset of the survey items from each of the two DSEC Alumni Surveys (Educator and Student) showed evidence of reliability for these samples of respondents.

We analyzed the same subsets of survey items as were analyzed in Option Year One. Both surveys used items that had been tested and used in other research (detailed in our survey development report) with similar populations, measuring constructs relevant to the DSEC Alumni Studies, e.g., STEM perceptions, STEM self-efficacy, and STEM identity. We assessed subscale reliabilities for our sample to help ensure that analyses involving these subscales could provide interpretable results. For measures of reliability, we assessed internal consistency with Cronbach's alpha and we ran exploratory factor analyses.[3] Both sets of analyses address the extent to which a set of items that are intended to measure the same underlying construct are correlated with each other. Results are presented in the **Appendix**. In summary, our analyses indicate that the subscale scores from the survey we are using to measure important DSEC outcomes each show strong reliability and indicate that they are measuring a single (vs. multiple) underlying factor or construct. **These results suggest that using scale scores to represent constructs such as STEM identity, STEM awareness, etc., is appropriate and statistically justifiable.**

[3] Cronbach's alpha measures the extent to which items intended to measure the same construct are correlated. Values range from 0 to 1, where values closer to 1 indicate stronger inter-item correlations or "consistency." Scales or measures with values of .70 or higher are generally regarded as showing high internal consistency. Similarly, factor analysis assesses the extent to which items correlate or "covary." Items that are intended to measure the same construct are expected to covary or correlate with each other. Items with high factor loadings show evidence of measuring a similar construct, while items with low factor loadings show evidence of measuring a different construct.

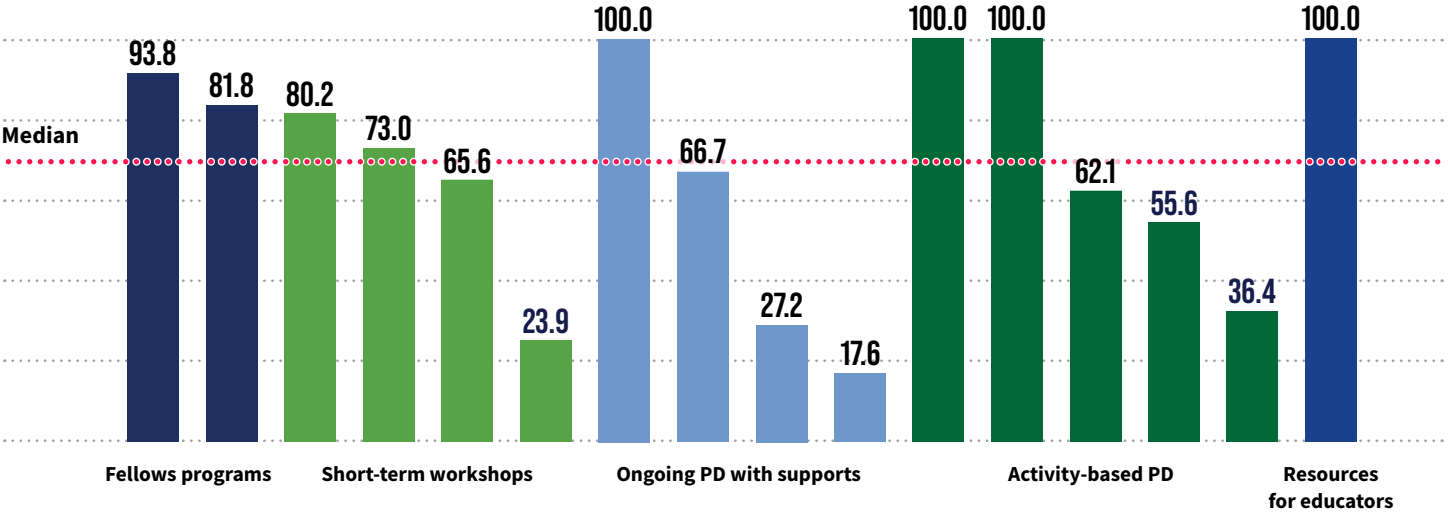
WHAT WAS THE IMPACT OF DSEC-FUNDED PROGRAMS ON EDUCATORS COMPARED TO LAST YEAR?

The DSEC Educator Alumni Survey was sent to all educators who participated in any one of the 16 programs directly serving educators listed in **Table 2**. However, like in many survey studies, not all program participants responded, despite multiple requests and reminders by DSEC partners. Of the 1,532 who were sent the survey, **784 educators (51%) responded**, which is about a **10% increase** over the response rates for Option Year One. The median response rate across the 16 programs offered by 15 DSEC partners was 69.8%, as shown in **Figure 4**. Survey response rates are shown by type of program. Not surprisingly, programs that served fewer participants and interacted with them more intensively (i.e., fellowship programs) had the highest response rates. **Given the ongoing impact of the COVID-19 pandemic on educators, the improvement in survey response rates across these 16 programs is impressive.**

10.0%

Increase over the response rates for Option Year One

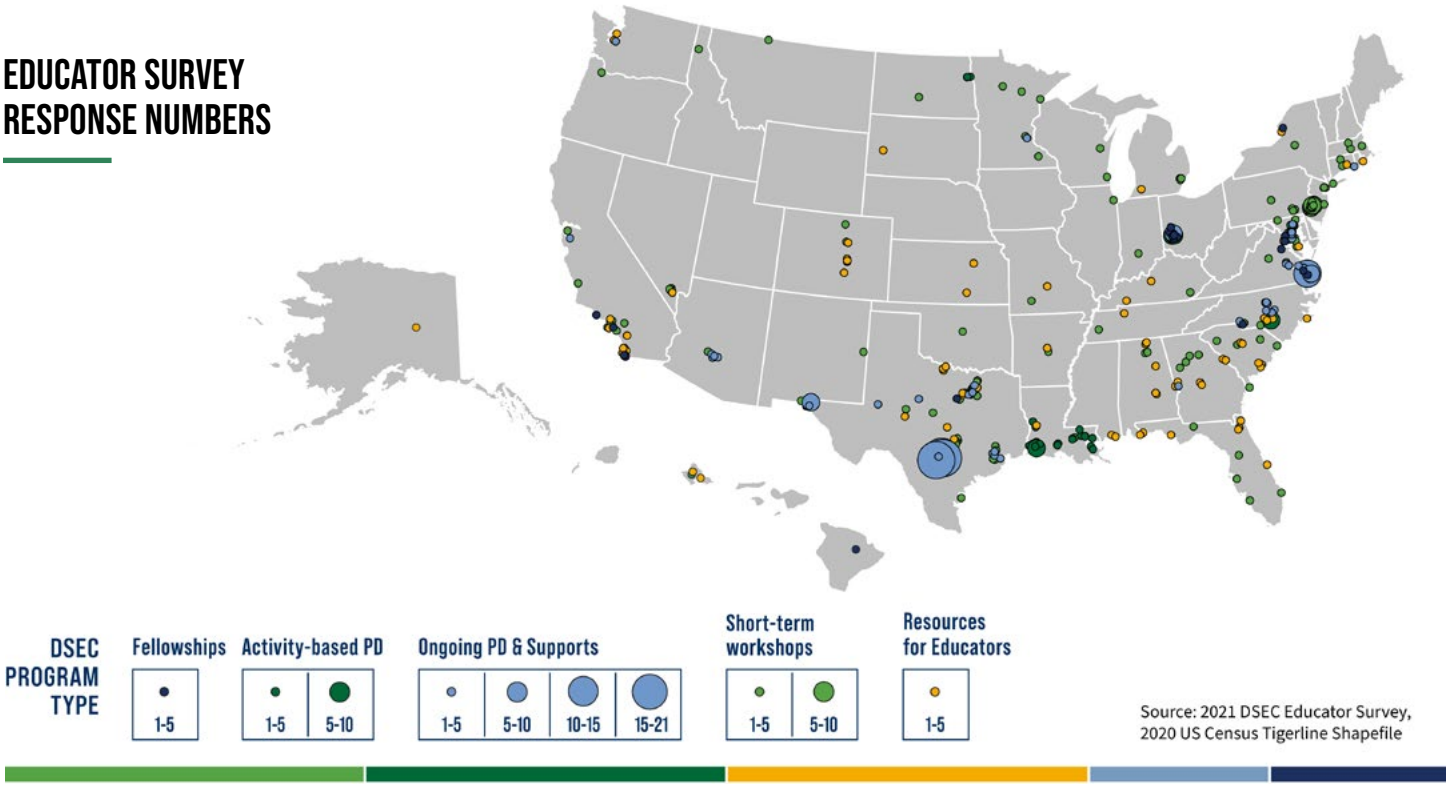
Figure 4. For the Educator Alumni Survey, Fellowship Programs Had the Highest Response Rates



The pink dotted line indicates the median response rate for the 16 programs serving educators.

Figure 5 shows the locations of survey respondents across the United States, by type of program (described in **Table 4**).

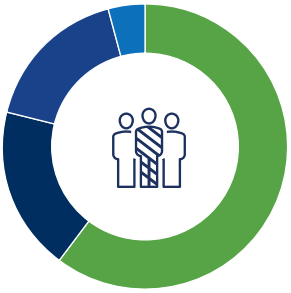
Figure 5. Educator Alumni Survey Response Numbers and Locations by Type of DSEC-Funded Program



For those who took the survey on RTI's platform (only 22% of the survey respondents), **the median time to compete the survey was about 5½ minutes**.[4] **Figure 6** describes the educators who participated in the survey and **Figure 7** shows the proportion of respondents from each of the DSEC STEM education and outreach partners serving educators. It is important to note that **NMSI, NCWIT, and Society for Science programs served the largest number of DSEC educators**, and therefore about two-thirds (64%) of the educator survey data come from those three programs. The gender breakdown is nearly identical to that of Option Year One survey data. **In Option Year Two, DSEC programs expanded the types of educators they served**—in the previous year, about 95% of the DSEC Educator Alumni Survey respondents were teachers, while only 54.5% were teachers for Option Year Two. **Additionally, Option Year Two seemed to extend well beyond STEM educators**, with only 31% indicating that they taught STEM subjects.

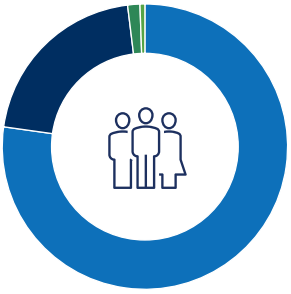
Figure 6. Surveyed Educators Were Primarily Female, White, and Educated

RACE



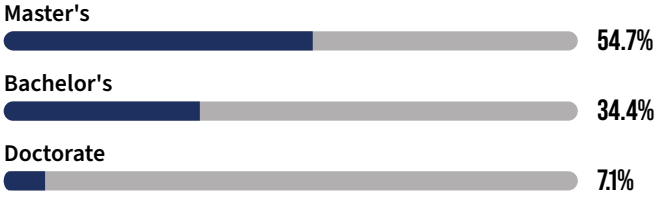
- 54.6% White
- 16.9% Black
- 15.3% Hispanic
- 4.0% Asian

GENDER



- 77.2% Female
- 20.6% Male
- 1.5% Prefer Not To Say
- 0.7% Non-Binary

HIGHEST LEVEL OF FORMAL EDUCATION



TEACHING EXPERIENCE

54.5%
Educators who are teachers

80.3%
Educators working directly with students

50.0%
Educators with STEM degree/certification

30.8%
Educators who teach STEM subjects

120
Average number of students the educator worked with while in this program (*n* = 549)

80%
Proportion Working in Public Schools

[4] The two largest programs serving DSEC educators—NCWIT and NMSI—did not use the RTI survey platform for data collection and instead collected DSEC Educator Alumni Survey data by incorporating the survey items into their own surveys. Data on survey response times comes from the educators from the other programs, who took the survey using the RTI platform (n = 97).

Figure 7. Proportion of All Survey Respondents from Each Partner Program Serving Educators

DSEC Partner Program	Proportion of survey sample
ASU CGEST CompuGirls PD	1.9%
Citizen Schools Catalyst PD	0.3%
CYBER.ORG PD	1.3%
Dayton Regional STEM Fellows	1.1%
DoD STEM Ambassadors	1.9%
Morgan State Micro:Bit PD	2.5%
NCWIT Counselors for Computing (C4C)	22.1%
NCWIT Leadership Development Series	5.3%
NMSI PD	24.4%
Prince George's Community College STEM Educator Learning Community	0.4%
RoboNation SeaPerch PD	9.8%
Society MS Research Teachers Conference	6.9%
Society *Science News* in High Schools	17.0%
Sinclair Community College Summer Bridge	1.0%
TGR STEM Studios	2.2%
STEM-on-the-GO van operated by TIES	1.9%

PD = professional development

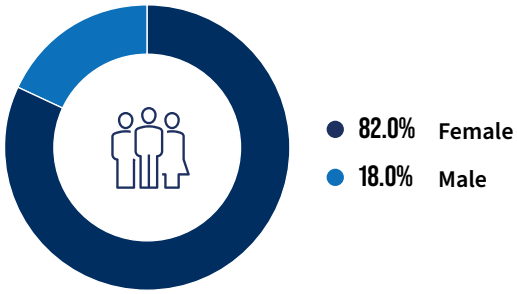
EDUCATOR INTERVIEWS TO SUPPLEMENT SURVEY DATA

To supplement results from the Alumni Educator Survey data, we interviewed 17 educators about their experiences in the DSEC-funded program in which they participated. Interviews were voluntary and all programs were asked to help recruit two to three educators from their programs to be interviewed. Many of the programs struggled to find volunteers. **The 17 interviewees represented seven (44%) of the 16 DSEC programs serving educators**. Figure 8 describes the interviewees. Results from the interviews are interspersed throughout this report to add depth and color to the survey findings.

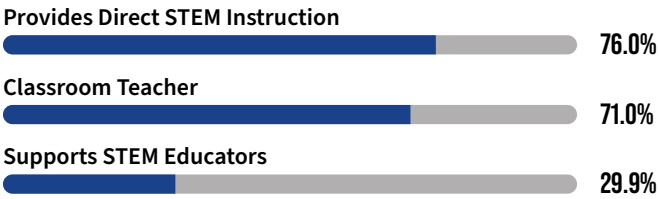
Figure 8. Interviewed Educators (n = 17) Predominantly Served Black and Underresourced Communities

3 MOST REPORTED RACIAL ETHNIC GROUPS*

GENDER



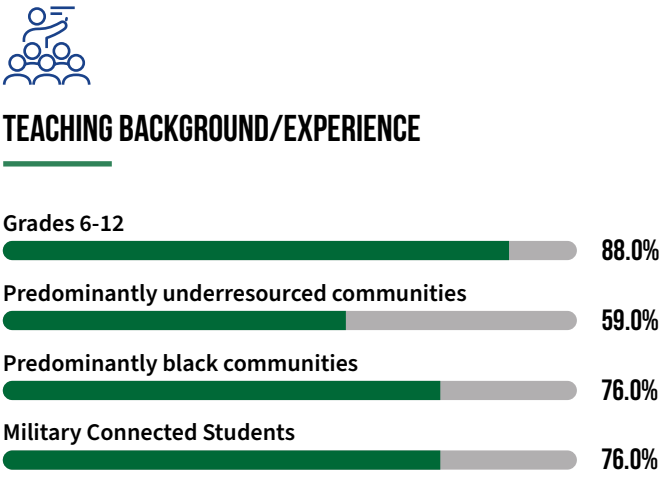
EDUCATOR ROLE



DSEC PROGRAMS REPRESENTED

- CGEST CompuGirls
- DoD STEM Ambassadors
- NCWIT Counselors for Computing
- NMSI College Readiness Program
- RoboNation SeaPerch
- Sinclair Community College/Central State University Summer Bridge Program
- The Society's *Science News* in High Schools

TEACHING BACKGROUND/EXPERIENCE



14 (5-28)

Median number (and range) of years teaching

10

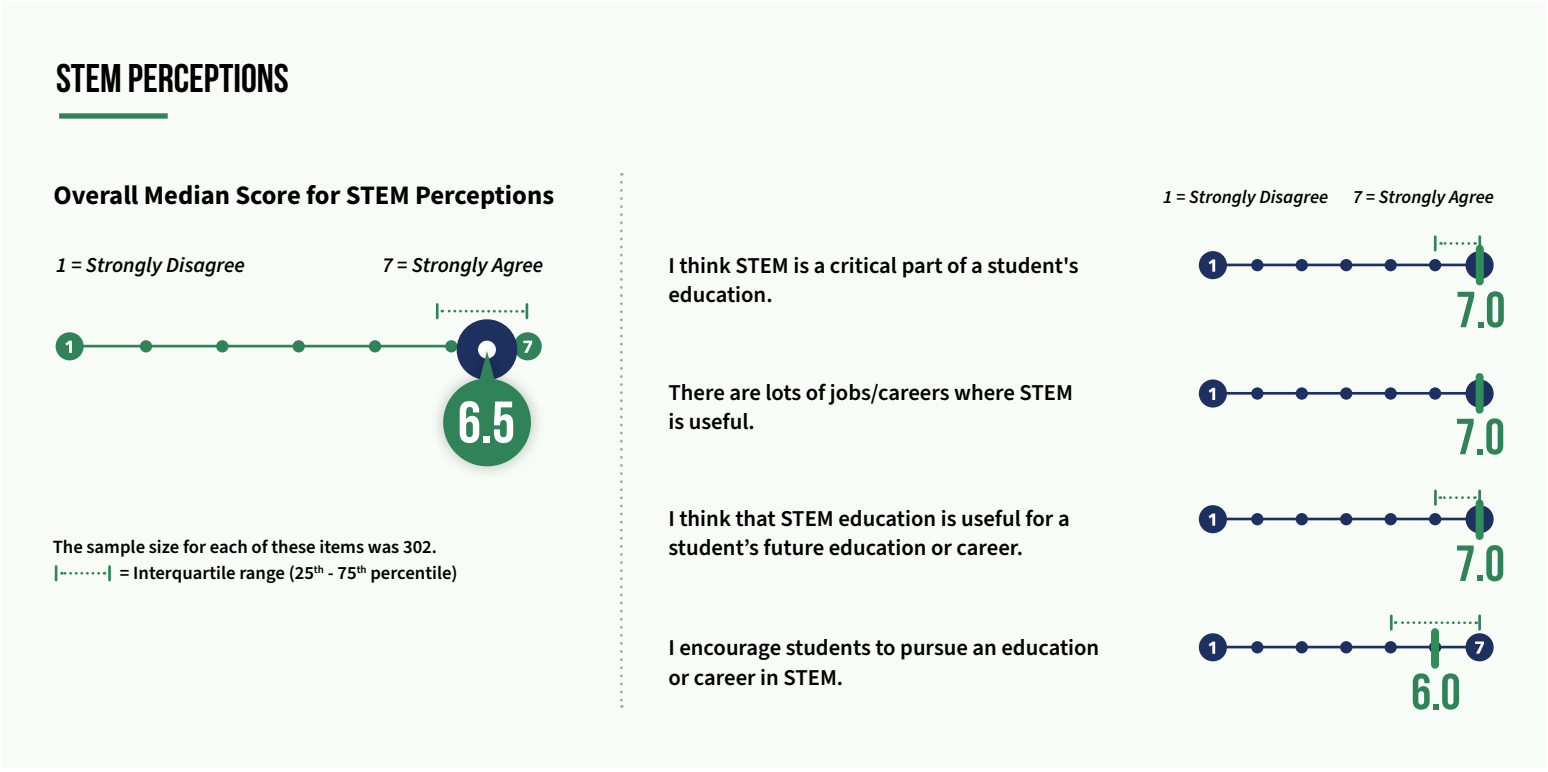
Number of states represented

> "Practicing how to explain concepts to students helped me to analyze and strengthen my own understanding of the topics."
>
> –Mentor, CGEST CompuGirls

EDUCATORS REPORT A STRONG IMPACT ON STEM ATTITUDES, BELIEFS, AND SELF-EFFICACY AS A RESULT OF PARTICIPATING IN A DSEC PROGRAM

Similar to survey results from Option Year One, results from this year's Alumni Educator Survey indicate positive STEM attitudes and beliefs and even stronger STEM self-efficacy as a result of participating in the DSEC-funded program. Results were slightly stronger for STEM-certified vs. non-certified educators, although the differences were 0.5 points or less on the 7-point scale. Measuring educators' STEM attitudes and beliefs is important because they impact instructional practice and student learning (e.g., Clarke et al., 2021; Hackman, Zhang, & He, 2021; Nadelson et al., 2013; Thibaut et al., 2018). Moreover, limited background knowledge, confidence, and efficacy for teaching STEM can hinder students' learning, preparation, and interest in more advanced STEM coursework (e.g., Nadelson et al., 2013). Educators answered questions measuring STEM perceptions[5] and STEM self-efficacy (a sample of items is shown in **Figure 9**).[6] Like the previous year's results using the same items, data from this year's survey suggest that overall, respondents' **STEM perceptions were strongly positive and they reported strong STEM self-efficacy as a result of participating in a DSEC-funded program**. On a scale of 1 (low) to 7 (high), the median response for all items measuring STEM perceptions was 6.5; for items measuring STEM self-efficacy, the median was 6.1.[7]

Figure 9. Educators Have Positive Perceptions of STEM and Strong STEM Self-Efficacy as a Result of Participating in DSEC



[5] Survey items were adapted from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), by Enochs, L.G., Smith, P.L., & Huinker, D. (2000). Accessed at https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1949-8594.2000.tb17256.x.

[6] Survey items are from NC State University Friday Institute's "Teacher Efficacy and Attitudes Toward STEM" survey, which can be accessed at: https://www.fi.ncsu.edu/pages/about-the-teacher-efficacy-and-attitudes-toward-stem-surveys-t-stem/.

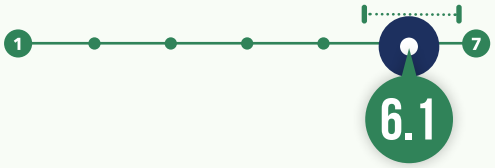
[7] For these and other figures throughout this report, we show the median score and interquartile range (scores at the 25th and 75th percentiles) because the data are skewed toward the high end of the response scales. When data are highly skewed, the mean and standard deviation can be misleading regarding the central tendency of the data.

Figure 9. Educators Have Positive Perceptions of STEM and Strong STEM Self-Efficacy as a Result of Participating in DSEC (continued)

STEM SELF-EFFICACY

Overall Median Scores for STEM Self-Efficacy

1 = Strongly Disagree *7 = Strongly Agree*



The sample sizes for each of these items ranged from 235 to 471: some DSEC partner programs did not include these items in their surveys.

|·····| = Interquartile range (25th - 75th percentile)

1 = Strongly Disagree *7 = Strongly Agree*

Sample of the STEM self-efficacy survey items:

I continually work to find better ways to teach my STEM content.

I am confident that I can teach my STEM content effectively.

I have the necessary skills to teach my STEM content.

When a student has difficulty understanding a concept in my STEM area, I am confident that I know how to help them understand it better.

I know where to find resources for teaching students about STEM careers.

"I think we had a lot of different ways to engage the students, either through different activities, or things like that. But in traditional STEM courses, it's normally not that way. It's normally: here's a lecture, here's maybe one tiny mini lab that they give to their students every semester. So yeah, just learning different ways to engage them either through technology, different activities, or throughout the lesson."

- Mentor, CGEST CompuGirls

"In English is where [students] struggle the most. So I was also using [*Science News*] as enrichment to kind of help support other content as well: 'Tell me why you picked that article. What were some interesting things you've learned? Is there something more that you wanna learn from that?' …[And] to kind of also build the relationships with my students that way too, by seeing what interested them."

- Teacher, the Society's *Science News* in High Schools

FOR 2 YEARS IN A ROW, EDUCATORS REPORT POSITIVE IMPACTS ON STUDENTS

The Option Year Two Alumni Educator Survey retained the same items from the previous year, measuring perceived impact of DSEC-funded programs on students to the best of the educators' knowledge. Those who did not work directly with students during their program participation did not answer these questions. Additionally, they could indicate if they did not know the impact on their students, because some of the impacts are not directly observable (e.g., inspired interest in STEM activities outside of school). **About 67%** of the survey respondents **answered items measuring student impacts**. **Figure 10** shows results for a sample of these survey items.

