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Outcome Evaluation of SMART Program 2.0

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Outcome Evaluation of SMART Program 2.0

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Executive Summary

The Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service Program was established in 2006, with the goal "to provide financial assistance for education in science, mathematics, engineering, and technology skills and disciplines … that are critical to the Department of Defense [DoD]." The program supports the DoD's science and engineering (S&E) workforce at sponsoring facilities (SF) across the Services (Army, Navy, and Air Force) and other DoD offices (i.e., the Fourth Estate).

The SMART Program provides scholarships and internships at the undergraduate and graduate levels (bachelor's, master's, and doctoral degrees) across 21 different science, technology, engineering, and mathematics (STEM) disciplines.[1] In return, the students will complete a year of paid employment (i.e., service commitment) for every year they received the scholarship. There are two types of scholars: recruitment (RC) scholars are not DoD employees before applying to the program, and retention (RT) scholars are current DoD employees when they apply.

Evaluation Method

The SMART Program has evolved and grown since its inception in 2006. Due to the evolution of the program and dedication to continuous improvement, the DoD STEM Office has periodically evaluated SMART's processes and outcomes. As part of this continual evaluation, the DoD STEM Office requested the Institute for Defense Analyses (IDA) conduct an initial evaluation of the SMART Program, identified as SMART 1.0 in the current evaluation, that resulted in two reports published in 2018 (Balakrishnan et al. 2018a; Balakrishnan et al. 2018b). This current evaluation, called SMART 2.0, extended the timeframe of evaluation to include subsequent cohorts up to the 2022 awardees and analyzed additional factors of the program such as differences across disciplines. This outcome evaluation report was preceded by a process evaluation report (Belanich et al. 2021). IDA had intended for a survey of program participants and SF coordinators to be part of this outcome evaluation, but as of the writing of this report, the Office of Management and Budget had not approved the distribution of the surveys.

For this evaluation, the SMART Support Contractor, LMI, provided data from the SMART Information Management System (SIMS) based on specific IDA requests; this

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[1] When this evaluation started there were 21 disciplines, but as of September 2023, SMART has added additional disciplines to bring the total to 24.

included applicant and award selection for the 2020–2022 cohorts as well as data on all awardees from the 2006–2021 cohorts. In addition to the SMART Program data, IDA also analyzed national data (e.g., Integrated Postsecondary Education Data System) to understand the applicant talent pool, in addition to anonymized Defense Manpower Data Center (DMDC) information on the DoD S&E workforce.

Findings

The findings of this outcome evaluation are aligned with the program logic model described in the recent process evaluation (Belanich et al. 2021), with a focus on the following segments of the model: 1) applications to awards, 2) degree pursuit, 3) hiring and service commitment, and 4) retention and post-service commitment.

Application to Awards

Due to considerable outreach efforts and expanding budgets, the SMART Program received 7,259 applications, which led to 1,577 award offers for the 2020–2022 cohorts. The resulting award rate of 21.7% indicates that the SMART Program could generally be considered a selective program, whereby it is able to select the best candidates from an ample supply. An analysis of factors associated with the selection of applications to awards has identified a number of interesting findings. For example, individuals applying for RT scholarships are nearly 3.5 times more likely to receive an award than are those seeking RC scholarships.

Further, the differences in award rate across STEM disciplines suggest that outreach efforts could be adjusted to meet the supply of applicants for the disciplines where there may not be enough (e.g., electrical engineering, operations research, and naval architecture and ocean engineering). In terms of scholar characteristics, awardees were less diverse than the distribution of SMART applicants, both in gender and in racial/ethnic backgrounds. However, the awardees were more diverse in gender, race, and ethnicity than the overall DoD STEM workforce. The long-term trend for the SMART Program is increasingly demographically diverse. The analysis of applications to awards also indicated that there is an intersection between gender and disciplines: the four disciplines with the most awardees (e.g., computer and computational sciences and computer engineering) were fields where female applicants were a minority (30% or less); females were the majority for nine disciplines all having relatively few awards (e.g., cognitive, neural, and behavioral sciences).

Finally, scorecard scores provided during SMART panel reviews may have a limited utility as a filter for selection of scholars for the disciplines with many applicants and low award rate (e.g., mechanical engineering). Additionally, scorecard scores do not seem to be useful when there are relatively few awards or a high award rate for a given discipline (e.g., operations research, industrial and systems engineering, and biosciences). A pilot process implemented by the SMART Program Office for the 2023 applicant class may help inform the use of scorecard scores for selection.

Degree Pursuit

The primary objective of SMART is to provide financial support to scholars completing STEM degrees, and, since its inception through calendar year 2021, SMART facilitated a total of 2,870 degrees (of which 1,412 were bachelor's degrees, 752 master's, and 706 doctoral). Further, RC scholars earned 2,559 degrees while RT scholars earned 311. Three disciplines dominated degree production: electrical engineering (22.3%), mechanical engineering (18.0%), and computer and computational sciences and engineering (16.9%), while no other discipline accounted for more than 10%.

The diversity of individuals completing degrees through support from the SMART Program has increased. As such, the percentage of female scholars earning degrees has increased over the years, from 27% in early years to over 32% in recent years. Likewise, the percent of scholars earning degrees who identify as minority races/ethnicities has increased over time.

Over 90% of scholars receiving SMART awards attain their planned degrees. This relatively low incompletion rate varies across disciplines, with some disciplines like industrial and systems engineering and computer science having incompletion rates of over 10%, while disciplines like chemical engineering and naval architecture have an incompletion rate below 3%.

Hiring and Service Commitment

Since the start of the SMART Program to the beginning of 2022, there have been 2,235 RC scholars hired into government service. RT scholars remain employed by the SF for the duration of their time in the SMART Program and therefore are not considered new hires, but they can be considered a success for the program in that they are existing employees that have attained a new degree. Of the new hires (RC scholars), 1,202 earned a bachelor's degrees (53.8%), 539 earned a master's degree (24.1%), and 494 earned a doctoral degree (22.1%).

Of the 1,921 scholars that started and were expected to complete Phase 2 by 2022, 96.0% (1844 Scholars) satisfied their commitment. Even though most scholars satisfy their commitment, it is informative to analyze those that didn't satisfy their commitment. For these