Results indicate that, on average, **respondents regarded their participation in the DSEC-funded program to have a moderate impact on their students across a range of outcomes**, from developing academic self-confidence to developing awareness of and inspiring interest in STEM degrees and careers, including in the DoD. On average, **the lowest-scoring item was about developing students' awareness of DoD STEM, research, and careers, with a median score of 3 on a scale of 1 (no awareness) to 5 (very aware)**, which was the same as in Option Year One. There was a slight increase in the average (not median) score in Option Year Two regarding inspiring students' interest in STEM careers in the DoD, from 3.4 in Option Year One to 3.7 in Option Year Two. The median remained the same at 4.0.

"Just participating in the program gave students more enthusiasm for the subject matter, and being surrounded by other girls who wanted to learn this, too, helped them to feel more comfortable. I think that seeing their gender so well represented in the program had the greatest impact on students."

- Mentor, CGEST CompuGirls

"Students expressed interest in certain career paths—particularly graphics, animation, and gaming. I've had engaging conversations with many students about their interest in certain STEM fields. I led especially engaging and in-depth classroom lessons with students in the gifted program."

–Title 1 Elementary School Counselor, NCWIT Counselors For Computing

"Introverted students feeling like they can achieve more [after participating in SeaPerch]… knowing that it's possible for them to play a part in construction of something that is a little more complicated than plugging in a cord—and then all of a sudden it works—is very empowering to them… That's priceless for this population."

- STEM Educator, RoboNation SeaPerch

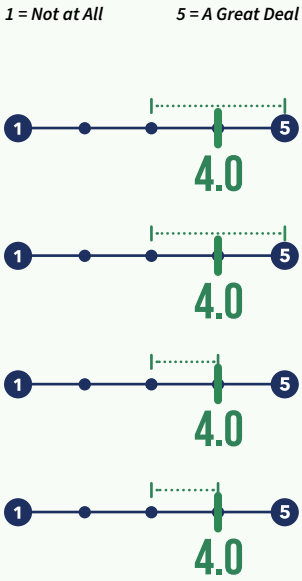
Figure 10. Educators Saw Favorable Impacts of Their Program Participation on Their Students

IMPACT OF STEM PROGRAMS ON YOUR STUDENTS

Overall Average Program Impact on Students

The sample sizes for each of these items ranged from 291 to 485. The median score for the full set of nine items was calculated for respondents who had answered at least two of the nine items (i.e., it allowed for missing data at the item level).
|·····| = Interquartile range (25th - 75th percentile)

Sample of impact of STEM programs on students items:



EDUCATORS REPORTED SIMILAR IMPACT ON THEIR OWN STEM AWARENESS, KNOWLEDGE, AND SKILLS, AND GREATER AWARENESS OF DOD STEM CAREERS COMPARED TO OPTION YEAR ONE

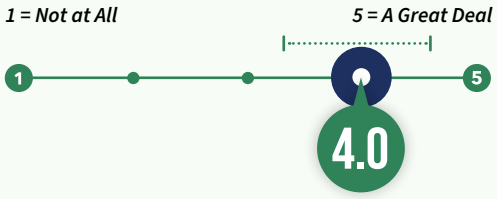
Like in Option Year One, the survey asked educators to indicate the impact of their participation in the DSEC-funded program on themselves. About 85% of survey respondents answered these items. On average, **respondents believed their participation in the DSEC-funded program benefited them in developing knowledge, skills, confidence, and interest in the STEM content they teach**, and in developing awareness of STEM careers—including in the DoD—to share with their students. **Like Option Year One, the highest-scoring item focused on inspiring their interest in the STEM content they teach**. When comparing the median scores for these items between both Option Years, they were the same (median = 4), with the exception of the item measuring awareness of DoD STEM research and careers to share with their students. Last year, the median score for this item was 3.5; for Option Year Two, it was 4.0. (It is important to note that only 37% of survey participants responded to this item due to some DSEC programs not including it in their program surveys). **Figure 11** shows results for these survey items.

Figure 11. Educators Report the Same Positive Impacts on Their STEM Awareness, Knowledge, and Skills and Greater Awareness of DoD STEM Compared with Option Year One

IMPACT OF STEM PROGRAMS ON YOU

Overall Average Program Impact on Students

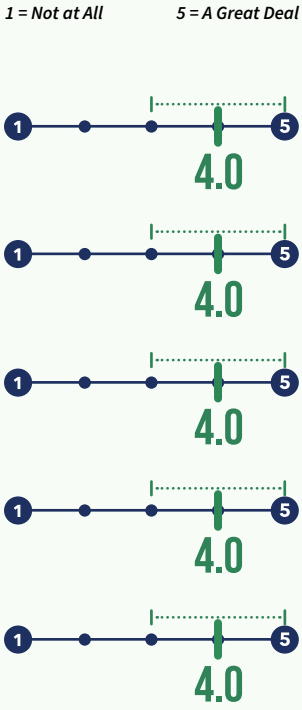
Option Year 1 Median Score = 3.7



The sample sizes for each of these items ranged from 291to 669.

|·····| = Interquartile range (25th - 75th percentile)

Sample of impact of STEM programs on students items:



Developed self-confidence in teaching STEM content
Option Year 1 Median Score = 4

Developed knowledge, skills, and abilities in STEM area(s)
Option Year 1 Median Score = 4

Inspired interest in the STEM content you teach
Option Year 1 Median Score = 4

Developed awareness of STEM research and careers
Option Year 1 Median Score = 4

Developed awareness of STEM research and careers in the DoD
Option Year 1 Median Score = 3.5

"Made me feel more confident in my ability to implement strategies and activities that I learned about, and gave me a better understanding of the risks and challenges that come with implementing those practices. Gave me more confidence in integrating technology with math in my classroom."

- High School Teacher, DoD STEM Ambassadors

"A lot of the articles actually talk a lot about different scientists, which is what's really cool with some of the kids because they learn about fields that they actually probably never even heard of before. So I think that the *Science News* magazine provides a lot of articles that showcase many different aspects of how you can work in the STEM fields."

- High School Teacher, the Society's *Science News* in High Schools

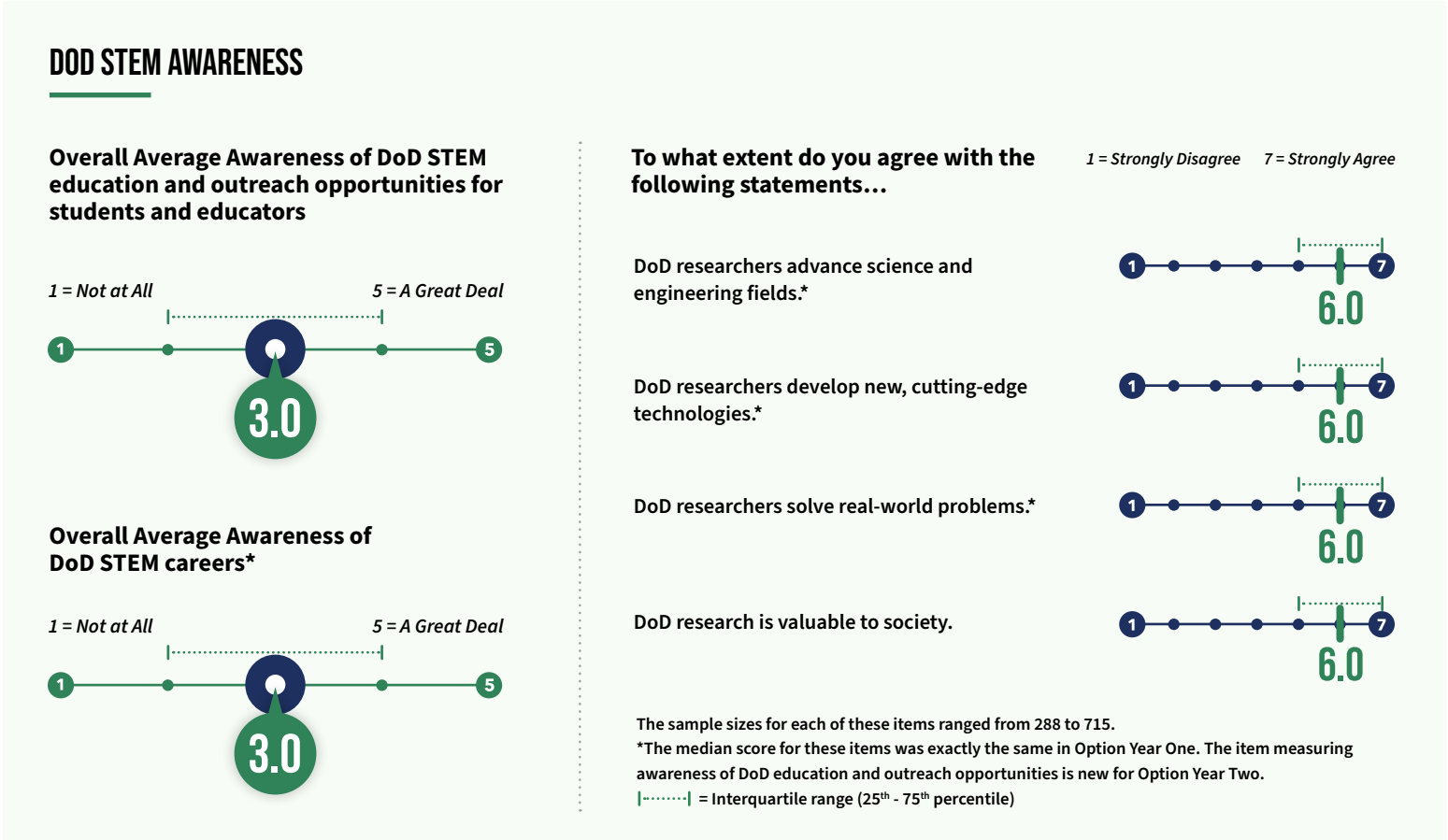
FOR A SECOND YEAR, EDUCATORS' REPORTED POSITIVE ATTITUDES TOWARD AND MODERATE AWARENESS OF DOD STEM

As shown in **Figure 11**, educators rated themselves as "quite aware" of DoD STEM research and careers to share with their students (median rating = 4 on a scale of 1 [Not Aware] to 5 [Very Aware]) as a result of participating in DSEC. Survey items also asked educators to indicate their general attitudes toward and awareness of DoD STEM research (not as a result of participating in DSEC). **Figure 12** shows the results for these survey items.

Like the results in Option Year One, data indicate that overall, educators have positive attitudes about DoD STEM.

On a scale of 1 (Strongly Disagree) to 7 (Strongly Agree), the median response was 6 (Agree) in response to four statements about the value of DoD STEM research for both Option Year One and Two data.[8] (See **Figure 12**). For items measuring DoD STEM awareness, the median was 3 (Somewhat) on a scale of 1 (Low Awareness) to 5 (High Awareness). The item measuring awareness of DoD education and outreach opportunities is new for Option Year Two. The item measuring awareness of DoD STEM careers was also asked in Option Year One and the median (a rating of 3) was the same.

Figure 12. Educators Have Positive Attitudes Toward and Moderate Awareness of DoD STEM



[8] The items are from the Army Educational Outreach Program (AEOP) Junior Science and Humanities Symposium evaluation report, and can be found in Table 51 on page 64 of https://www.usaeop.com/wp-content/uploads/2018/06/FY17-JSHS-Evaluation-Report-Findings.pdf

“It gave me a lot of knowledge that I didn’t have about STEM fields and STEM careers. Mostly I’m thinking about information technology, computer information systems and networking, and things like that. But, it just really broadened my knowledge… When I had a conversation with them during my classroom lesson, I had a lot of kids who wanted to enter into fields, like, where they could do… gaming and design. So it was bigger than what I thought.”

– School Counselor, Virginia, NCWIT Counselors for Computing

“I think that could be one more thing that was added…giving examples of what’s going on with cybersecurity with the DoD and in Arizona and Maryland. I think we could have covered a little bit more to show specifically what they would do and what those jobs would look like and what degree paths you [need] to get to those jobs.”

– Mentor, Arizona, CompuGirls

“In elementary [grades] you’re not going to be having them choose a career, but I think it’s always effective to plant that seed: ‘Hey, there are these careers out here, if you really like doing this kind of thing, maybe later you’ll get into engineering in this capacity.’ …Early on, our training was exploring the DoD STEM website and there was always some kind of career connection.”

– Teacher, Ohio, STEM Ambassadors

FOR A SECOND YEAR, EDUCATORS' PERCEPTIONS OF STEM PREDICT THEIR STEM SELF-EFFICACY, WHICH PREDICTS REPORTED PROGRAM IMPACTS

We measured whether educators had a STEM degree, years teaching STEM, grade levels taught (PreK-5, 6-12, or postsecondary), perceptions of STEM, and the type of DSEC-funded program in which they participated to evaluate the impact of these factors on key DSEC outcomes. **Table 3** shows the list of predictors and outcomes, and **Table 4** shows the type of program the educator participated in. **It is important to note that as much as 80% of survey respondents' data were excluded in these analyses due to missing data for at least one of the variables in the statistical models**.[9] Therefore, these results should be interpreted with caution.

Table 3. Tested Predictors of Key DSEC Outcomes

Predictor Variables	Key DSEC Outcomes
STEM degree (Yes or No)	Perceived impact of DSEC program on educators' students
Years teaching STEM	Perceived impact of DSEC program on the educator
Grade levels taught (PreK-5, 6-12, postsecondary)	STEM self-efficacy
STEM perceptions scale score	Awareness of DoD STEM
Type of DSEC-funded program (see Table 4)	Awareness of DoD STEM careers

Table 4. Types of DSEC-Funded Programs Serving Educators

DSEC Partner Program	Type of Program
ASU CGEST CyberGirls Professional Development	Ongoing PD and supports
Citizen Schools Catalyst	Ongoing PD and supports
Citizen Schools Maker Fellows	Fellowship programs
CYBER.ORG Cybersecurity Professional Development	Activity-based PD
Dayton Regional STEM Center Fellows	Fellowship programs

[9] Missing data are primarily due to three issues related to DSEC programs incorporating the DSEC Educator Alumni Survey items into their own surveys: (1) some of these programs did not include the teaching history items, e.g., having a STEM degree or years teaching STEM; (2) some allowed respondents to skip survey items (whereas the DSEC survey platform required items to be completed before moving forward in the survey); and (3) these programs used the brief version of the Educator Alumni Survey to reduce the response burden on their educators, which excluded the STEM perceptions scale.

Table 4. Types of DSEC-Funded Programs Serving Educators (continued)

DSEC Partner Program	Type of Program
DoD STEM Ambassadors program	Fellowship programs
Morgan State Micro-bit PD	Activity-based PD
NCWIT Counselors for Computing webinar series	Short-term workshops
NCWIT Leadership Development Series	Short-term workshops
NMSI Laying the Foundation and College Readiness Professional Development	Ongoing PD and supports
RoboNation SeaPerch PD	Activity-based PD
Society for Science Middle School Research Teachers Conference	Short-term workshops
Society for Science *Science News* in High Schools	STEM resources for educators*
TGR Foundation STEM Studios	Short-term workshops
STEM-on-the-Go van operated by TIES	Short-term workshops

*Because only one DSEC program belongs in this category, it was not included in the analyses comparing program types.
PD = professional development

We hypothesized that positive STEM perceptions should predict greater perceived impact on educators and their students, as well as greater STEM awareness, interest, and self-efficacy.[10] We were not sure whether or how having a STEM degree, years teaching STEM, grade level, or type of program would impact these key DSEC outcomes for educators. It is plausible that the impact could be greater for those with less experience in STEM, and equally plausible that those with more STEM experience would benefit more, as Option Year One results confirmed. Option Year One results also indicated that programs with ongoing and more intense participation (i.e., fellowships) had stronger positive impact than those of shorter duration and/or lesser intensity.

Building on results from Option Year One survey data, we generated five program categories (adding to the three from last year, due to new DSEC programs) that applied to those offered to educators. "**Ongoing PD and supports**" describes programs that support educators virtually and/or in person throughout the school year in the use of effective instructional practices for STEM teaching and learning. "**Short-term workshops**" describes programs in which educators are exposed to STEM teaching practices or content in shorter-duration (ranging from hours to days

[10] Addressing STEM perceptions was not a direct focus of some of the DSEC-funded programs serving educators. This factor was measured only to evaluate the extent to which it played a part in the DSEC outcomes of focus.

or weeks) virtual or in-person workshops. These programs are not intended to provide ongoing supports. "**Fellowship**" programs are those that engage participants intensively in building STEM competencies, usually working with a mentor or mentors to support their growth and apply their learning to STEM education settings. "**Activity-based PD**" applies to programs that provide STEM educators, mentors, and coaches with training to effectively implement specific hands-on STEM activities, e.g., building an underwater robot or delivering a lesson unit on cybersecurity. "**Resources for educators**" describes materials and resources offered to educators to include in STEM-focused lessons, including lesson planning assistance. This final category applied only to Society's *Science News* in High Schools. Given that only one program is represented in this category, results for this category cannot be disentangled from the program. **Table 5** shows the proportion of survey respondents in each of the five program types.

Table 5. The Highest Proportion of Respondents Came from Ongoing and Short-term PD Programs

Type of Program	Proportion of Survey Respondents
Activity-based PD	n = 130 (16.5%)
Fellowships	n = 24 (3.1 %)
Ongoing PD	n = 212 (27.0%)
Short-term PD	n = 287 (36.5%)
Resources for educators	n = 134 (17.0%)

PD = professional development

We assessed the relationships of the factors and outcomes listed in **Table 3** first by assessing the bivariate correlations between STEM self-efficacy and (a) impact of STEM program participation on educators, and (b) perceived impacts on their students. **STEM self-efficacy explained statistically significant variability in perceived DSEC program impact on educators** (r = .43, or 18.5% of the variance) and on their students (r = .22, or 5% of the variance).[11] It is important to note that these statistics measure covariations, or the strength and direction of relationships between variables, not whether they are causal. It may be that educators with the highest STEM self-efficacy are more likely to perceive and/or report positive program impacts on themselves and their students.

Next, we ran a series of regression analyses in which we used STEM degree (yes/no), years teaching STEM, STEM perceptions, and type of program as predictors of (a) impact of educator participation in the STEM program on their students; (b) impact on themselves; (c) STEM self-efficacy; (d) attitudes toward DoD STEM; and (e) awareness of DoD STEM careers. **The outcomes for which these predictors explained a statistically significant amount of variance included all but perceived impact of the educator's participation in the DSEC program on students**. **Table 6** summarizes these results.

[11] All bivariate correlations had p values < .0001 and sample sizes were n = 464 (impact on educators) and n = 340 (impact on students).

Table 6. Significant Predictors of Key DSEC Outcomes for Educators

DSEC OUTCOME	STEM Degree	Years Teaching STEM	Grade Levels Taught	STEM Perceptions Scale Score	Type of Program	Model R^2
Impact of your participation on your students	○	○	○	○	○	.065
Impact of your participation on you	○	○	○	●	○	.10
STEM self-efficacy	○	●	○	●	●	.26
Attitudes toward DoD STEM research	○	●	○	●	○	.19
Awareness of DoD STEM careers	●	○	○	●	●	.13

Model R^2 = proportion of variance in the outcome (left column) explained by the predictors (columns to the right, i.e., STEM degree through Type of Program). For example: R^2 = .065 means that 6.5% of the variance in impact on students is explained by the predictors; an empty circle "○" indicates that the predictor variable was not significantly related to the outcome; a green filled circle "●" indicates a statistically significant correlation.

Results indicate that more positive STEM perceptions, more years teaching STEM, and having a STEM degree were related to higher levels of the outcome variables in models where those predictors were statistically significant. For STEM self-efficacy, **activity-based, fellowship, and ongoing PD program types were related to higher STEM self-efficacy**, whereas only **activity-based and fellowship programs were related to higher awareness of DoD STEM careers**.

EDUCATOR OUTCOMES DIFFER BASED ON PROGRAM TYPE

To evaluate whether program type had an impact on key DSEC outcomes, we examined the proportion of survey respondents within each program type (listed in **Table 5**, with the exception of "resources for educators")[12] who scored at the high end of the following scales:

- DSEC program impact on your students
- DSEC program impact on you
- Your DoD STEM awareness

The sample sizes across the four program types included in the analyses differ widely, making the use of parametric statistical tests of mean differences unadvisable[13]; therefore, we used the nonparametric Chi-square test, a distribution-free test of how groups differ—in this case, in proportions of responses at or above a given scale score. Results from each Chi-square test indicate a

[12] "Resources for educators" was not included in the analyses because only one program represented that category (the Society's *Science News* in High Schools), and therefore results could not be untangled between type of program and the program itself.

[13] Parametric statistical tests of mean differences, such as t-tests or ANOVA, are based on a set of assumptions about the probability distributions of the data, the variance in the data, and other assumptions that are likely not met by these survey data. The Chi-square test does not make these assumptions of the data and therefore is more appropriate to use for analyses comparing differences across program types.

statistically significant relationship between type of program and the outcome. That is, the outcome is at least somewhat dependent on the type of program in which the survey respondent participated. The values in **Table 7** indicate **fellowship programs had a consistently higher proportion of high scores, indicating stronger program impacts on educators and their students and more positive attitudes toward DoD STEM research**. Scores for those participating in activity-based PD were the next highest. Interestingly, **those participating in ongoing PD reported the lowest impact on students and on themselves, on average**, whereas **attitudes about DoD STEM research were less positive for those participating in short-term PD workshops**.

Table 7. Greatest Impact on Students and on Educators Attributed to Fellowship Programs and Activity-Based PD

IMPACT ON YOUR STUDENTS[1]		IMPACT ON YOU[1]		DOD STEM ATTITUDES[2]	
% Scoring 4 or Higher		**% Scoring 4 or Higher**		**% Scoring 6 or Higher**	
Activity-based PD n=65	73.8%	**Activity-based PD** n=130	72.3%	**Activity-based PD** n=60	73.3%
Fellowship n=23	87.0%	**Fellowship** n=24	75.0%	**Fellowship** n=24	91.7%
Ongoing PD & supports n=191	24.1%	**Ongoing PD & supports** n=134	49.3%	**Ongoing PD & supports** n=17	70.6%
Short-term workshops n=130	67.7%	**Short-term workshops** n=251	54.6%	**Short-term workshops** n=187	58.8%
Resources for educators*	–	**Resources for educators***	–	**Resources for educators***	–
Chi-square value (prob): **94.9, (< .0001)**		Chi-square value (prob): **19.2, (0.0002)**		Chi-square value (prob): **12.7, (0.0052)**	

***Resources for educators was represented by only one program and therefore not included in the analyses.**

[1] 1 = Not at All; 2 = Very Little; 3 = Somewhat; 4 = Quite a Bit; 5 = A Great Deal

[2] 1 = Strongly Disagree; 2 = Disagree; 3 = Somewhat Disagree; 4 = Uncertain; 5 = Somewhat Agree; 6 = Agree; 7 = Strongly Agree

These results should be regarded as exploratory and preliminary, given the vastly different sample sizes for the four program types and the large amounts of missing data. It is plausible that program types that offer educators more intense professional training and development (e.g., fellowship programs), would produce more positive impacts. It is interesting that activity-based PD produced the next-strongest set of outcomes.

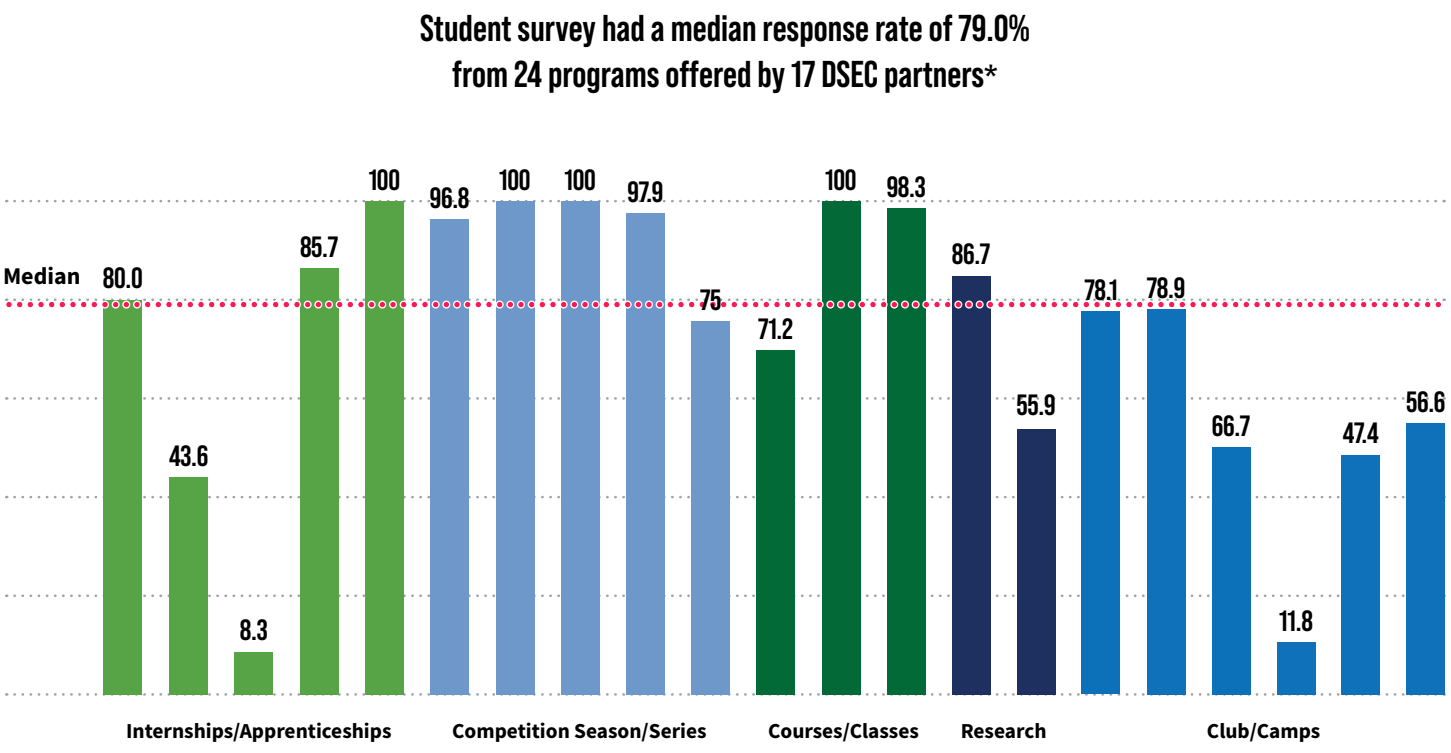
WHAT DO THE SURVEY RESULTS TELL US ABOUT THE IMPACT OF DSEC-FUNDED PROGRAMMING FOR STUDENTS?

For the Student Alumni Surveys Study, we surveyed students ages 13 and older who participated in DSEC-funded programs designed to provide meaningful STEM opportunities. **We also interviewed 26 students to obtain more in-depth information** on their experiences and perspectives about participating in a DSEC-funded STEM program. In this section we supplement student survey results with interview data.

MORE STUDENTS PARTICIPATED IN THE OPTION YEAR TWO SURVEY AND OVERALL RESPONSE RATES INCREASED

The DSEC Student Alumni Survey was sent to 2,704 students who participated in any one of the programs listed in blue in **Table 2** (in the previous section) and who were at least 13 years old. This is about 10% of the number of students surveyed in Option Year One. Given the very low response rate to the student survey last year (about 4%), we shifted the focus of the larger student-serving programs—i.e., *FIRST* and MATHCOUNTS—from collecting data from all students they served, to a smaller sample that could be attributed to being funded by DSEC. By focusing on the smaller samples, **we were able to increase the overall student survey response rate from 4% in Option Year One to 84% in Option Year Two**. For the 24 DSEC programs offered by 17 DSEC partners serving students, **the median program survey response rate was 79%, up from 51.4% in Option Year One**. **Figure 13** shows the response rates by types of student-serving programs. Unlike Option Year One, the highest response rates in Option Year Two came from programs offering competition series. This is largely due to having our largest student programs, offered by *FIRST* and MATHCOUNTS, focus on a more targeted sample of students to survey (i.e., those supported by DSEC funds), based on lessons learned from Option Year One data collection.

Figure 13. For the Student Alumni Survey, Competition Series Had the Highest Response Rates



The pink dotted line indicates the median response rate for all 21 programs.

*24 programs provided survey data but only 21 provided student counts from the Post Event Survey data by which to calculate response rates

Given that programs and participants were still being impacted by COVID-19 policies and practices, these high response rates are particularly impressive.

Figure 14 shows the proportion of survey responses that came from each program. The two programs offered by *FIRST* (Robotics and Tech Challenge) combined provided about 36% of the student survey responses, and overall, four programs provided about 70% of the student survey data for these results. This is important to bear in mind while interpreting results: **as with the educator survey data, the majority of student data are attributed to a handful of programs**.

> "We got to learn several things about cybersecurity, some that I didn't know before and some that I heard somewhere but didn't exactly know what it was. And we also got… to work with the other girls from our own state, but also other states, which is pretty cool. And yeah, I had a lot of fun doing CompuGirls."
>
> –Student, CGEST CompuGirls

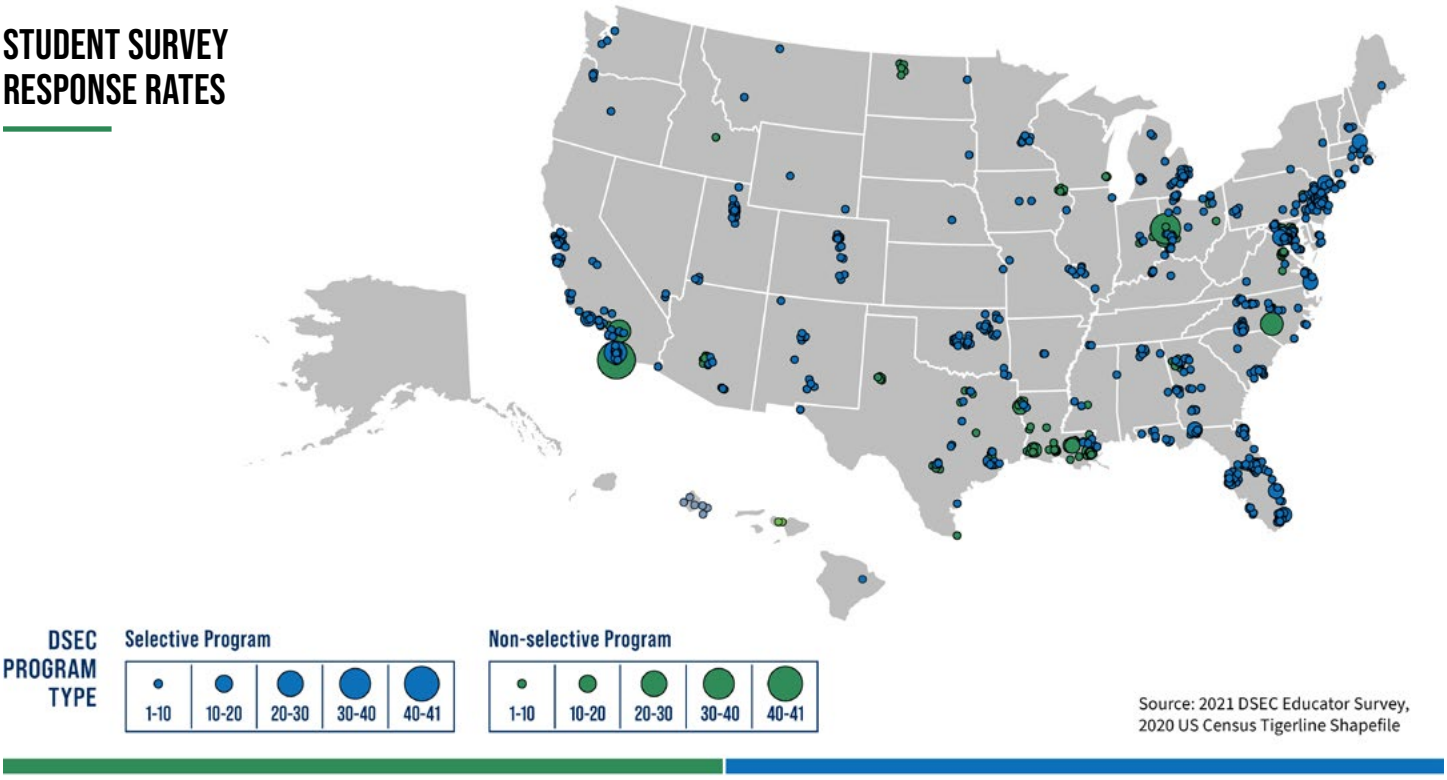
Figure 14. Twenty-Four DSEC Programs Provided Survey Data from 2,525 Students

Proportion of Student Survey Respondents from Each Program

DSEC Partner Program	Proportion of survey sample
ASU CGEST CompuGirls	2.0%
CEE DoD Summer Lab Research Intern Program	0.3%
CEE Research Science Institute	0.5%
CSU Summer Residential Program	0.4%
Citizen Schools STEM Catalyst	3.5%
CYBER.ORG Capture the Flag	5.7%
Dayton Regional STEM Center Air Camp	0.08%
Dayton Regional STEM Center Full Throttle	3.0%
FIRST Robotics Competition & Tech Challenge	36.0%
Learning Undefeated Emerging Leaders in Biotech Mentorship	0.04%
Learning Undefeated Emerging Leaders in Biotech Mentorship	1.0%
MATHCOUNTS Competition Series 20/21	13.5%
MATHCOUNTS Video Challenge	3.5%
NCWIT Aspirations in Computing Awards	1.4%
Prince George's Community College STEM Learning Community	0.2%
RoboNation SeaPerch	9.6%
San Diego Miramar BIO courses	1.8%
San Diego Miramar Life Sciences Internship	0.4%
Sinclair Community College Summer Bridge Program	0.6%
St. Petersburg College Career Readiness Workshops	2.3%
St. Petersburg College Summer Internship	1.7%
The Society Broadcom MASTERS Semi-finalists and DoD STEM Prize	10.2%
STEM-on-the-go van operated by TIES	1.3%

Figure 15 shows the locations of survey respondents across the United States, based on whether the program was open to all students or more selective (described in detail in **Figure 24**).

Figure 15: Locations of Student Alumni Survey Respondents by Type of DSEC-Funded Program (Open and Selective)



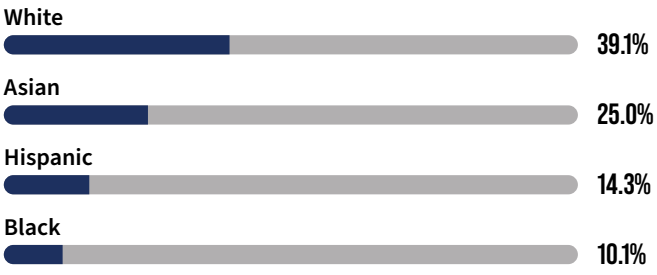
All but two programs surveyed the students using RTI's platform.[14] The median time to compete the student survey was 7 minutes.

Figure 16 describes the students who participated in the survey. Although the race, ethnicity, and gender of the largest proportion of student respondents was similar to Option Year One—i.e., Asian, white, and male—Option Year Two saw a lower proportion of white and Asian students responding and a higher proportion of Black and Hispanic students responding comparatively, suggesting a more racially and ethnically diverse sample of students. Other indicators of broadening participation in STEM include gender and socioeconomic status. The sample of students surveyed reflected a higher proportion of males and lower proportion (less than 20%) of students who would qualify for lower socioeconomic status. Notably, indicators of lower socioeconomic status—i.e., living with one's mother only, having parents or guardians who have not gone to college, and families renting vs. owning the home—indicate that less than 20% of the survey respondents would be classified as coming from low income homes. These indicators of socioeconomic status were chosen for the DSEC Student Alumni Survey based on research on measuring socioeconomic status with adolescents (Cowan et al., 2012; Ensminger et al., 2000; Hammond, Khurana, & Stormshak, 2021; and Svedberg et al., 2016). Less than 20% of secondary students qualified as military-connected.

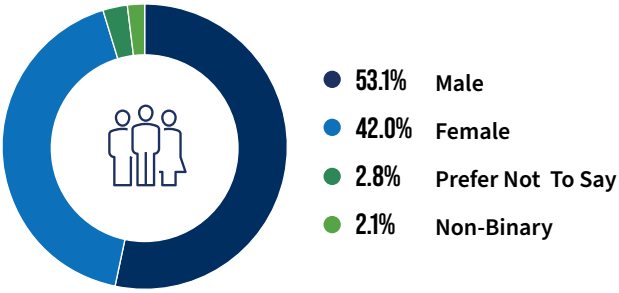
[14] Citizen Schools and the Society regularly collect their own survey data from students for the Citizen Schools' Catalyst program and Broadcom MASTERS semi-finalists, respectively. Both programs inserted the Alumni Student Survey items into their existing surveys.

Figure 16. Like Option Year One, Surveyed Students Were Primarily Asian, White, and Male

4 MOST REPORTED RACIAL/ETHNIC GROUPS*

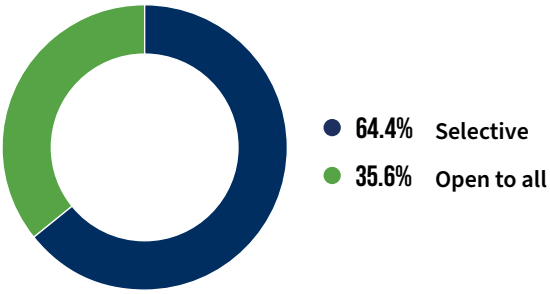


GENDER



TOP 5 GRADE LEVELS SURVEYED

PROGRAM TYPE



STUDENT'S HOME SITUATION

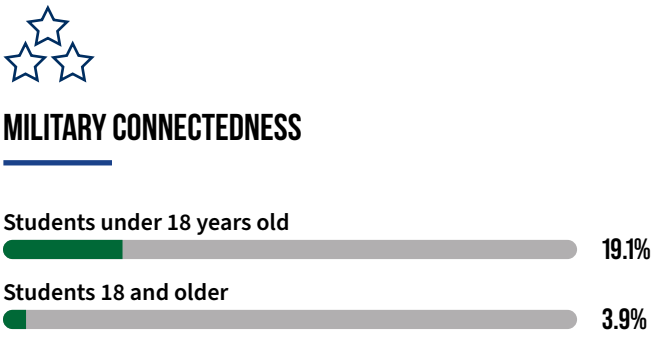
82.0%
English as the home language

19.2%
Family rents their dwelling

82.0%
Parent(s) went to college

12.2%
Lives with mother only

MILITARY CONNECTEDNESS



*Students could select "All that apply" and therefore values sum to > 100%.

To supplement the survey data, **we interviewed 26 students from 8 of the 24 programs (33%) participating in the Student Alumni Studies**. **Table 8** describes the interviewees. This report will supplement student survey results with interview results from these 26 students.

Table 8. Interviewees Were Primarily Female and Represented Multiple Racial/Ethnic Groups

Student Characteristics	Secondary Students n (%) of 17	%	Secondary Students n (%) of 9	%
Total	17	65%	9	35%
Gender				
Female	11	65%	8	89%
Male	6	35%	1	11%
Race/Ethnicity*				
Asian	7	41%	2	22%
Black or African American	4	24%		
Hispanic	1	6%	2	22%
White	1	6%	4	44%
Multiple races/ethnicities	3	18%	—	—
Prefer not to say	—	—	1	11%
Military Connected				
Parents (for students < 18) or self (students 18 or older)	3	18%	0	—
Age	Median = 14 [12-19 years old]		Median = 23 [18-39 years old]	
Language spoken at home				
English	13	76%	6	67%
Non-English (Arabic, Chinese, French, Hindi, Spanish, Turkish, Vietnamese)	4	24%	3	33%
College status				
Parents went to college	13	76%	—	—
First in family to go to college	—	—	2	22%
States represented				
	AK, CA, FL, MD, MA, MN, NC, OH, TX		CA, FL, OH	

***Students could select multiple responses to questions about their race and the military status of parent(s)/guardian(s); thus, counts for individual categories may sum to more than the total student count.**

STEM AWARENESS WAS STRONG WHILE STEM IDENTITY TRAILED FOR STUDENTS HISTORICALLY UNDERREPRESENTED IN STEM

Research on STEM education for students who are traditionally underrepresented and underserved in STEM indicates the importance of developing STEM awareness (UMASS Donahue Institute, 2011) and **STEM identity** (Seyranian et al., 2018). For Option Year Two, we measured STEM awareness using six of the eight items used in Option Year One; and to measure STEM identity, we asked students to report how they felt about themselves as a STEM person and about their STEM capabilities before and after participating in the DSEC program to measure change they would attribute to participating in the program.[15] **Figure 17** shows the median scores for a sample of four of the six survey items measuring STEM awareness and all four items measuring STEM identity. **Overall STEM awareness was quite strong** (with a median item score of 4.3 on a scale of 1 to 5) and **there were no differences between male and female students** (both groups had a median score of 4.3). However, **White students and Asian students, who are generally traditionally represented in STEM, reported higher overall STEM awareness compared to students who are historically underrepresented and underserved in STEM**, e.g., Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, and multiracial students (median scores of 5.0 and 4.0, respectively, for the traditionally represented and underrepresented groups). Overall, students' awareness of DoD STEM careers and of STEM opportunities in general (e.g., courses, camps, and internships), reflected the greatest variability as shown by the wider brackets around the median.

Additionally, for this group of student survey respondents, **STEM identity was quite strong before** (median = 3.8) and after (median = 4.1) participating in the DSEC program, on a scale of 1 to 5. **Because STEM identity was relatively strong prior to participating in the DSEC program, change in STEM identity, although positive, was small**. Male and female students reported the same overall median STEM identity scores, while students traditionally represented in STEM (White and Asian) reported stronger STEM identity both before and after participating in their DSEC program compared to those underrepresented in STEM (Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, and multiracial students).[16] We tested the difference between the mean STEM identity score for both groups after participating in DSEC (4.4 vs. 3.6, respectively) and the difference is statistically significant.[17]

[15] Items measuring STEM awareness were adapted from a survey used by Brandeis University for evaluation of *FIRST* programs. Items measuring STEM identity were adapted from the U.S. Department of Education 2009 High School Longitudinal Survey. Survey items measuring these two constructs are shown in the Appendix of this report.

[16] Not all students who report as Asian belong to groups traditionally represented in STEM. However, to reduce the survey burden, we included broad race and ethnicity categories, understanding that there are pros and cons to doing so.

[17] Using an independent samples t-test to compare group means, results indicate $t(822.55) = -10.61$, $p < .0001$.

Figure 17. Overall, Students' STEM Awareness and Identity are Quite Strong, Especially for Those Traditionally Represented in STEM

AWARENESS OF STEM

Overall Average Awareness of STEM

The sample sizes for each of these items is 2502.
|·····| = Interquartile range (25th - 75th percentile)

STEM IDENTITY

The sample sizes for each of these items ranged from 1,234 (Before) to 1,470 (After).
Indicates lowers scores for students traditionally under-represented in STEM

Interviews indicated that most students viewed themselves as a "STEM person" and attributed their STEM identity at least "somewhat" to participating in the DSEC program. Sample quotes include the following:

"Going to the ceremony, seeing other minorities and women who are in STEM and who are interested, and that it's local and associated with a known school in my area, made me feel that it is easier to see myself as a STEM person after this. After this award, I feel more comfortable going into computer science."

–Student, NCWIT Aspirations in Computing Regional Awards, San Diego

"It's just one of those things—like, I've always had self doubt about, Am I good enough? And I think that's just as a woman ourselves. I mean, we just mentally think that way, but I also like to challenge myself—like, I want to know a lot about something before I can promote, you know, myself on the matter. So I think the internship is an excellent opportunity… I do like to learn, but I know I'm [not] parallel to some people [who] have advanced degrees and a lot more experience. But as I am now and where I am in this journey, I do feel like I have contributions to make."

–Student, St. Petersburg College internship

"It gave me confidence in my abilities as a lab technician or person working in biotech. It made me more comfortable in my own skin [as a STEM person]."

–Student, San Diego Miramar biotech internship

We also asked whether they believed people were born to be good at STEM, or could learn to be good at it with the proper supports, which is indicative of a growth mindset. All students (100%) agreed that one could learn to be good at STEM with the right supports, while several acknowledged that some people are naturally better at STEM subjects than others but still need the proper supports. Sample quotes include the following:

> "I don't really think it's something to be born to be good at it because when I started, like, trying to learn how to code, I wasn't really good at that either. I wanted to stop sometimes, but it is something that I really enjoy doing. And I really… enjoy the feeling of when I coded something and it actually worked, so I kept going at it. So if someone does want to be in the field like this, it just will take a lot of practice. I mean, I'm not the most experienced person either, but like, you can keep learning and take the opportunities as you can to be better."
>
> – African American student (female), CGEST CompuGirls

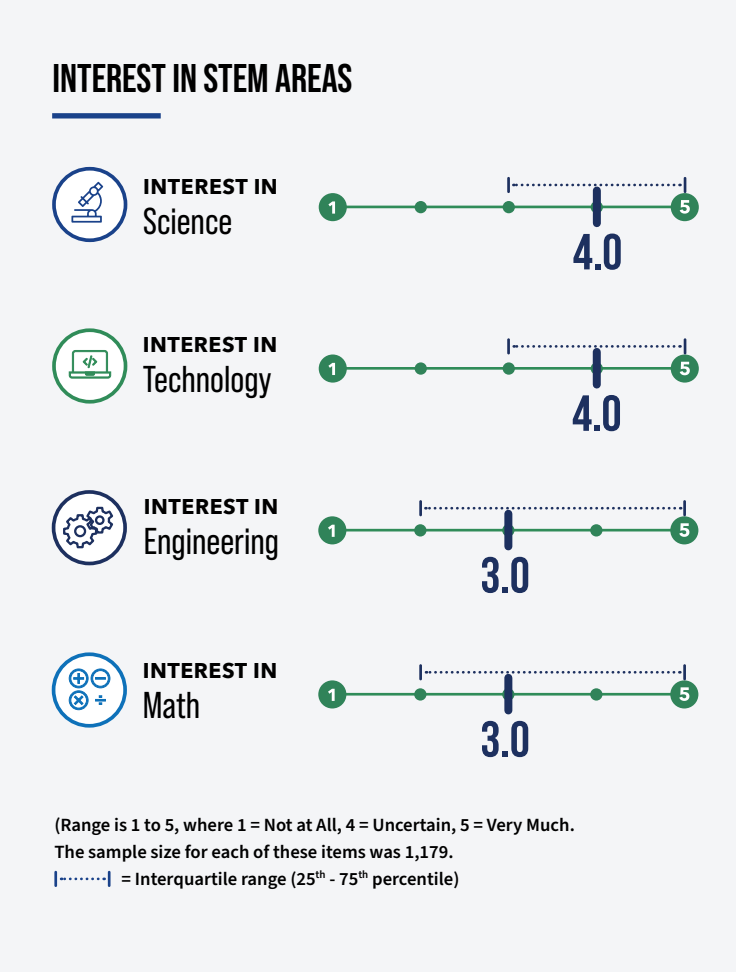
> "I noticed that for myself, with programming and talking to [others]… I know a software engineer who works for a contractor at Wright Patterson Air Force Base. He said it's something you gotta do to get good at over time. I've talked to my math teacher as well. It's something you have to get good at over time with more practice. It all comes down to the practice and you might not like it but that's okay, but just give it a try."
>
> – White student (male), Sinclair Community College Summer Bridge Program

> "People who aren't good at STEM can learn to be good at it. When I was younger, my knowledge of STEM was behind grade level. I improved at STEM through learning and spending time in STEM environments and programs."
>
> –Student, St. Petersburg College internship

STUDENTS ARE MOST INTERESTED IN SCIENCE AND TECHNOLOGY, AND GAINED NEW KNOWLEDGE OR SKILLS IN STEM

Two key DSEC objectives are to increase student interest and engagement in STEM, especially for those who are historically underrepresented and underserved in STEM and for military-connected students. The survey asked students the extent to which their interests in STEM changed as a result of participating in the DSEC-funded program in the four major STEM areas (science, technology, engineering, and math) on a scale of 1 (Not at All) to 5 (Very Much). **Overall, students indicated gaining more interest in science and technology** (median = 4 for both) **than in engineering and math** (median = 3 for both) as shown in **Figure 18**.

Figure 18. Students Report Strong Interest in STEM, Especially Science and Technology



"I was fascinated by gene editing and CRSPR and I enjoy learning about that more in depth... I never imagined that I would end up where I have. I learn a lot of new things every day, and I am being seen for the efforts I put in. Because I try my best to deliver the best results and be as efficient as possible and they notice that. And I really like that—it motivates me and pushes me to keep wanting to do better."

– Hispanic student (female), San Diego Miramar Biotech Internship

"I think what I really enjoyed was the people, and [the] meeting new people aspect of it and exploring new things. Like when I dropped off that Navy path, I actually didn't realize that there are more scholarships out there that I can get—I realized that I can get more internships through the Air Force. There's also—I found out that I can do a summer research job up at Central State next summer, which is pretty cool as well."

– White student (male), Sinclair Community College, Summer Bridge Program

"I know, there's a lot of stigma about [how] women in STEM are always so upset because the conditions are terrible. It is like a lot of what the media portrays or like the general public idea of females and in STEM environments. But they [CompuGirls female STEM mentors] were, like, all happy and nice and they weren't like, 'Ooh, tear down the patriarchy,' you know?"

–African American student (female), CGEST CompuGirls

We also asked students about ways in which the DSEC program had an impact on their interest in STEM, ranging from interest in a new STEM topic, to feeling prepared for more challenging STEM, to gaining interest in STEM careers in and outside the DoD. **Figure 19** shows results for a sample of these STEM interest outcomes, as well as the overall STEM interest impact scale score.

Results indicate a relatively high STEM interest overall, as a result of participating in a DSEC program (median = 4.1 on a scale of 1 [Low] to 5 [High]). There were **no differences in overall STEM interest associated with gender, and slightly stronger interest for students of racial/ethnic groups that are traditionally represented in STEM** (White and Asian) **compared with students of underrepresented racial/ethnic groups** (Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, and multiracial students), with medians of 4.2 and 3.9, respectively. For three of the nine STEM interest items, we compared mean item responses by gender and by traditionally represented vs. underrepresented. Results indicate that **students of racial/ethnic groups traditionally represented in STEM have a statistically stronger interest in wanting a STEM career in and outside the DoD, and feel more prepared for more challenging STEM activities** compared with students of underrepresented racial/ethnic groups.[18] Although statistically significant, the actual differences in mean scores were small enough on the scale of 1 to 5 to likely not be meaningful, as shown in **Figure 19**. Additionally, and not surprisingly, **students' awareness of STEM careers and overall awareness of STEM** (as described earlier) **were relatively strong predictors of wanting a STEM career in and outside the DoD**.[19]

[18] We compared the mean item scores for students of racial/ethnic groups traditionally represented and underrepresented in STEM for both of these outcomes (wanting a STEM career and feeling prepared for more challenging STEM) using independent samples t-tests. For the career item, $t(1,183.6) = -8.81$, $p < .0001$. For the challenging STEM item, $t(1,141.7) = -9.45$, $p < .0001$.

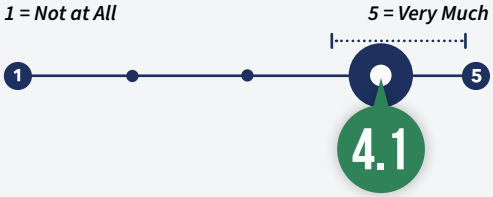
[19] R^2, a measure of the proportion of variance explained in an outcome, indicated that awareness of STEM careers and overall awareness of STEM explained from 17% to 43% of the variance in wanting a STEM career or a DoD STEM career.

Figure 19. Students Report Increased Interest in STEM Due to DSEC Program

STEM INTEREST

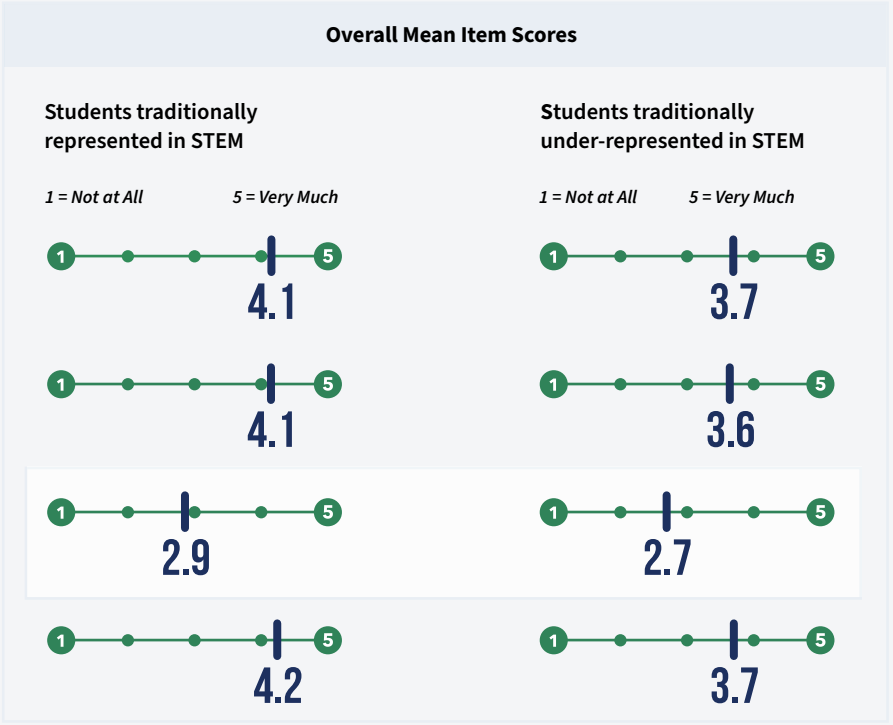
How much do you think DSEC has had an impact on you in the following areas?

OVERALL IMPACT ON STEM INTEREST



The sample size for each of these items was 2,498.
|·····| = Interquartile range (25th - 75th percentile)

How much do you think DSEC has had an impact on you in the following areas?



Another indicator of interest in STEM is engagement in STEM activities. Survey data indicate a **moderate level of extracurricular engagement** (median = 3 on a scale of 1 [Never] to 5 [A Lot]). **About half (53%) indicated participating in a STEM club, camp, or competition in or outside of school,** as shown in **Figure 20**.

Figure 20. Overall, Students Are Moderately to Quite Engaged in Extracurricular STEM

ENGAGEMENT IN STEM

How often do you do STEM-related activities in your free time, outside of school?

The sample sizes for each of these items ranged from 746 to 1,415.
= Interquartile range (25th - 75th percentile)

STEM PARTICIPATION

Participated in other STEM clubs, camps, or competitions in or outside of school

52.7%

Types of clubs, camps, or competitions, in or out of school:

Math	67.2%
Computers / Technology	61.0%
Science	56.0%

To supplement these survey data, we also interviewed students (n = 26) about what inspired them to participate, what kinds of activities they did, and what they enjoyed and did not enjoy about the DSEC program. Similar to Option Year One, the RTI research team coded interview responses using categories from the DSEC definition of meaningful STEM opportunities to assess the extent to which student reports aligned with those categories.[20] **Table 9** summarizes student responses.

[20] DSEC produced a document defining what is meant by "meaningful STEM opportunities" for students. The definition came from meetings with the Advisory Board and with DSEC partner programs, resulting in a compiled list of features of meaningful STEM activities (e.g., hands-on, inquiry-based, collaborative). Those features were used to code interview responses about DSEC program experiences.

Table 9. Secondary and Postsecondary Students Enjoyed Learning New Things and Building Their Knowledge and Skills, While Emphasizing Hands-on and Inquiry-Based Activities

WHAT INSPIRED YOU TO PARTICIPATE IN THE PROGRAM?

Top 3 Interview Responses - Secondary (*n* = 17)

71%	Love for/interest in the topic
24%	Strengthen resume/college application/job skills
18%	Teacher recommended

Top 3 Interview Responses - Postsecondary (*n* = 9)

78%	Strengthen resume/college application/job skills
78%	Sounds fun, interesting, useful
33%	Love for/interest in the topic

WHAT KINDS OF ACTIVITIES DID YOU DO IN THE PROGRAM?

Top 5 Interview Responses - Secondary (*n* = 17)

65%	Inquiry-based
47%	Inspired wonder, creativity
47%	Collaborative teamwork, and problem-solving
41%	Real-world application
29%	Connected to STEM careers

Top 5 Interview Responses - Postsecondary (*n* = 9)

100%	Hands-on activities
67%	Collaboration, teamwork, and problem-solving
56%	Real-world application
44%	Connected to STEM careers
33%	Connected across different sectors

Table 9. Secondary and Postsecondary Students Enjoyed Learning New Things and Building Their Knowledge and Skills, While Emphasizing Hands-on and Inquiry-Based Activities (continued)

WHAT DID YOU ENJOY ABOUT THE PROGRAM?

Top 5 Interview Responses - Secondary (*n* = 17)

59%	Learning new things, building knowledge/skills
41%	Collaboration, teamwork, and problem-solving
35%	Inspired wonder, creativity
24%	Real-world application
24%	Inquiry-based

Top 5 Interview Responses - Postsecondary (*n* = 9)

67%	Learning new things, building knowledge/skills
56%	Hands-on activities
56%	Collaboration, teamwork, and problem-solving
44%	Real-world application
44%	Sense of achievement

What did you enjoy about the DSEC Program?

"The most I 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 about a certain opportunity that came up or just about my own experiences or like, if I had a project in mind, then I had people who I could rely on and they would be able to support me."

–Student, NCWIT Aspirations in Computing Regional Awards, San Diego

"There's people willing to facilitate it and actually care about you, and who actually want the next generation to succeed."

–Student, NCWIT Aspirations in Computing Regional Awards (San Diego)

"I enjoyed getting to know the different careers that they had, like engineering, mechanical engineering, computer science, and robotics."

–Student, Central State University Summer Bridge Program

When asked about what they did *not* enjoy about the DSEC program, the most common response was "nothing" (47% for secondary and 57% for postsecondary students). The other responses did not combine into other common themes (i.e., they were unique to each individual). Sample quotes include the following:

> "Wish I had more hours. The internship was 150 hours total for the summer and would have loved more time!"
>
> –Student, San Diego Miramar Life Sciences Internship

> "Maybe we could have more virtual events if possible, because I don't recall that there were many. And maybe… a more interactive website for the affiliates for some situation, where it would make it so that it would be multiple sources of information. So it'll be able to incorporate the students and everybody more efficiently, maybe."
>
> –Student, NCWIT Aspirations in Computing Regional Awards, San Diego

STEM EDUCATION AND CAREER PLANS DIFFERED BY GENDER AND BY RACE/ETHNICITY FOR SECONDARY AND POSTSECONDARY STUDENTS

The ultimate objective of DSEC is to increase interest in and plans for STEM degrees and careers, with an emphasis on DoD STEM careers. Our survey measured course-taking plans for secondary and postsecondary education, as well as interest in STEM careers in and outside the DoD.

Survey results for secondary students indicate that, overall, most (> 60%) would take more high school STEM classes than they needed to graduate, while 24% were unsure. There were no differences between male and female secondary students, while **students of racial/ethnic groups traditionally represented in STEM were two times more likely than those from underrepresented groups to report interest in taking more STEM courses in high school** (68% compared to 50%, respectively).[21]

Regarding their postsecondary plans, **most of the secondary students planned to go to a 4-year college/university (77%) and pursue a STEM degree (69%)**. However, there were **differences by gender and by racial/ethnic groups** traditionally represented in STEM, as shown in **Figure 21**. Additionally, **students traditionally represented in STEM were twice as likely as students underrepresented in STEM to pursue a STEM degree**.

For **postsecondary students**, a similar pattern emerged, **with students identifying as White or Asian being more likely to pursue a Bachelor's degree in STEM than students traditionally underrepresented in STEM**. It is important to acknowledge that the sample size for postsecondary students is small, and therefore group comparisons should be regarded as more exploratory.

[21] We compared the proportion of students from both groups (traditionally represented and underrepresented in STEM) using an odds ratio. Results indicate an odds ratio = 2.1 (95% confidence intervals ranging from 1.7-2.7). An odds ratio of 1 indicates equal probability for both groups, while values above or below 1 indicate a greater or lesser probability for one group compared to the other. If the 95% confidence intervals do not include 1, the odds ratio is considered to be statistically significant, where $p \leq 0.05$.

Figure 21. Postsecondary Plans Differed by Gender and Race/Ethnicity

SECONDARY STUDENTS: HIGH SCHOOL PLANS

I will take as many STEM classes as I can in high school.*

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
60.3%	62.1%	67.7%	50.0%

SECONDARY STUDENTS: DEGREE PLANS

Go to a technical or vocational school to earn a certification

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
19.1%	12.6%	15.9%	17.2%

Go to a 2-year college (community college, junior college)

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
16.9%	18.1%	11.1%	27.2%

Go to a 4-year college/university

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
73.6%	81.7%	78.4%	76.7%

Join the military

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
7.8%	4.6%	6.2%	7.2%

Find a job

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
64.6%	70.8%	65.2%	73.1%

SECONDARY STUDENTS: DEGREE PLANS

Extent to which the DSEC program influenced high school STEM education plans

Do you plan to get a degree in a STEM subject?

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
70.3%	68.1%	74.6%	58.3%

POSTSECONDARY STUDENTS: DEGREE PLANS

Extent to which the DSEC program influenced postsecondary STEM education plans

Do you plan to or are you pursuing a Bachelor's degree in STEM?***

Males*	Females*	Traditionally Represented	Traditionally Underrepresented
60.4%	46.2%	49.5%	58.5%

*These data reflect the combined responses for two items: taking as many STEM classes as they can AND looking for more outside of their high school to take.

** Scale ranges from 1 (Not at All) to 5 (Very Much).

***Sample size for this item and these comparisons is small: only 70 of the 135 postsecondary students who responded to this survey item indicated they planned on a Bachelor's degree in STEM.

We used odds ratios to evaluate the probability of endorsing these outcomes by gender group and by racial/ethnic groups traditionally represented or underrepresented in STEM. Results indicated that **female students were 1.6 times more likely to plan on attending a 4-year college or university, but there were no gender differences in plans to pursue a STEM degree**. Interestingly, in Option Year One, the same analyses indicated that male students were more likely to pursue a STEM degree. Additionally, **students traditionally represented in STEM were more than twice as likely as those underrepresented in STEM to plan on pursing a STEM degree**.[22]

Interviews with 26 students added context and color to the survey findings. For the **secondary students**, 16 of 17 had postsecondary plans, all of which included a STEM major. Sample quotes include the following:

"I think I'll try to get into college… I would like to study ways to fight climate change and I might want to do desktop support."

–Hispanic student (male)

"Hopefully I will go to college, but I haven't really thought about what to major in. I'm more interested in a career in STEM than in any other area, but I'm not sure of exactly what I want to do. I'm interested in science [as well as math], and I'm thinking about maybe becoming a pharmacist or something like that."

–Asian student (female)

"I want to take a lot [of college courses] in… technology. So I was thinking maybe… college for editing, so I can learn more about editing or being someone in film or another platform like that."

–Alaska Native student (female)

"I am definitely gearing for a doctorate in information technology. So after high school I might…go to community college to try and start out."

–African American student (female)

[22] The odds ratio for female students vs. male students for attending a 4-year college was 1.6 (95% confidence intervals = 1.2-2.2). For pursuing a STEM degree, the odds ratio was 2.1 for traditionally represented vs. underrepresented students (95% confidence intervals = 1.7-2.7).

For interviewed **postsecondary students**, all nine (100%) were pursuing a STEM certificate or degree. Three students (33%) were pursuing a certificate/industry-recognized credential; three (33%) were pursuing an associate's degree; and three were pursuing a bachelor's degree.

These are sample quotes from secondary and postsecondary students about the influence of the DSEC program on their STEM education plans:

> "MATHCOUNTS made me more interested in math, which influenced my interest in studying physics."

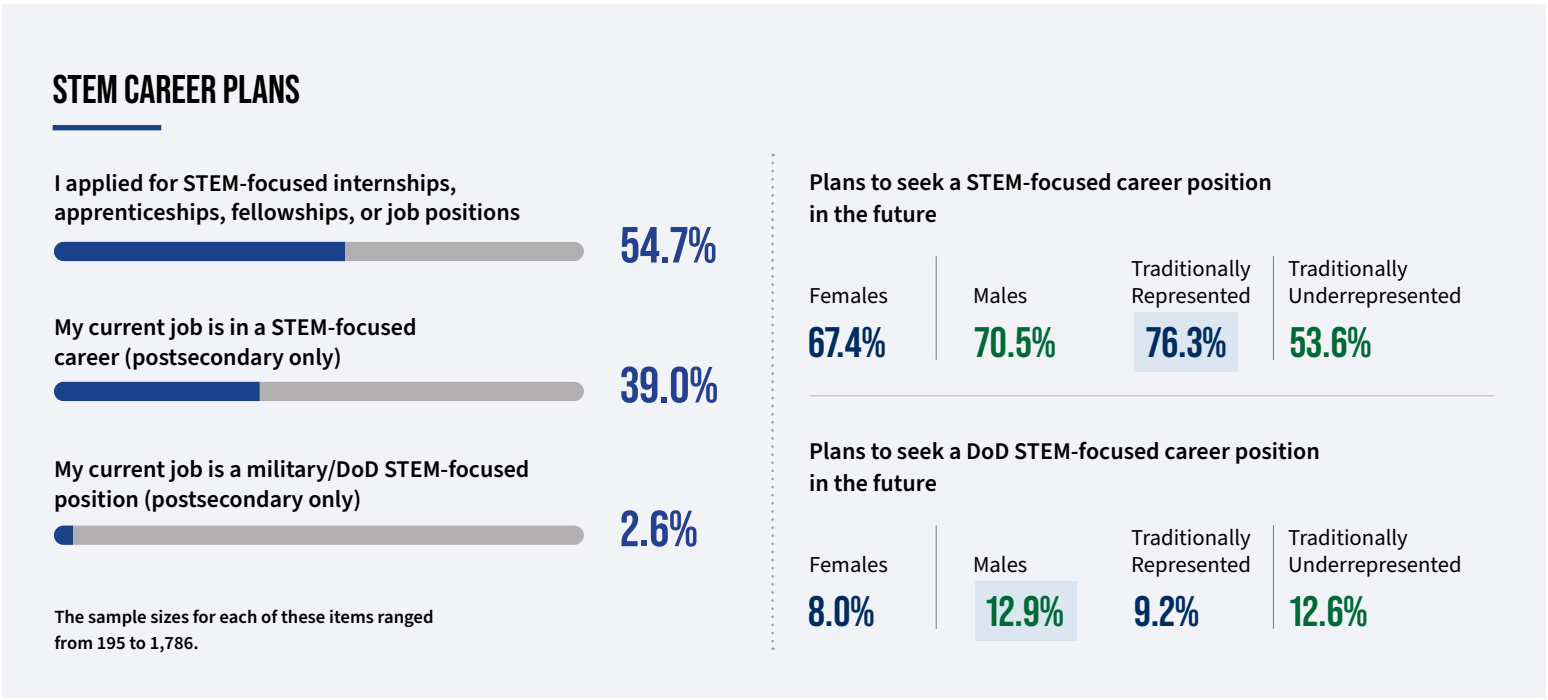
> "[NCWIT Aspirations in Computing] gave me an interest in engineering, the more technical side of STEM. Before, I was more interested in something like pre-med or biology, but now I want to incorporate biology and engineering together."

> "[The Society DoD Leadership Prize] [influenced my education plans] a little bit. Basically it says that maybe I am good at some science stuff."

Regarding interest in and plans for careers in STEM, **most survey respondents (secondary and postsecondary) planned on a STEM career (68.5%) while few (10.4%) planned on a STEM career in the DoD**. These proportions were nearly the same as they were in Option Year One survey results. STEM career plans were different by gender and by racial/ethnic groups: **those traditionally represented in STEM were almost three times more likely than those underrepresented in STEM to plan for a STEM career** and **female students were about one-third less likely than male students to plan on a STEM career in the DoD**.[23] **Figure 22** shows results for plans to seek STEM-focused careers in and outside the DoD.

[23] The odds ratio for traditionally represented compared to underrepresented students in STEM for planning on a STEM career was 2.8 (95% confidence intervals from 2.3-3.4). The odds ratio for females compared to males to plan for a STEM-focused career in the DoD was 0.59, $p < .05$, (95% confidence intervals from 0.39-0.88).

Figure 22. Most Plan on a STEM Career, with Race/Ethnicity Group and Gender Differences



To supplement the survey data, we interviewed students about their career interests, which they could share in more depth than in a survey. Most secondary (65%) and postsecondary (78%) students indicated that the program had shared information about STEM careers with them. We asked about their dream careers if time and resources were not an issue. All of the 17 secondary students and 8 of the 9 postsecondary students indicated interest in a STEM career. **Nine (53%) of the 17 secondary students and 4 (44%) of the postsecondary students said they are interested in a STEM career in the military**. Secondary students mentioned cybersecurity, coding (e.g., for autonomous vehicles), IT, something in the CIA, biology or biochemistry, aviation, and being a pilot. Students who were not interested in a DoD STEM career cited their beliefs and assumptions about the military as reasons. Common assumptions include that the military is more authoritarian than civilian organizations, which hampers freedom of choice (e.g., where to live or what kind of career to pursue); and that the military uses STEM to wage war.

> "Some people in the military mostly maintain the equipment, whereas if you're a defense contractor, you can actually work the equipment, create it and all that—you know how it works much better than someone who is in the military knows it… The military provides great training from what I hear… You can't go wrong. I mean, there's the Reserve option. It's just, I would rather get straight into actually being able to study it rather than having to wait to study it then apply it later on."
>
> –Military-connected (Navy) high school student (male), Sinclair Community College Summer Bridge Program

> "I want to be a biologist in the Navy because I love STEM and I love my country."
>
> –Military-connected (Navy) middle school student (female), the Society's DoD STEM Leadership Prize

Our interviews also asked students about ways in which they became interested in STEM and STEM careers. We asked them if they knew anybody in the career(s) in which they were interested and who encouraged them the most to be involved in STEM. The following table shares results from these questions.

Table 10. Parents, Families, Friends, and Mentors Inspired Students to Pursue STEM

INSPIRATON TO PURSUE STEM

Who has encouraged you the most to be involved in STEM?

Secondary Students (n = 17)		Postsecondary Students (n = 9)	
65%	Parents	33%	Teachers/Mentors
29%	Relatives	22%	Friends
24%	Teachers	11%	Parents
18%	Friends		

> "I have a friend who completed the program I'm in… and went on to get a bachelor's and is now working in a biotech lab. He told me about his work, and that sparked my interest. He encouraged me to attend the program, and that's where I met the mentor who encouraged me to apply for the internship."
>
> –Community college student (female), San Diego Miramar Life Sciences internship

Do you know anyone with the career in which you're interested?

Secondary Students (n = 17)		Postsecondary Students (n = 9)	
59% (10)	Yes	66% (6)	Yes

> "Yes—many people I work with at my internship work in environmental studies or environmental engineering. One of them works in wildlife rescue, which is really interesting to me!"
>
> –Community college student (female), St. Petersburg College internship

Table 10. Parents, Families, Friends, and Mentors Inspired Students to Pursue STEM (continued)

INSPIRATON TO PURSUE STEM

Have you encountered any barriers to pursuing a STEM degree?

Secondary Students (n = 17)	Postsecondary Students (n = 9)
Not asked of secondary students	78% (7) Yes

> "Yes—a field I was formerly interested in is heavily male-dominated, and webinars about the subject were frustrating because I felt my input wasn't valued."
>
> –Community college student (female), St. Petersburg College internship

We asked secondary students about the things they have done in their lives that got them the most interested in STEM-related topics. Students mentioned in- and after-school STEM-focused programs most frequently, as well as watching YouTube videos, help and support from family, playing video games and wanting to learn about how they were developed, as well as job shadowing and talking with professionals. Some sample quotes include the following:

> "In elementary school, I did basic robotics/ programming activities. Now that I'm in high school, I'm on an engineering pathway, which is focused on engineering and technology. I do coding and work on STEM projects independently. Recently I was inspired to work on a project that I saw modeled by a YouTuber."
>
> –High school student (female), NCWIT Aspirations in Computing Award

> "I think [participating in RoboNation's SeaPerch] did really get me more into STEM because again, it was just a really cool experience… It was my first after-school program too. So it was my first experience with staying outside of school and doing something that I was interested in…Seeing all the magic happen is cool."
>
> –Middle school student (female), CompuGirls

> "Participating in my robotics team program—doing STEM as a team—is more fun than doing it by yourself. MATHCOUNTS was really fun and I want to do it again next year too."
>
> –Middle school student (male), MATHCOUNTS Video Challenge

WHAT DO LONGITUDINAL DATA SAY ABOUT THE IMPACT OF DSEC'S TWO LARGEST PARTNER PROGRAMS ON STUDENTS?

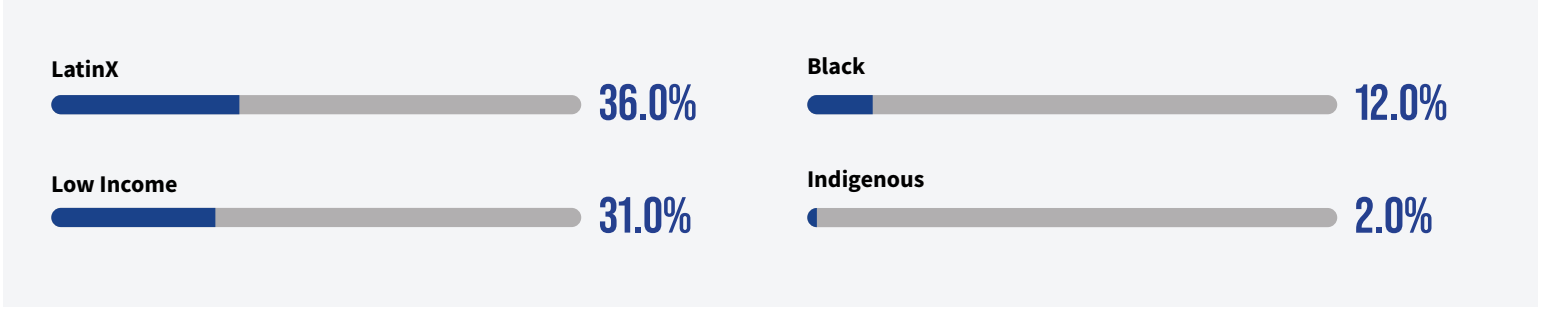
NMSI and *FIRST* are two of DSEC's largest partners providing STEM programming to educators and/or students. Both programs have been conducting independent evaluations for years, prior to joining DSEC. Their longitudinal data were first reported in the Option Year One Alumni Studies report. Here, we summarize the results of their ongoing longitudinal studies one year later, during Option Year Two. Additionally, San Diego Miramar College has collected data from students who participated in their DSEC-funded biotechnology courses and/or summer internship in Option Year One, and at the time of this report, in Option Year Two. The following summarizes findings from the longitudinal data collected by these three DSEC STEM education partners.

NATIONAL MATH + SCIENCE INITIATIVE

NMSI CONTINUES TO SEE STRONG LONG-TERM OUTCOMES FOR STUDENTS TRADITIONALLY UNDERSERVED IN STEM

The National Math and Science Initiative or NMSI, is a nonprofit organization that provides professional development for STEM educators to strengthen their practice and support students to become STEM leaders and innovators. Their College Readiness Program (CRP) is designed to expand access to rigorous coursework for traditionally underrepresented students in AP math, science, computer science, and English. Using College Board data, NMSI characterized the students they serve through these AP courses. Student demographics for the 2021-22 school year include the following, indicating that about **half of the students served come from racial and/or ethnicity groups traditionally underserved through AP courses**.

Figure 23. Proportion of students served by CRP in 2021-22



In a longitudinal study of CRP, NMSI collects data from the National Student Clearinghouse (NSC) for all CRP students enrolled in 12th grade between Spring 2015 and Spring 2022, and includes those who graduated in 2022. The sample includes 95,986 students from the graduating classes of 2015 – 2022. **Figure 24** describes the students in this NSC sample.

Figure 24. National Student Clearinghouse Sample, 2015-2022

OVERALL SAMPLE SIZE

95,986

All students from HS Graduation Classes 2015-2022

ENROLLMENT SAMPLE SIZE

95,933

All students from HS Graduation Classes 2015-2022

PERSISTENCE SAMPLE SIZE

59,258

All students from HS Graduation Classes 2015-2021 that had enrolled in a postsecondary institution

COMPLETION SAMPLE SIZE

11,493

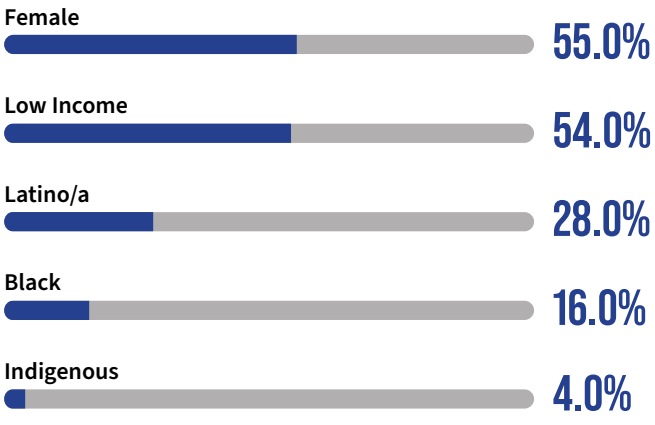
All students from HS Graduation Classes 2015-2016 that had enrolled in a postsecondary institution

STEM DEGREE SAMPLE SIZE

14,332

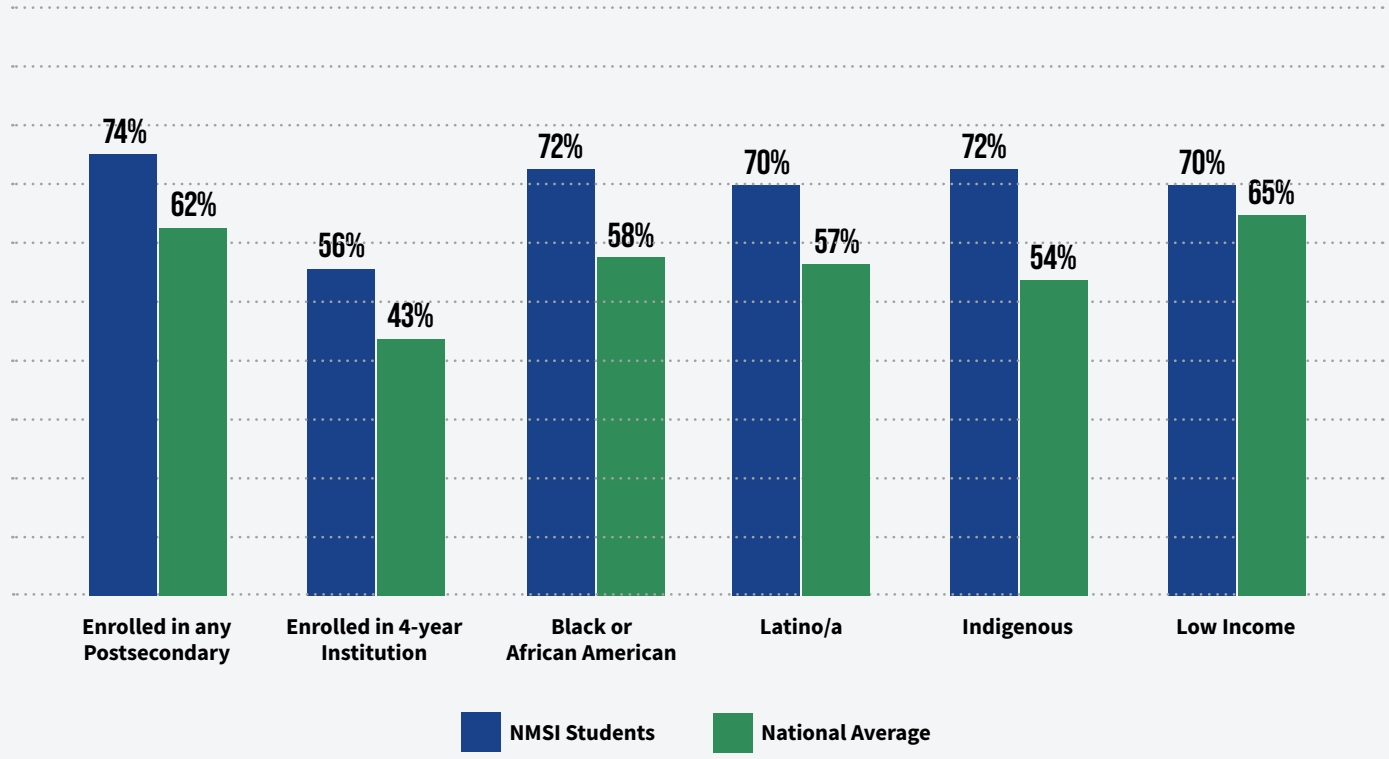
All students completing post secondary from HS Graduation Classes 2015-2018

OVERALL DEMOGRAPHICS



Furthermore, NMSI has broken out the data from students enrolled in DSEC funded schools. Outcomes from NSC data indicate that NMSI DSEC students have a higher rate of postsecondary enrollment than the national average, as shown in **Figure 25**. This trend holds true for Black, LatinX, and Indigenous students as well as those from low income households.

Figure 25. Postsecondary enrollment is higher for NSMI DSEC students vs. the national average

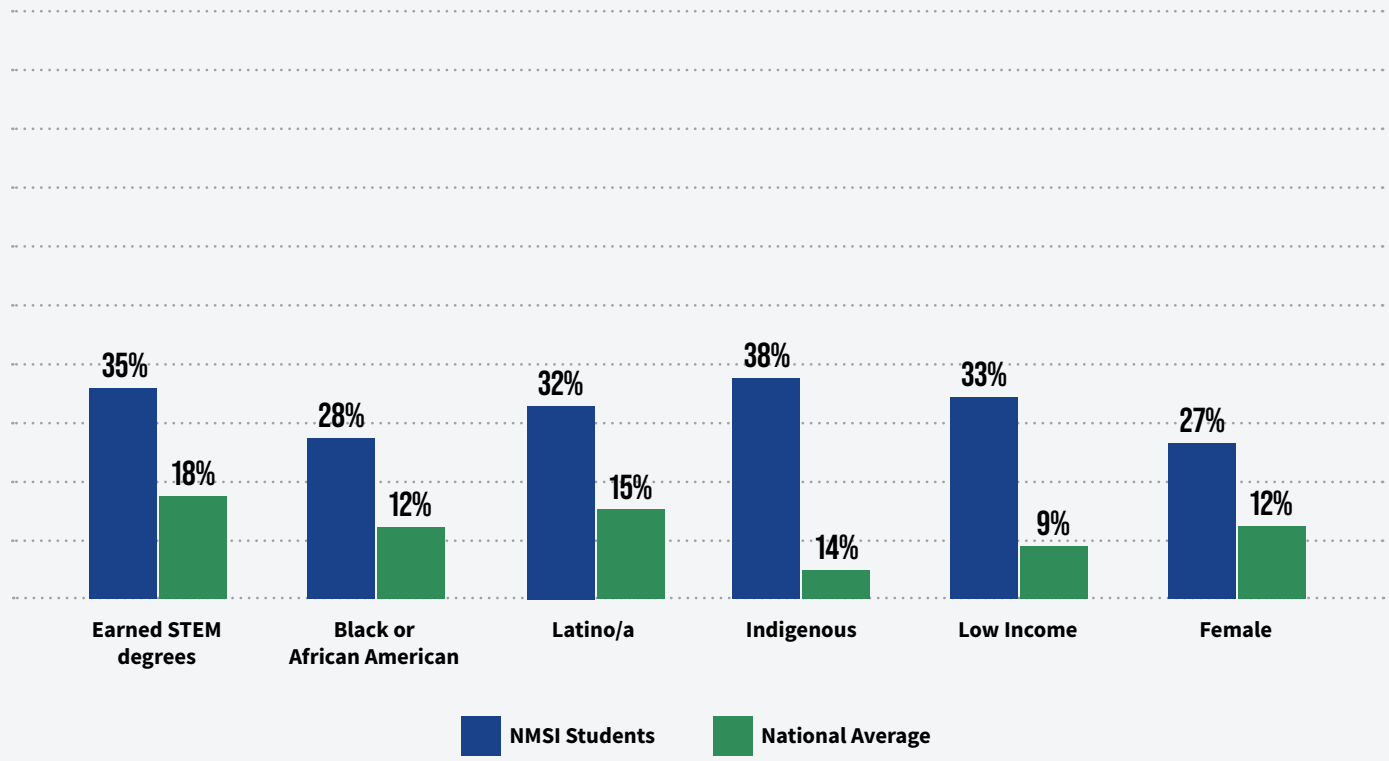


Not only do they enroll at higher rates, but **NMSI DSEC students are more likely to persist (i.e. attend at least 3 semesters) in postsecondary institutions compared to the national average**. For Classes of 2019 – 2021, persistence rates averaged at **88%** while the national average was **73%**.

Assessing graduation rates and STEM degree earning for NMSI students applies to students from the classes of 2015 – 2018, before DSEC funding. For those NMSI students, they graduate at slightly higher rates within 6 years (66%) compared to the national average (62%).

Regarding STEM degrees, **NMSI college graduates earn STEM degrees at twice the national average**, and the proportion of NMSI students earning STEM degrees has remained consistent for the Classes of 2015 – 2018 (ranging from 34% - 36%). Moreover, **a higher percentage of NMSI students from traditionally underrepresented groups in STEM earn STEM degrees compared to non-NMSI students** as shown in **Figure 26**.

Figure 26. A higher proportion of NMSI students earn STEM degrees



In summary, NMSI continues to see strong long-term outcomes for Black, LatinX, and Indigenous students as well as those from low income households who learn with and from teachers that participate in NMSI's College Readiness Program. These data suggest that NMSI is meeting its mission to serve students furthest from opportunity by helping to ensure that they earn credits in advanced level high school courses, and that they go on to attend, persist, and earn degrees from postsecondary institutions, and complete degrees in a STEM field.

FIRST STUDENTS CONTINUE TO SHOW STRONGER STEM INTEREST, ENGAGEMENT, KNOWLEDGE, AND IDENTITY THAN COMPARISON STUDENTS, 9 YEARS LATER

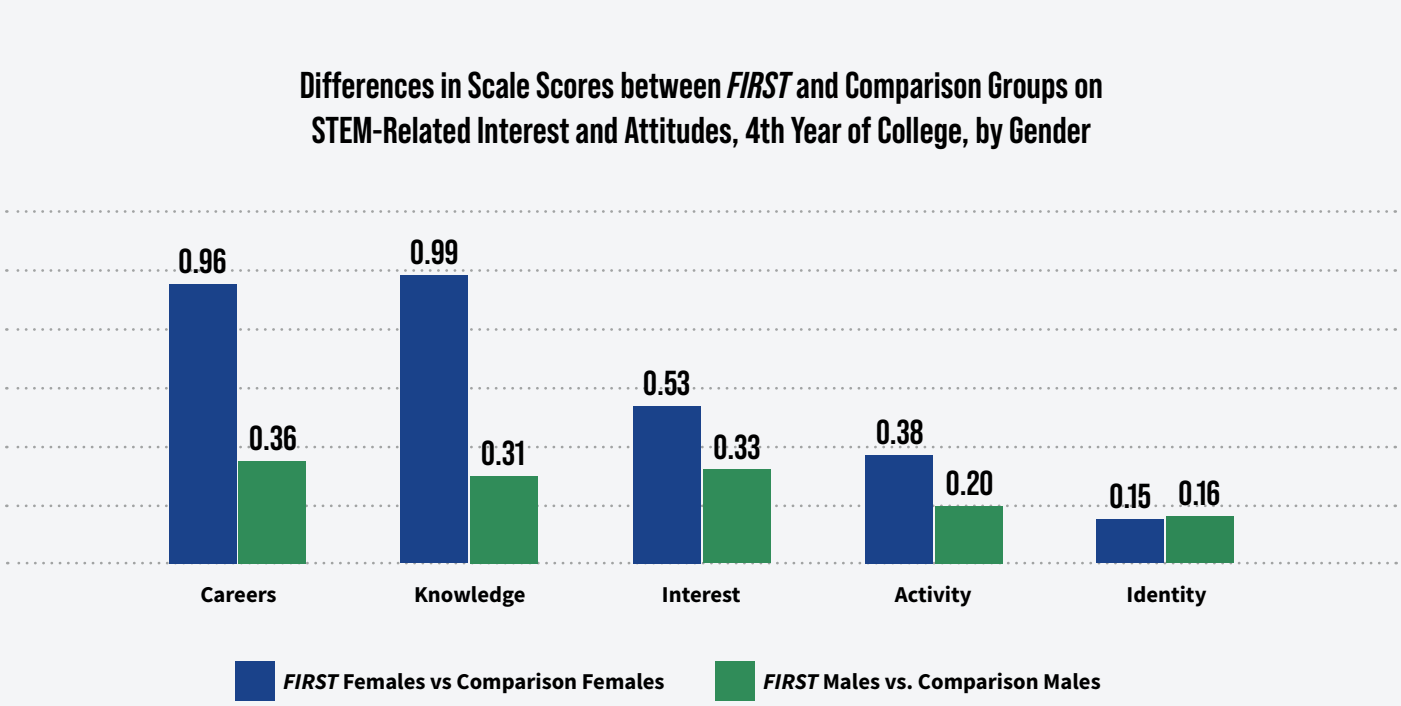
FIRST is a global nonprofit organization focused on inspiring young people to be leaders in science and technology through mentor-based, hands-on experiences designed to build science, engineering, and technology skills, inspire innovation, and foster well-rounded life skills including confidence, communication, and leadership. *FIRST* offers programs for students in PreK-12, ages 4 -18, from Lego League (grades Prek-8), Tech Challenge (grades 7-12), and Robotics Competitions (grades 9-12).

The longitudinal study, described in the Option Year One Alumni Studies Report, is being conducted by Brandeis University and involves tracking a set of 1,273 students (822 *FIRST* participants, and 451 matched comparison students) over time, since the 2012-13 and 2013-14 school years. The matched comparison students were enrolled in math and science classes at the same schools but did not participate in *FIRST* programs. All students received a baseline survey at the beginning of the study, and every year thereafter, all receive a follow up survey. The most recent results were reported in February 2023, 9 years since the start of the study, when 96% of the sample was post-high school. The study had retained 74% of the original sample, with 68% of the *FIRST* students and 84% of the comparison students remaining in the study. The following summarizes the main findings as of this ninth year of the study. A detailed report can be found at www.firstinspires.org/impact.

On measures of STEM attitudes, interests, involvement in STEM-related activities, STEM identity, STEM knowledge, and interest in STEM careers, *FIRST* participants continued to score significantly higher than the comparison students. *FIRST* students are about 2 times more likely to show higher levels in each of these measures, regardless of race, gender, income, or community type (rural, urban, suburban). For females, economically disadvantaged students, traditionally underrepresented racial/ethnic groups in STEM, and in urban and rural areas, students who participated in *FIRST* programs scored statistically significantly higher on measures in all of these aforementioned areas.

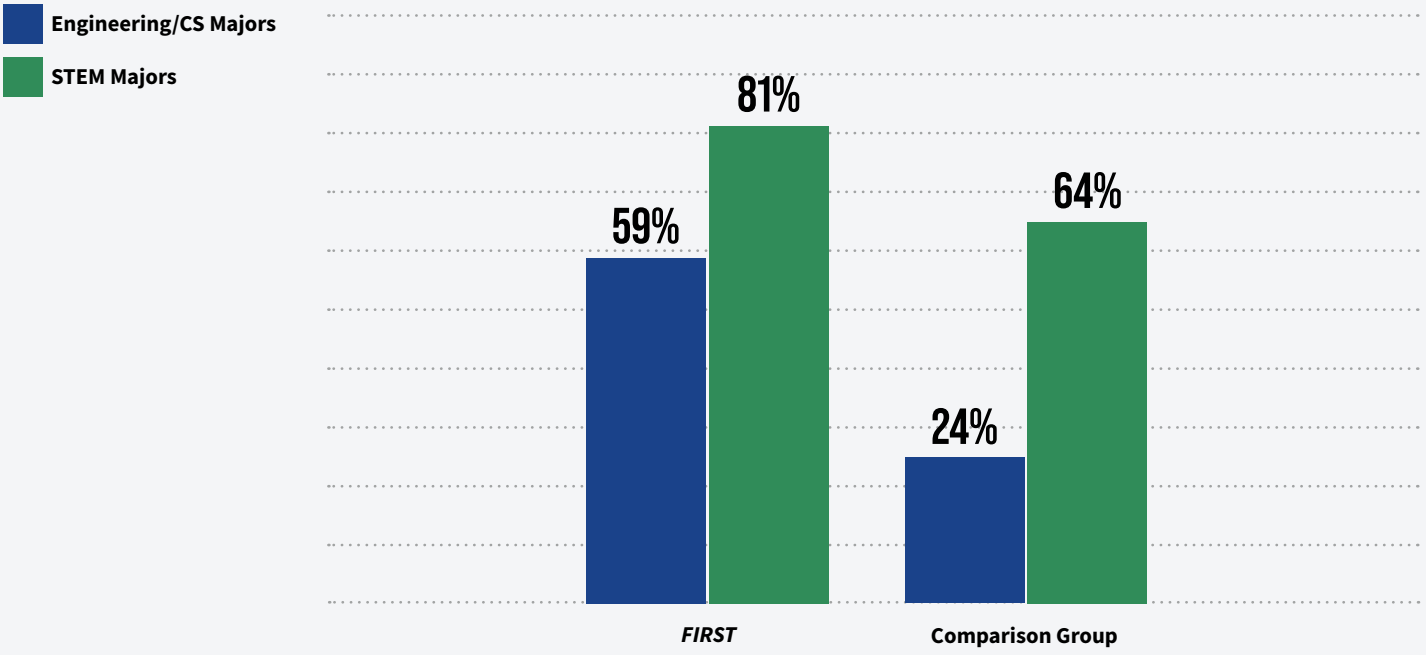
Longitudinal data continue to indicate that female students participating in *FIRST* report the greatest impacts in 5 STEM-related areas (see **Figure 27**) compared to all other study participants, and these differences persist into the fourth year of college. **Figure 27**, adapted from the Brandeis University evaluation report referenced above, illustrates these findings.

Figure 27. FIRST female students scored significantly higher on STEM-related outcomes, which persists into college



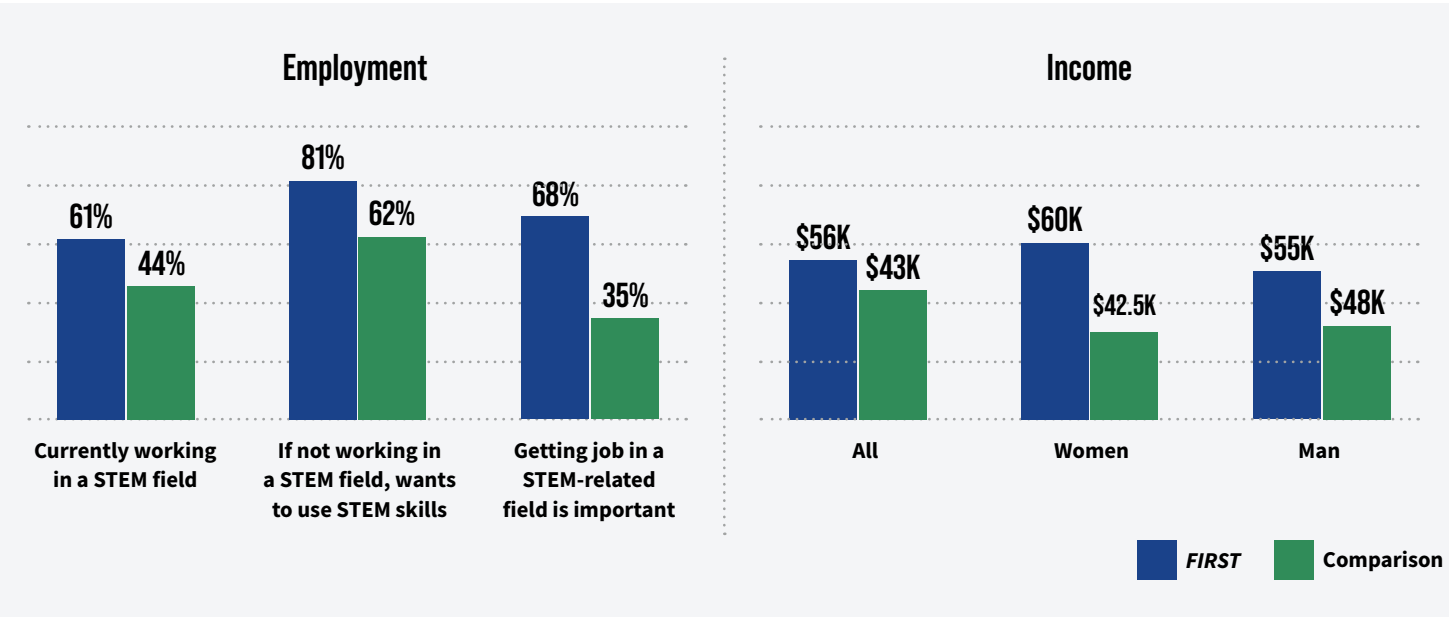
Additionally, participating in *FIRST* has a significant impact on STEM college pathways, especially for females. Through their fourth year of college, *FIRST* alumni are significantly more interested in majoring in engineering and computer science; they were significantly more likely to take courses in these disciplines; and they were significantly more likely to declare a major in these fields or any STEM field by the end of their fourth year of college, as shown in **Figure28**, adapted from the Brandeis University evaluation report. Not shown in **Figure 28**, **this pattern is stronger for female alumni of *FIRST*, especially in engineering**, when compared to females in the comparison group: the gap in STEM majors overall and especially in engineering majors was wider between females than males in the two groups.

Figure 28. By their 4th year of college, FIRST alumni more likely to declare STEM majors



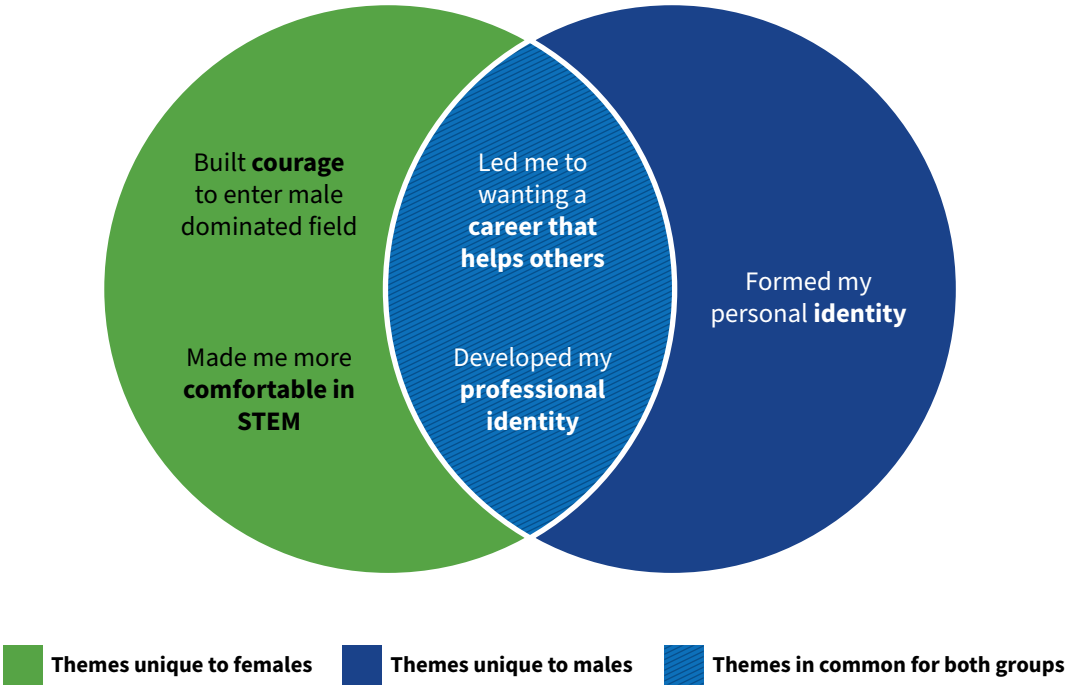
In year 9 of this study, Brandeis University was able to collect data on early careers in STEM. Although the sample of respondents employed post-graduation is small (N = 398), preliminary results indicate that ***FIRST* alumni are significantly more likely to be working in a STEM field** compared to the comparison group **and are notably more likely to be working as an engineer. Moreover, the median annual income for those employed is higher overall for *FIRST* alumni**, as shown in **Figure 29**.

Figure 29. FIRST students show stronger employment outcomes and median annual income



In year 9 of the study, Brandeis University also analyzed qualitative data from *FIRST* program participants and compared what male and females said about how *FIRST* impacted their career and interpersonal skills. Females noted how participating in *FIRST* helped them feel more comfortable in entering "male dominated" STEM fields, while males spoke to how it impacted their general personal identity development. Both were inspired to pursue careers that allowed them to engage in philanthropic efforts. **Figure 30** shows themes unique to females (green), unique to males (dark blue), and areas of overlap for both groups (light blue).

Figure 30. Females more focused on how FIRST made them feel more comfortable in STEM



In summary, 9 years after entering *FIRST*, program participants continue to show consistently greater STEM-related interests and attitudes, particularly for female participants, when compared to classmates who did not participate in *FIRST*. For those in college, *FIRST* alumni were significantly more interested in STEM majors, in taking engineering and computer science courses, and in declaring a STEM major, again, particularly for female alumni. Preliminary employment data post college indicate a higher proportion of *FIRST* alumni working in a STEM field, being interested in a STEM career, and wanting to use their STEM skills, as well as reporting a higher income than the folks in the comparison group.

In summary, 9 years after entering *FIRST*, program participants continue to show consistently greater STEM-related interests and attitudes, particularly for female participants, when compared to classmates who did not participate in *FIRST*. For those in college, *FIRST* alumni were significantly more interested in STEM majors, in taking engineering and computer science courses, and in declaring a STEM major, again, particularly for female alumni. Preliminary employment data post college indicate a higher proportion of *FIRST* alumni working in a STEM field, being interested in a STEM career, and wanting to use their STEM skills, as well as reporting a higher income than the folks in the comparison group.

SAN DIEGO MIRAMAR COLLEGE

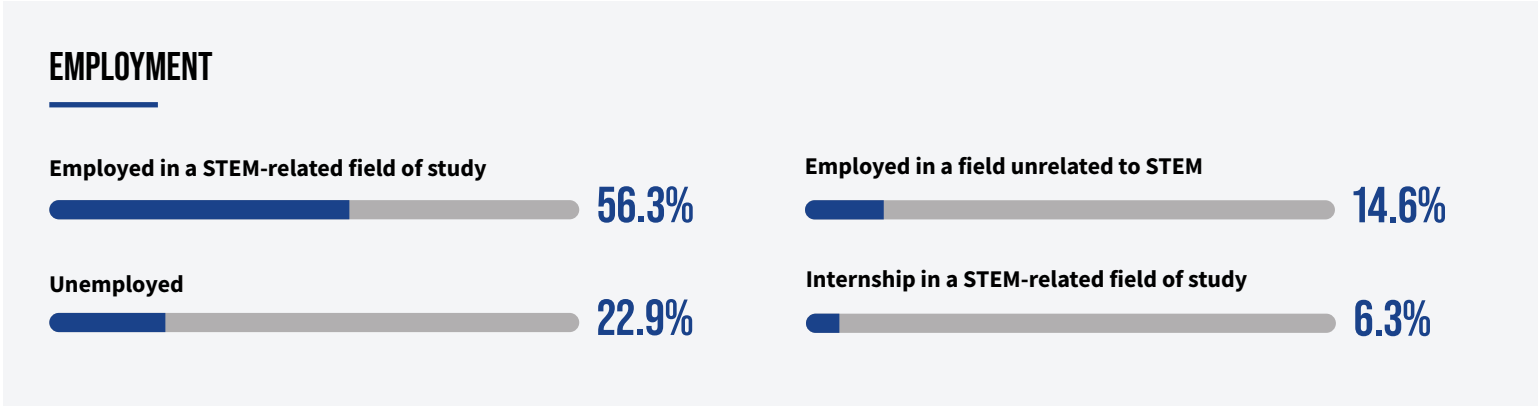
SAN DIEGO MIRAMAR BIOTECH STUDENTS COMPLETE OR CONTINUE TO PURSUE STEM CERTIFICATES AND DEGREES, AND WORK IN STEM-RELATED FIELDS

San Diego Miramar College's biotechnology program is designed to develop students' laboratory skills to meet entry-level employment requirements in the biotechnology industry. In Option Year One, 49 students (Cohort 1) completed at least one biotech course and/or internship funded by DSEC; in Option Year Two there were 55 completers (Cohort 2). Program staff surveyed these students in November 2022, two years after Cohort 1 participated, and one year after Cohort 2 participated. The survey had a 43% response rate from Cohort 1 (N = 21) and a 49% response rate (N = 27) from Cohort 2. The following summarizes the findings from those surveys.

Three of four respondents (75%) identified as female, and the largest racial/ethnic group was Asian students (48%), followed by White (17%). Eight students (16.5%) identified with more than one race/ethnicity, e.g., LatinX and Asian, Mexican and Yugoslavian, and about 20% of students identified as either African American or LatinX. Eight reported military connected status, either as a veteran, spouse of a veteran, or as a child dependent.

One to two years after their participation in the biotech program, more than half of the survey respondents (56%) reported being employed in a STEM-related field, as shown in **Figure 31**. Three (6%) indicated that their job or internship was DoD STEM related. Employers included Allele Biotech, Aspen Neuroscience, Kaiser, Quell Therapeutics, Scripps Health, among many others. Some of the more common jobs included laboratory assistant, manufacturing associate, and research assistant.

Figure 31. More than half were in a STEM-related job after participating in the biotech program



Many of the survey respondents were still enrolled in some form of education as well. One in four (25%) had transferred to and enrolled in a Bachelor's degree institution, while almost half (48%) were enrolled in community college courses. **As of November 2022, 100% of these survey respondents were pursuing or had earned either a certificate or degree in a STEM-related field, including biotechnology**. **Table 11** shows these results.

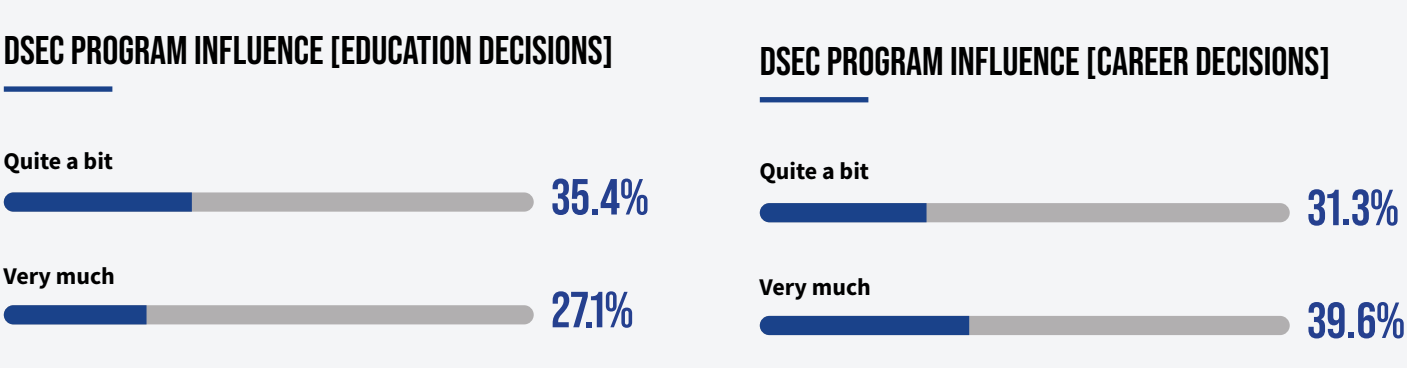
Table 11. All students completed or are earning a STEM-related certificate, degree, or both.

35.4%	Completed certificate or AS degree in biotech	27.1%	Will earn biotech certificate next year
8.3%	Completed STEM related certificate or AS degree	18.8%	Pursuing other (non-biotech) STEM related discipline
4.2%	Received BS in Biology	2.1%	Will complete AS degree next year
2.1%	Completed Graduate Degree	2.1%	Will earn biotech certificate and AS degree

AS = Associate's of Science degree; BS = Bachelor's of Science degree

One to two years after program participation, the majority of survey respondents believed that participating in the DSEC-funded biotechnology courses and/or internship influenced their education and career decisions quite a bit to very much. **Figure 32** illustrates these results.

Figure 32. San Diego Miramar's program had a moderate to strong impact on participants' education and career decisions.



In summary, San Diego Miramar's biotechnology courses and/or internship had a positive impact on participants' pursuit of a STEM-related degree and a STEM related career. Moreover, of those who responded to the follow up survey one to two years after their program participation, three of four **(75%) indicate interest in a DoD STEM-related career**.

WHAT DO OUR ALUMNI SURVEYS AND INTERVIEWS TELL US ABOUT HOW DSEC IS BROADENING PARTICIPATION IN STEM?

Based on discussions with DSEC partners, DSEC STEM Advisory, and other STEM education experts, Alumni Studies for Option Year Two updated survey and interview items focused on addressing the extent to which DSEC programs are broadening participation in STEM to students who are female, students of racial/ethnic groups traditionally underrepresented and underserved in STEM, students who are challenged socioeconomically, and students who are military-connected.[24]

HOW WE MEASURED BROADENING PARTICIPATION IN STEM THROUGH ALUMNI SURVEYS AND INTERVIEWS

The DSEC **Educator** Alumni Survey and interview asked educators whether they received any training through their DSEC program on strategies for engaging students who are traditionally underrepresented in STEM, and the perceived impact of educators' participation in the DSEC program on their students who are traditionally underrepresented in STEM.

For the DSEC **Student** Alumni Survey, we added items that serve as indicators of socioeconomic status (e.g., for students younger than 18, who they live with; and for students 18 and older, whether they received a Pell Grant) to use in our analyses, and we coded each of the programs that serve students as either open to all students or more selective. By selective, we mean that students had to compete against others and/or apply in order to participate in the program. These programs were focused on serving students with more advanced knowledge in a STEM area, and included programs that required qualification rounds (e.g., competitions), applications for limited slots (e.g., internships, research apprenticeships) and award programs. Our interviews included questions about how to include and engage students who are traditionally underrepresented and underserved in STEM, and about barriers they may have faced in participating in STEM programs or pursuing STEM degrees or careers. The following summarizes our findings.

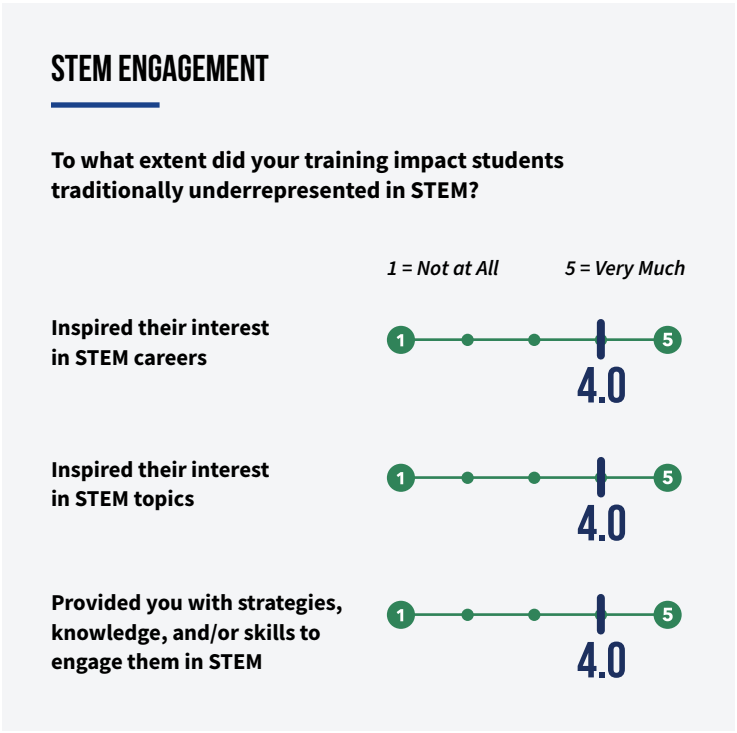
BROADENING PARTICIPATION IN STEM THROUGH EDUCATOR PROFESSIONAL LEARNING

As shown earlier in this report, slightly more than half of the educators who participated identified as white, whereas around 17% identified as Black and about 15% identified as Hispanic, indicating more diversity in educator survey respondents compared to Option Year One, where 68.9% identified as white. Additionally, DSEC programs appear to have extended beyond serving mainly teachers, with the proportion of teachers dropping from 94.6% in Option Year One to 54.5% in Option Year Two, and with a high proportion who had never taught STEM subjects (62.2%).

[24] Broadening participation also refers to students with disabilities, students who are not English proficient, and others who are historically underserved in our public education system. We did not include items in our surveys asking students about disabilities or English language status because these items are viewed as protected or personal information and would require multiple items for accuracy, which would put undue burden on survey respondents.

Survey data indicate that overall, **educators regarded DSEC programs as providing "quite a bit" of strategies, knowledge, and/or skills to help to engage students who are traditionally underrepresented in STEM** (median = 4.0 on a scale of providing these strategies ranging from 1 [Not at All] to 5 [Very Much]). **Underrepresented students were defined in the survey as females, students of color, students from low-income families, and students with disabilities**. Of the 588 surveyed educators who worked directly with students, **457 (78%) indicated on average that their participation in the DSEC program inspired "quite a bit" of student interest in (a) STEM topics and (b) STEM careers, for their students who are traditionally underrepresented in STEM** (median = 4.0 for both items on a scale of inspiring student interest ranging from 1 [Not at All] to 5 [Very Much]). These results are shown in **Figure 33**.

Figure 33. Educators Learned Strategies to Engage Students Underrepresented in STEM and Saw Positive Impacts



"Applying STEM topics to other types of issues to get students engaged in research—that's really a great jump-off point for students with getting engaged in science and STEM. And even if they don't necessarily plan to pursue it in the future, maybe they have some other passion in mind."

–Biology and Ecology Teacher, Society's *Science News* in High School

In interviews, 11 (65%) of the 17 interviewees acknowledged that they received insights on how to engage students in a culturally responsive way through their DSEC program, while five (29%) stated they did not (one did not respond). Sample quotes include the following:

"They definitely taught me how to be more cognizant of being inclusive with my pedagogy and also just different ways to engage. So not directly calling on students, but finding ways to pique their interests so that they're more keen to participate."

–Mentor, CGEST CompuGirls

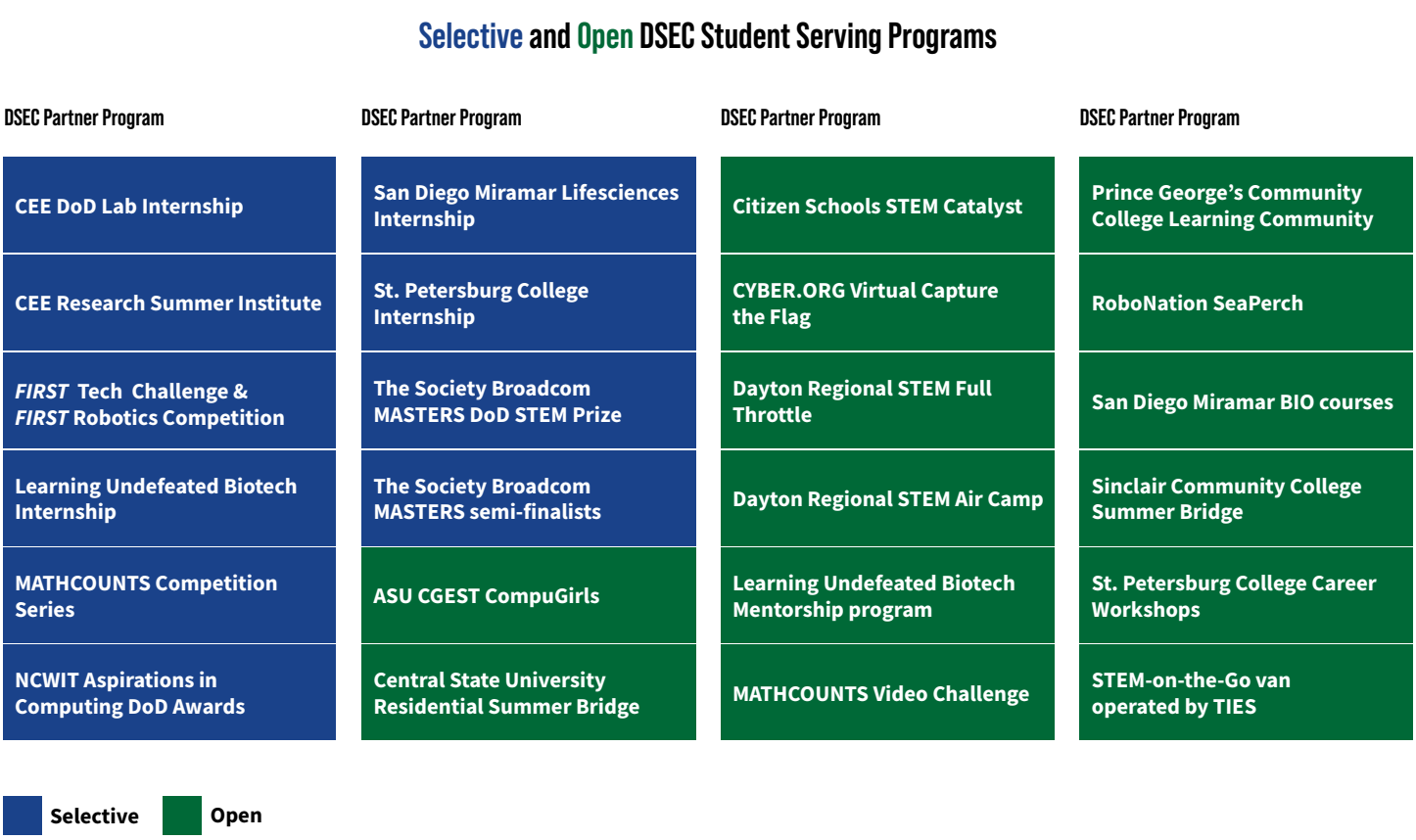
"I felt like a lot of our training was more kind of general...there wasn't necessarily a lot of discussion or training on specifically equity, because it was stuff you could do with all your kids. And of course, if you work in a diverse classroom, then doing that, you are reaching those students... I kind of thought it was going to be more of an equity lens, and more of a focus on specifically reaching those populations, but I felt like it was just more general STEM."

–DoD STEM Ambassador

BROADENING PARTICIPATION IN STEM THROUGH PROGRAMS OPEN TO ALL STUDENTS

DSEC programs offered to secondary and postsecondary students cover a wide span of programming ranging from competitions and internships to summer camps and learning communities. All of these programs serve an important role in building multiple and diverse pathways by which students can enter and persist in a STEM career, in and outside the DoD. Their priorities include creating awareness, inspiring interest in STEM, enhancing specific STEM skills, and preparing students for STEM careers. DSEC programs designed to create awareness, inspire interest, and/or build specific STEM skills are open to all students, while some programs specifically target those who are traditionally underrepresented and underserved in STEM (e.g., female students, students of color, and students in underresourced communities and schools). Other DSEC programs—those designed to support more advanced STEM knowledge, skills, and abilities and to prepare students for STEM careers—tend to be more selective, focusing on students who are already interested in STEM topics, STEM degrees, and/or STEM careers. These programs tend to focus on competitions, internships, and awards. **Figure 34** indicates which of the DSEC partner programs we have categorized as open vs. more selective. It is important to note that *FIRST* Tech Challenge and *FIRST* Robotics Competition programs are initially open to all students; however, we surveyed those who competed at the National Championships and therefore were more selective at that point in the program.

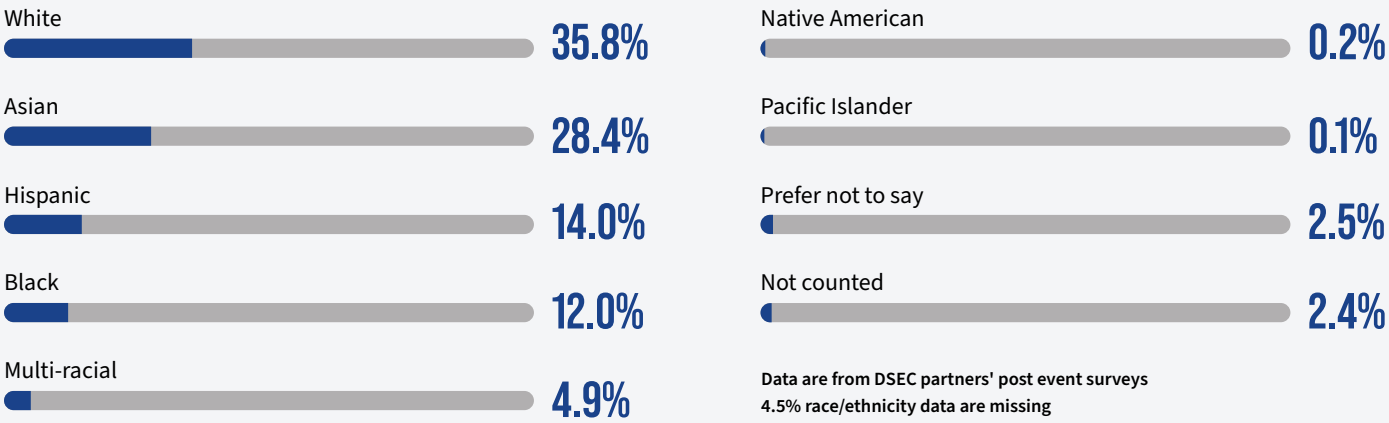
Figure 34. DSEC provided a mix of STEM programming from entry level (Open) to more advanced skills (more Selective)



One way in which we can evaluate the extent to which and how DSEC is broadening participation in STEM is to compare the students and their outcomes in the open vs. more selective programs. We were able to do these comparisons by using data that each program partner provided about the number and demographics of participants they served. The following shows the results of those comparisons.

First, we reviewed the racial and ethnic groups reported by each of these programs for the students they served in Option Year Two. The two largest racial/ethnic groups reported are white and Asian, both of which are traditionally represented in STEM.[25] **Figure 35** highlights these data.

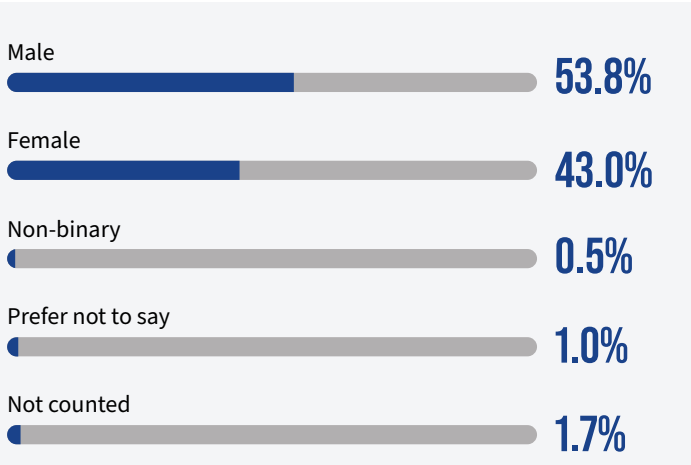
Figure 35. Two of Three DSEC Students from Surveyed Programs Are from Traditionally Represented Racial/Ethnic Groups in STEM



Data are from DSEC partners' post event surveys
4.5% race/ethnicity data are missing

We did the same analysis with gender and found that, overall, DSEC-funded programs served more male than female students, as shown in **Figure 36**.

Figure 36. Surveyed DSEC Programs Served More Male Students Than Female Students



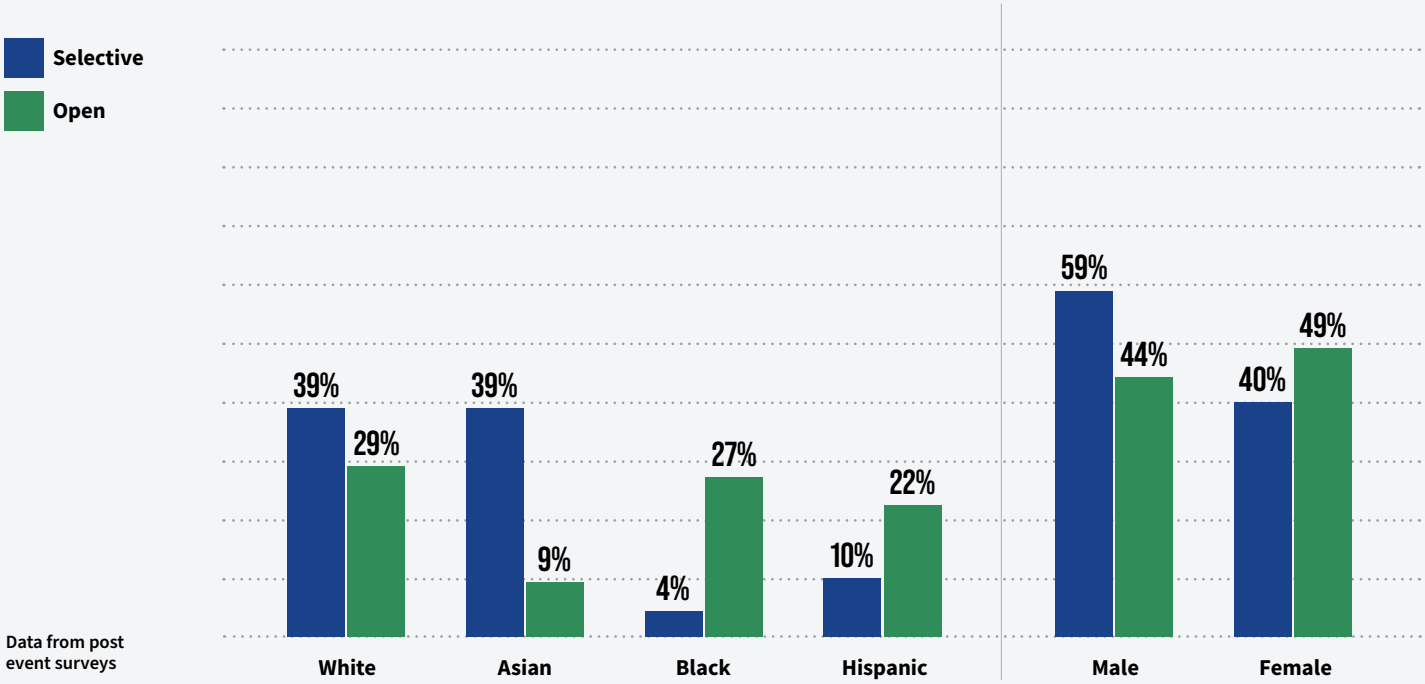
Data are from DSEC partners' post event surveys
1.7% of gender data are missing

> "I used to struggle with science and math, but I would go to my parents for help and they really motivated me to study and keep going, even if I'm not getting it the first time. Their patience with me really helps me to continue. My friends have also been really oriented towards STEM from a really young age, and being with them and having a community where so many people were interested in STEM really motivated me to learn and grow in STEM."
>
> –High school student (female), NCWIT Aspirations in Computing Regional Award

[25] Earlier in this report, we note that not all Asian groups are traditionally represented in STEM; however, we had to balance data collection related to a wide array of race/ethnicity groups with survey response burden on students.

When comparing the racial/ethnic and gender makeup of the open and more selective DSEC programs, we found that the **open programs tend to serve a higher proportion of female students and students traditionally underrepresented in STEM** compared to the more selective programs, as reflected in **Figure 37**.

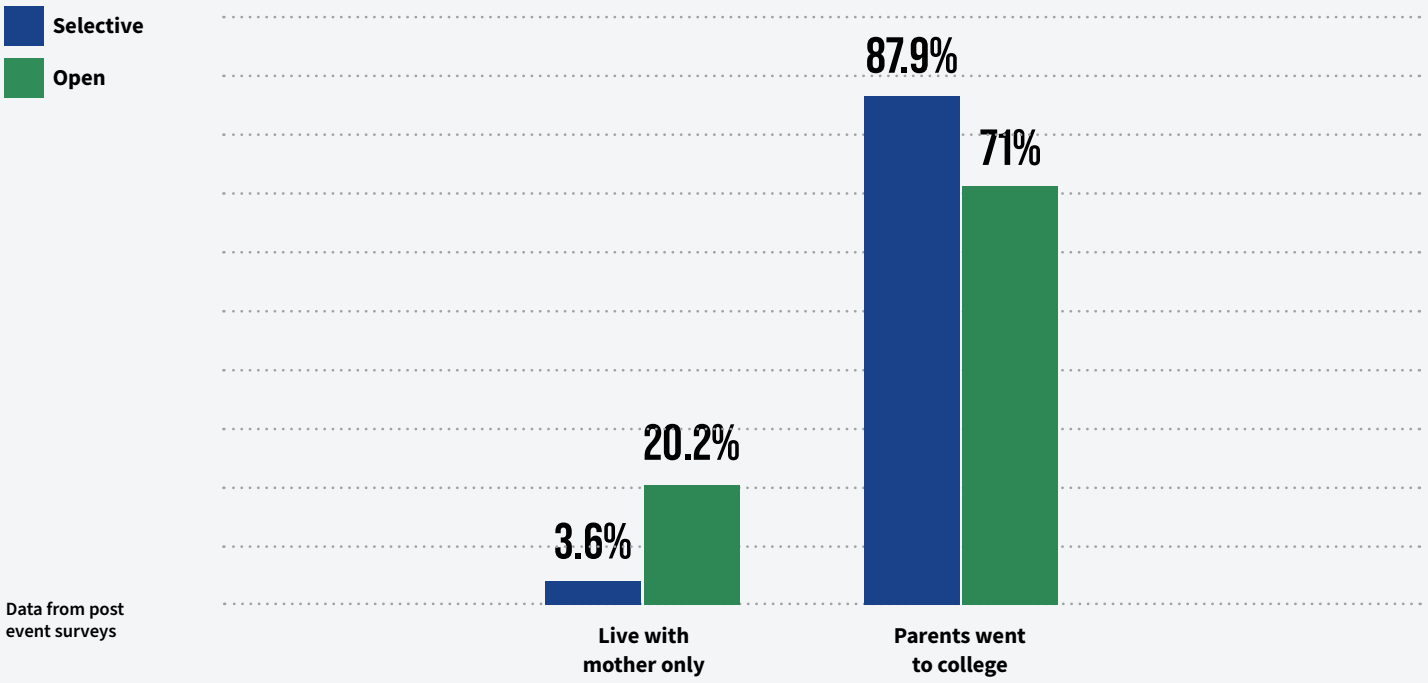
Figure 37. Open Programs Served a Higher Proportion of Traditionally Underrepresented Students in STEM by Racial/Ethnic Group and Gender



> "Currently I'm doing my internship with [organization name]. They are a nature preserve...so it's really interesting. I've just been inputting [data] that they need [into Excel worksheets]. And then after that, I'm going to go over with the director there any variances that they have in those statistics and anything that may be... alarming or anything, and just sort of having all that data online instead of on paper so that it can be shared to be researched by other people, which would be very helpful in that field, I hope."
>
> –Student, St. Petersburg College internship

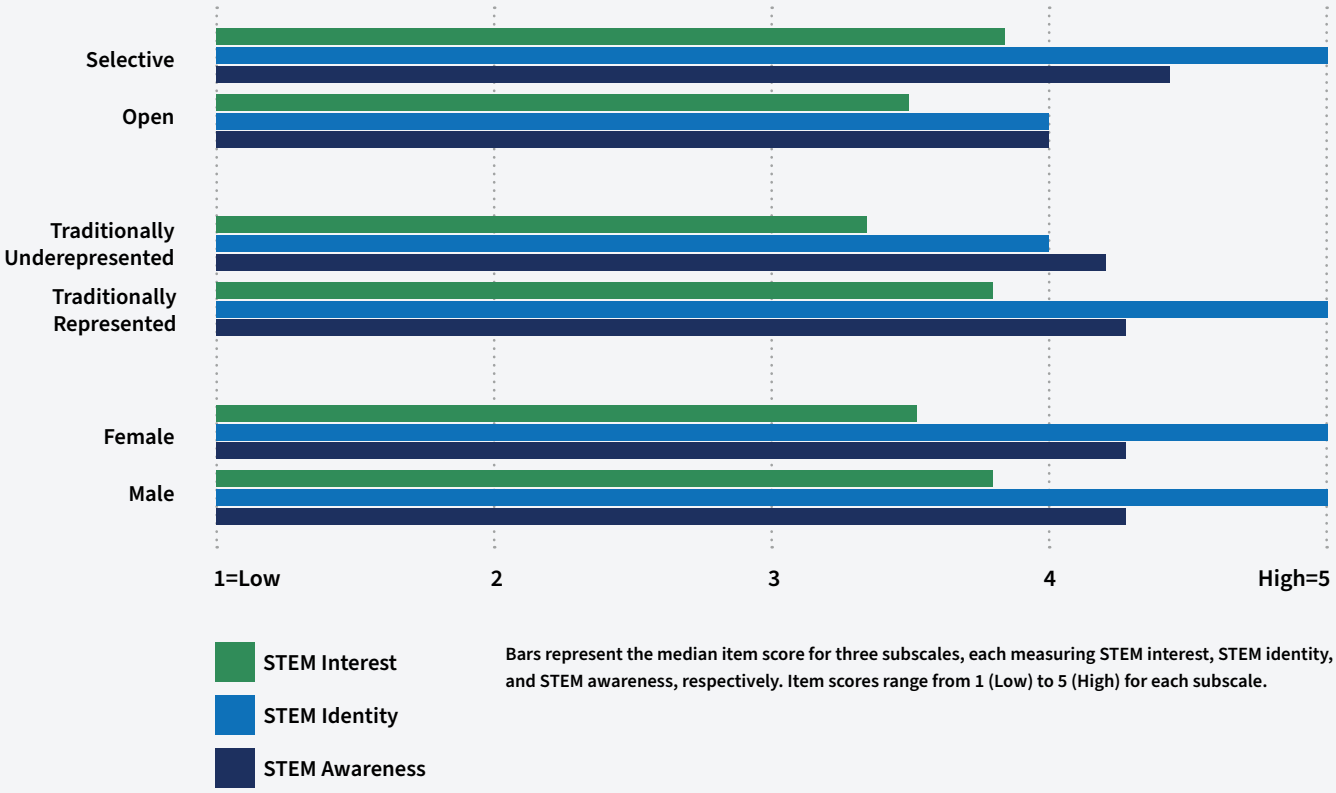
Comparing two indicators of socioeconomic status—living with a single mother (an indicator of socioeconomic challenges) and having parents who went to college (an indicator of stronger socioeconomic standing)—we found that the **open programs tend to serve a higher proportion of students who face socioeconomic challenges**, as reflected in **Figure 38**. As noted earlier in this report, these two indicators are considered to be valid indicators of socioeconomic status for adolescents.

Figure 38. Open Programs Serve a Higher Proportion of Students Facing Socioeconomic Challenges



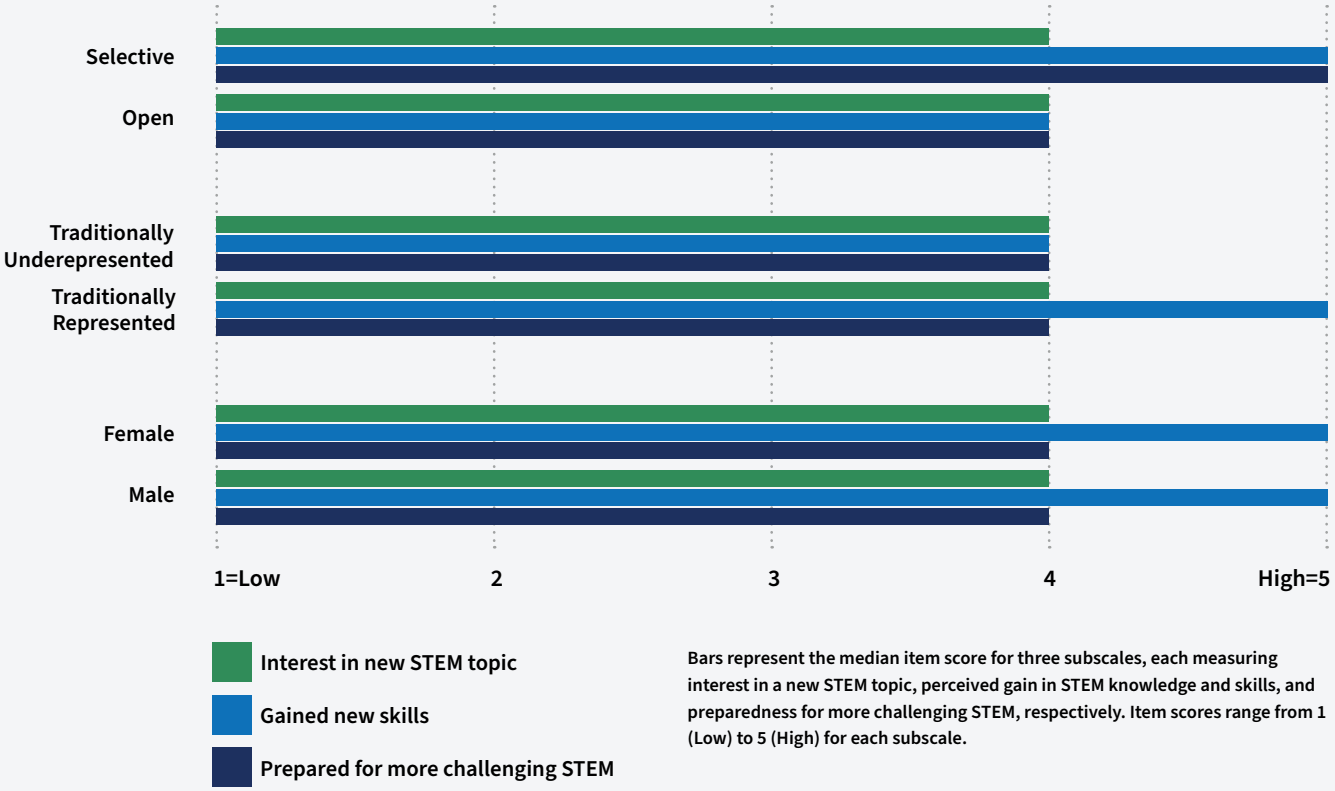
Our analyses also focused on comparing key DSEC outcomes for students in open and more selective DSEC programs, as shown in **Figures 39**, **40**, and **41**. **Students who attended more selective DSEC programs reported stronger STEM interest, identity, and awareness** when compared to students who attended open programs. Similarly, **students traditionally represented in STEM reported stronger STEM interest and STEM identity** compared to students in racial/ethnic groups that are traditionally underrepresented. Notably, there were no meaningful gender differences on these outcomes.

Figure 39. STEM Interest, Identity, and Awareness Are Higher in More Selective Programs and for Students Traditionally Represented in STEM



We conducted the same comparisons on three specific items within the STEM interest subscale, measuring gains in interest in a new STEM topic, gains in STEM knowledge and skills, and feeling more prepared for more challenging STEM. From those comparisons we found that **students in more selective programs and who are traditionally represented in STEM reported greater gains in STEM knowledge and skills** compared to students in open programs and those who are traditionally underrepresented in STEM, respectively. **Students in more selective programs also reported feeling more prepared for more challenging STEM** compared to students in open programs. **Notably, male and female students did not differ on these outcomes**.

Figure 40. Students in More Selective Programs Report Stronger Gain in New Knowledge, New Skills, and Preparedness for More Challenging STEM



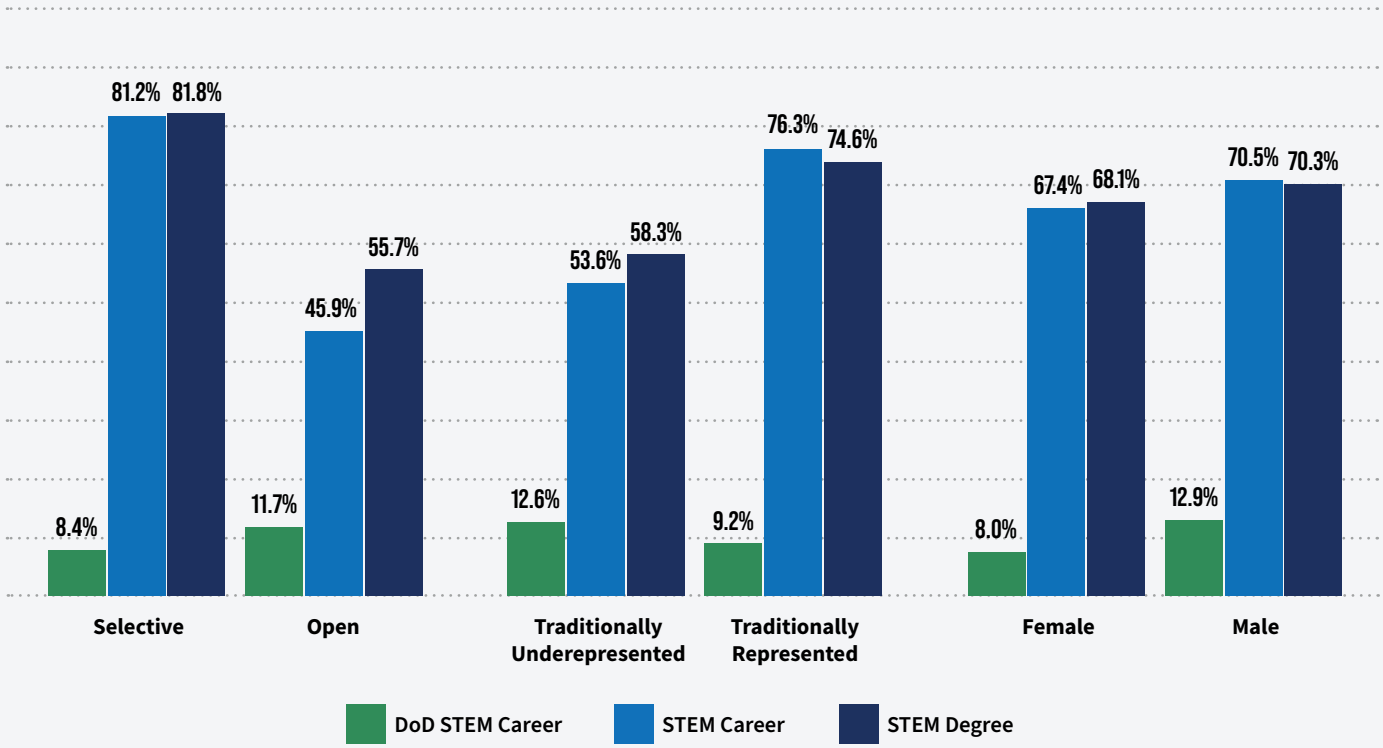
Ultimately, the goal of DSEC is to increase the number of students who pursue STEM degrees and careers both in and outside the DoD, with an emphasis on the latter. **Students from more selective programs are 3.6 times more likely to report interest in pursuing a STEM degree** than students from open programs, **and five times more likely to report interest in pursuing a STEM career**.[26] Similarly, **students from racial/ethnic groups traditionally represented in STEM are two times more likely to plan to pursue a STEM-related degree and three times more likely to pursue a STEM-related career**.[27] There were no significant differences between these groups in likelihood of pursuing a DoD STEM career. However, **female students had statistically lower odds of planning to pursue a STEM career in the DoD compared to male students**.[28] These results are shown in **Figure 41**.

[26] The odds ratio comparing selective and open program participants on interest in pursuing a STEM career = 3.6 (95% confidence intervals 2.8-4.5) and on interest in pursuing a STEM degree = 5.1 (95% confidence intervals 4.1-6.3), both of which are statistically significant and reflect large differences between the two groups.

[27] The odds ratio comparing traditionally represented to underrepresented students on interest in pursuing a STEM career = 2.8 (95% confidence intervals 2.2-3.4) and on interest in pursuing a STEM degree = 2.1 (95% confidence intervals 1.7-2.7), both of which are statistically significant.

[28] The odds ratio comparing female students to male students on plans to purse a DoD STEM career = 0.6 (95% confidence intervals 0.4-0.9), indicating a statistically significantly lower likelihood given that the odds are significantly < 1.0.

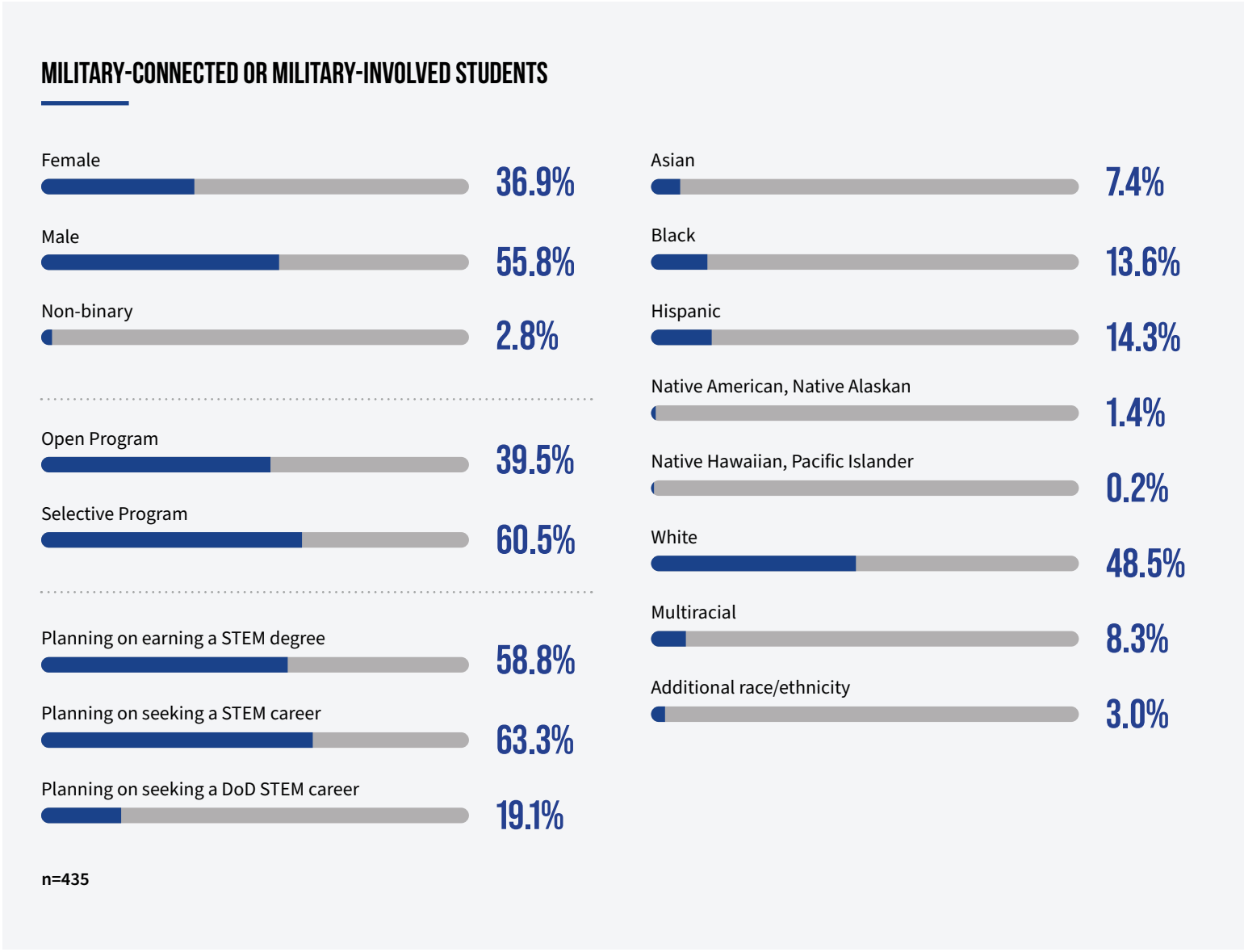
Figure 41. Students from More Selective Programs and Traditionally Represented in STEM More Likely to Plan for STEM Degree and Career, Except in the DoD



BROADENING PARTICIPATION OF MILITARY-CONNECTED STUDENTS

Of the 2,212 secondary students who responded to the survey, **19% indicated that their parents were military-connected** (e.g., enlisted, veterans, working for the DoD, etc.) **and 4% of the students who were 18 and older indicated their own military involvement** (e.g., enlisted, veteran, working for the DoD, etc.). **Figure 42** highlights the characteristics of military-connected or military-involved students and their STEM education and career interests. Because only 12 students (18 and older) identified as military-involved, we combined their data with the military-connected students (under 18 years old). For military-connected or military-involved students, **the highest proportion is White, male, and participated in a more selective DSEC program. The proportion planning on a STEM degree and STEM career is slightly lower than the full sample of students (which was about 68.5% for both). Almost twice the proportion of military-connected students are planning on a STEM career in the DoD compared to the full sample of students**.

Figure 42. Broadening Participation of Military-Connected and Military-Involved Students



These results suggest that DSEC is reaching a good proportion of military-connected students—at least one in five students are connected to the military according to these survey results, which is likely an underestimate given that data are missing on this variable from some DSEC partner program surveys. Additionally, **about one in five military-connected or military-involved students are planning on seeking a STEM career in the DoD, suggesting that DSEC is having the intended impact on a significant proportion of these students**.

STUDENT GENDER, RACE/ETHNICITY, AND/OR SOCIOECONOMIC STATUS ARE RELATED TO THE KEY OUTCOMES

These results indicate that DSEC programs have differential impact on students depending on the type of program (open vs. more selective); on whether students are from racial/ethnic groups traditionally represented in STEM; and, in several cases, on gender. We further evaluated whether these variables, among a larger set of variables we measured in the student survey, correlated with the key DSEC outcomes also measured in the survey. It is important to note that for these analyses, **there was a good amount of missing data on predictor variables and/or outcome variables such that results should be interpreted with caution**. Data were missing due to program-specific surveys that pared down the number of DSEC Alumni Student Survey items they included to reduce the survey burden on their participants, and/or allowed respondents to skip items that were required for surveys on the DSEC platform. For each of the analyses, we include the sample size so the reader can evaluate the strength of the findings.

We started by evaluating the correlation of STEM job and career awareness (in general and in the DoD) with wanting a STEM career (in general and in the DoD). For these analyses, of the 2,525 students who were given the survey, only 27 (about 1%) were missing data. Results indicate that **awareness of STEM careers, awareness of DoD STEM careers, and overall STEM awareness significantly correlate with interest in STEM careers (in and outside the DoD)**.[29]

We also assessed the correlates of the impact of the DSEC program on students' STEM outcomes shown in **Table 12**. The predictor variables we tested are as follows:

- **Student's age**
- **Student's reported gender** as female (compared to male only; too few students identified as non-binary to include in these analyses)
- **Student's reported race/ethnicity** as traditionally represented in STEM (Asian, White) compared to race/ethnicities traditionally underrepresented in STEM (Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, multiracial)
- **Student's parents went to college**
- **Student (secondary only) lives with their mother only**, an indicator of socioeconomic status (described earlier in this report)
- **STEM identity**, a subscale of four items (see **Table A-2 in the Appendix**) measuring STEM identity after participating in the DSEC program
- **STEM awareness**, a subscale of six items (see **Table A-2 in the Appendix**) measuring students' awareness in STEM (e.g., awareness of careers, job skills, etc.)

[29] Wanting a career in STEM was significantly and positively related to awareness of STEM careers ($R2 = 0.28$, $dfs = 2,498$, $p < .0001$) and overall awareness of STEM (measured by six items, as shown in Table A-2 in the Appendix; $R2 = 0.43$, $dfs = 2,498$, $p < .0001$). Wanting a career in DoD STEM was significantly and positively related to awareness of DoD STEM careers ($R2 = 0.19$, $dfs = 2,498$, $p < .0001$) and overall awareness of STEM ($R2 = 0.17$, $dfs = 2,498$, $p < .0001$).

Table 12 illustrates with an X which of the predictors (the columns in the table) were statistically significantly related to the each outcome (the rows in the table). Cells without an X indicate predictor variables that were not statistically significantly related to the outcome. All but the last three outcomes were analyzed using multiple regression and therefore show the model R2 in the rightmost column. R2 indicates the proportion of variance in the outcome variable explained by the predictors in the model (e.g., R2 = 0.67 means 67% of the variance in overall interest in STEM was explained by the set of eight predictor variables). A plus sign (+) or minus sign (-) after the X indicates whether the predictor variable is positively or negatively related to the outcome. For example, "X (+)" in the column for "female" indicates that female students reported greater overall interest in STEM than male students.

Results shown in **Table 12** indicate the following:

- **Older students** report greater overall interest in STEM and in wanting a STEM career, a greater sense of accomplishment in STEM, and greater inclination toward planning a STEM degree/career compared to younger students.
- **Female students** report greater overall interest in STEM and in a STEM career, a greater sense of accomplishment in STEM, and a greater sense of preparedness for more challenging STEM activities than male students. Female students also report less interest in a DoD STEM career than male students.
- **Students who attended programs that were more selective** (vs. open to all students) were more likely to plan on a STEM degree and a STEM career, but not a DoD STEM career.
- **Students traditionally represented in STEM** (White and Asian) were less likely to be planning to seek a DoD STEM career than those traditionally underrepresented in STEM (Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, and multiracial).
- **Having parents who went to college** positively predicted planning to seek a STEM degree and a STEM career, and related to less interest in a DoD STEM career.
- **Living with one's mother only** (an indicator of socioeconomic challenges) was related to less overall interest in STEM, and feeling less prepared for more challenging STEM activities.
- **Stronger STEM identity** was related to greater overall interest in STEM and a STEM career, a greater sense of accomplishment in STEM, and a greater sense of preparedness for more challenging STEM.
- **Overall STEM awareness** was positively related to all of the outcomes of interest except planning to pursue a DoD STEM career.

Table 12. Predictors of Key DSEC Outcomes for Students

	PREDICTOR VARIABLES								
DSEC OUTCOME	AGE	SELECTIVE PROGRAM	FEMALE	RACE TRAD REP'D IN STEM	PARENTS WENT TO COLLEGE	LIVE WITH MOTHER ONLY	STEM IDENTITY	STEM AWARENESS	MODEL R^2
Overall interest in STEM*	x (+)		x (+)			x (−)	x (+)	x (+)	.67
Wanting a STEM career*	x (+)		x (+)			x (−)	x (+)	x (+)	.49
Wanting a DoD STEM career*			x (−)		x (−)			x (+)	.18
Sense of accomplishment in STEM	x (+)		x (+)				x (+)	x (+)	.53
Feeling prepared for more challenging STEM			x (+)			x (−)	x (+)	x (+)	.53
Plan to pursue STEM degree**	x (+)	x (+)			x (+)			x (+)	--
Plan to seek STEM-focused career***	x (+)	x (+)			x (+)			x (+)	--
Plan to seek DoD STEM-focused career***			x (−)	x (−)		N/A			--

Green shading indicates predictors that show a trend toward significance ($p > .05$ and $< .10$). The plus sign (+) and minus sign (-) indicate whether the predictor variable in the column was positively or negatively correlated with the outcome variable in the row.
*Models for these outcomes included data from 892 (35%) of the survey respondents, due to missing data for at least one of the predictors or for the outcome.
**Models for this outcome included data from 857 (34%) of the survey respondents due to missing data. Additionally, this model was run as a logistic regression due to the binary nature of the outcome variable (Yes/No) and therefore does not produce an R^2 value.
***Models for these outcomes included data from 446-453 (about 18%) of survey respondents due to missing data.These models were also run as a logistic regression due to the binary nature of the outcome variable (Yes/No) and therefore do not produce an R^2 value.

WHAT DO OPTION YEAR TWO RESULTS SAY ABOUT DSEC-FUNDED PROGRAMS?

For DSEC Option Year Two, the Alumni Surveys and interviews provide positive evidence of the impact of the DSEC-funded programs on educators and on students, particularly for students who participated in more selective programs and who belong to racial/ethnic groups traditionally represented in STEM.

Overall, educators and students reported positive outcomes with respect to impact on STEM interest, including in pursuing a STEM-related degree and/or a STEM-related career. When we disaggregated the student data, a clear pattern emerged indicating that (1) reported program impacts were stronger for students who took part in DSEC-funded programs that were more selective in their participants; and (2) those selective programs tended to serve more male students, more students of racial/ethnic groups traditionally represented in STEM (White and Asian), and more students with higher socioeconomic status.

The more selective and open programs funded by DSEC in general seem to have somewhat different purposes. The more selective programs tended to be more focused on honing more advanced STEM skills (e.g., via competitions and internships) and preparing students for STEM careers, whereas the open programs tended to be more focused on building interest and engagement in STEM by inviting students of all abilities and backgrounds to participate. These programs also provided skill-building activities and shared information about STEM careers, but they were not generally targeted toward students who already possessed more advanced skills. For a consortium of STEM education programs like DSEC, it is important to attract students at different points along the STEM education pathway—at different grade levels, ability levels, and levels of interest, and different cultural backgrounds and experiences—and work to help all

students persist in their STEM interests and engagement so they can ultimately pursue STEM degrees and careers. DSEC provides such an array of programming and, in doing so, seems to have an overall positive impact on the educators and students those programs serve.

For a second year in a row, DSEC-funded programs show a positive impact on educators' STEM perceptions, beliefs, self-efficacy, and—most of all—on STEM interest, all of which are related to positive STEM outcomes for students according to research. Additionally, educators perceived that their DSEC-funded program participation **positively impacted their students, including those traditionally underrepresented in STEM**. Overall, educators reported that DSEC-funded programs provided them with strategies to engage and interest traditionally underrepresented students, and described positive impacts on these students in surveys and interviews.

Also for a second year in a row, DSEC-funded programs show a positive impact on students' STEM awareness, interest, engagement, and identity, factors that research suggests are related to persistence in STEM, earning STEM degrees, and pursuing STEM careers. Additionally, for a second year, **students believed their participation in these programs increased their interest in new STEM topics, helped them to gain new knowledge and skills in STEM, prepared them for more challenging and advanced STEM activities, and increased their interest in pursuing STEM-related degrees and careers**. It is important to acknowledge that although there were differences in these outcomes between types of programs and racial/ethnic groups, **in many cases there were NO differences between male and female students, which suggests that these programs are having a positive impact on broadening participation** in STEM with respect to gender.

DSEC's ultimate goal continues to be to increase the number of individuals prepared for and interested in pursuing a STEM career, especially in the DoD.

We found that the same proportion of students as in Option Year One planned on pursuing a STEM degree (about 70%), a STEM career (about 70%), and a STEM career in the DoD (about 10%). However, this year, **male and female students were equally likely to plan on a STEM degree**, whereas last year, male students were almost three times more likely than female students. Results this year also indicate that students traditionally represented in STEM were about twice as likely as those underrepresented to plan on pursuing a STEM degree and about three times more likely to pursue a STEM career. There were **no differences by gender regarding plans for a STEM career. Our analyses indicate that interest in a DoD STEM career varied by gender and by race/ethnicity: male students and those traditionally underrepresented in STEM** (Black, Hispanic, Native American, Native Alaskan, Native Hawaiian, Pacific Islander, and multiracial students) were more likely to be interested in a STEM career in the DoD than female students and students identifying as White or Asian, respectively, which are similar to results from Option Year One. Based on interviews, some of the reluctance to consider a STEM career in the DoD included the assumption that careers in the military are more limiting than non-military careers (e.g., in regards to where one lives, one's ability to innovate, and timing one's education and career). It is interesting that most of these concerns came from military-connected students.

WHERE DO WE GO FROM HERE?

Option Year Two saw a large improvement in survey response rates for students. This was primarily due to sampling plans for the bigger programs such as MATHCOUNTS and *FIRST*, and changes to data collection timing. More programs offered the survey immediately at the end of the program, and in some cases researchers were present on-site (e.g., during the *FIRST* National Robotics and Tech Challenge Competitions) to administer the surveys and offer incentives for completed ones. We also discarded the requirement to collect parent permission for students under 18 in the survey, and instead had programs gather that permission if their program required it. **Changes we have made to build on these successes and continue to improve response rates in Option Year Three include the following:**

1. **Further reduce the number of items in the educator and student surveys.** Based on our data analyses from Option Year Two results, we identified items that were not providing useful information or that were redundant to other, better-worded items and deleted them. This will help ensure that the surveys take no longer than an average of 5 minutes to complete.

2. **Continue to collect program participant numbers and demographics** via the AMAZE platform, allowing us to compare who completed the surveys vs. who was served by these programs.

3. **Continue to support DSEC STEM education and outreach partners in administering the survey to eligible participants.** The Alumni Surveys Research Team meets with each program partner to determine which programs are eligible for the survey, and which are not feasible to survey or do not qualify as providing meaningful STEM, per DSEC. This should help establish response rates and data collection protocols that are feasible for DSEC partners. Additionally, we are helping to ensure that partners who collect data via their own surveys are encouraging participants to respond to ALL survey items.

4. **The RTI Alumni Studies team will work with DSEC STEM education and outreach partners to be more successful in recruiting participants for alumni interviews.** We started Option Year Three with the expectation that program partners will provide a list of volunteers to interview so we have better representation of the programs in our interview data.

Additionally, to continue to support the desire to obtain longitudinal data from DSEC-funded programs, the RTI Alumni Studies team is continuing to leverage data from NMSI and *FIRST*, the largest DSEC STEM education and outreach partners, as well as other partners such as San Diego Miramar and CGEST who are collecting their own longitudinal data.

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APPENDIX

Building on the Option Year One results, our DSEC Alumni Surveys were designed to capture information on key DSEC outcomes relevant to providing meaningful STEM experiences and broadening participation in STEM for K-12 and postsecondary students. Results from our Option Year Two psychometric analyses of survey items are summarized in the following sections.

EDUCATOR SURVEY ITEMS CONTINUE TO SHOW STRONG RELIABILITY

The subscales for which we evaluated Cronbach's alpha and factor structure from the educator survey are presented in **Table A-1**. As noted earlier in this report, the items that made up these subscales were adopted or adapted from existing measures with established reliability and/or validity data. We conducted our analyses to explore how these items functioned for this sample of educators in the context of an Alumni Survey.

Results indicate that the subscales showed high internal consistency and seemed to be measuring a single factor. These results suggest that using a subscale score to summarize a group of items thought to be measuring the same construct (e.g., STEM perceptions, STEM self-efficacy) is an acceptable approach. The high Cronbach's alpha for the subscales measuring perceived impact of the program on (a) their students and (b) themselves suggests that educators either regarded those impacts as highly correlated (e.g., students developing academic self-confidence and interest in STEM activities outside of school), and/or they regarded the programs as effective in producing a wide range of impacts on students.

Table A-1. Reliability and Factor Analyses for Educator Alumni Survey Subscales

STEM Perceptions Changes for OY2 version: none.	Cronbach's Alpha	Factor Loading	
		1	2
I think STEM is a critical part of a student's education.	0.97 (0.95 in OY1)	✓	
There are lots of jobs/careers where STEM is useful.			
I think that STEM education is useful for a student's future education or career.			
I encourage students to pursue an education or career in STEM.			

STEM Self-Efficacy Changes for OY2 version: none.	Cronbach's Alpha	Factor Loading	
		1	2
I continually work to find better ways to teach my STEM content.	0.97 (0.95 in OY1)	✓	
I am confident that I can teach my STEM content effectively.			
I know the steps necessary to teach STEM concepts in my content area effectively.			
I have the necessary skills to teach my STEM content.			
I understand concepts in my STEM area well enough to be effective in teaching in my STEM area.			
I am confident that I can answer students' questions in my STEM area.			
When a student has difficulty understanding a concept in my STEM area, I am confident that I know how to help them understand it better.			
When teaching in my STEM area, I am confident enough to welcome student questions.			
I know what to do to increase student interest in my STEM area.			
I know where to find resources for teaching students about STEM careers.			
I know about current STEM careers.			
Impact of STEM programs on YOUR STUDENTS Changes for OY2 version: none.			
Developed academic self-confidence	0.95 (0.97 in OY1)	✓	
Developed knowledge, skills, and abilities in STEM area(s)			
Inspired interest in taking STEM classes in school			
Inspired interest in STEM activities outside of school requirements			
Inspired interest in earning a STEM degree			
Developed awareness of STEM research and careers			

	Cronbach's Alpha	Factor Loading	
		1	2
Impact of STEM programs on YOUR STUDENTS Changes for OY2 version: none.			
Developed awareness of STEM research and careers in the DoD	0.95 (0.97 in OY1)	✓	
Inspired interest in STEM careers			
Inspired interest in STEM careers in the DoD			
Impact of STEM programs on YOU Changes for OY2 version: dropped 2 items from the OY1 version and replaced with the final item.			
Developed self-confidence in teaching STEM content	0.94 (0.94 in OY1)	✓	
Developed knowledge, skills, and abilities in STEM area(s)			
Inspired interest in the STEM content you teach			
Developed awareness of STEM research and careers			
Developed awareness of STEM research and careers in the DoD			
Gave you the strategies, knowledge, and/or skills to help to engage students who are traditionally underrepresented in STEM			
Awareness of DoD STEM Changes for OY2 version: none.			
DoD researchers advance science and engineering fields.	0.97 (0.97 in OY1	✓	
DoD researchers develop new, cutting-edge technologies.			
DoD researchers solve real-world problems.			
DoD research is valuable to society.			

OY1 = Option Year One; OY2 = Option Year Two
Green highlighted cells with a checkmark inside indicate items that "held together" as part of a common factor, i.e., they were strongly correlated.
***Growth mindset items were reverse scored so that higher scores showed a stronger growth mindset.**

STUDENT SURVEY ITEMS SHOW EVEN STRONGER RELIABILITY WITH SEVERAL CHANGES TO THE SURVEY ITEMS

Like the DSEC Educator Alumni Survey, the student survey was designed to capture key DSEC outcomes shown in **Figure 2** at the beginning of this report, as well as participant characteristics and demographics. The subscales for which we measured internal consistency and conducted factor analyses are shown in **Table A-2**, along with the results. For Option Year Two surveys, we used most of the items from the Option Year One student survey. However, we restructured several survey items and factors (e.g., STEM identity) based on results of the Option Year One analyses. Those changes and the results of our analyses of student survey items are shown in **Table A-2**. In summary, internal consistency was high and factor analyses suggested a single factor structure, indicating that using a single scale score in our analyses was acceptable.

Table A-2. Reliability and Factor Analyses for Student Alumni Survey Subscales

Awareness of STEM Changes for OY2 version: dropped 3 items from the OY1 version.	**Cronbach's Alpha**	**Factor Loading**	
		1	2
I want to learn more about STEM.	0.90 (Improved from 0.85 for OY1 version)	✓	
I can use STEM to do something interesting.			
I learned about other things I can do to learn more about STEM, like classes I can take, camps, competitions, or internships I can participate in.			
I know more about a variety of jobs and careers in STEM (like jobs with computers or technology, jobs that require math or science, etc.).			
I know more about a variety of jobs and careers in STEM in the military/ Department of Defense (like research, engineering, cybersecurity, medicine, etc.).			
I have a better understanding of the kinds of skills that are needed to be a STEM professional (e.g., mathematician, computer programmer, engineer, etc.).			

STEM Identity Changes to the OY2 version: Kept the first 2 items from OY1 and added the last 2, and had students rate themselves on each item BEFORE and AFTER participating in the DSEC program	Cronbach's Alpha	Factor Loading	
		1	2
I see myself as a science, technology, engineering, or math person.	BEFORE RATINGS: 0.91 AFTER RATINGS: 0.93 (Improved from 0.88 for OY1 version)	✓	
Others see me as a science, technology, engineering, or math person.			
I believe I can do advanced work in a STEM area (e.g., math, engineering, medicine or other health fields, computer science, etc.).			
I believe I can be successful in a career in a STEM field (e.g., math, engineering, medicine or other health fields, computer science, etc.)			
Interest in STEM Changes to the OY2 version: Removed 2 items from the OY1 version and added the last 3 items			
Change in interest in the following areas due to participating in the DSEC-funded program:			
Interest in a new STEM topic	0.93 (Improved from 0.91 for OY1	✓	
Wanting a STEM career			
Wanting a STEM career in the military/ Department of Defense			
Feeling like I accomplished something in STEM			
Feeling prepared for more challenging STEM activities			
Thinking creatively about a STEM project or activities			
Gaining new knowledge or skills in a STEM area			
Working together with others to solve a problem or create something in a STEM area			
Introducing me to people (like coaches, teachers) who can help me learn more about STEM opportunities (like competitions, scholarships, internships, etc.)			

The green cells with a checkmark inside show that the OY2 scales seem to measure a single factor. Evidence is based on the size of the factor loadings, which are not included in this table for simplicity and clarity.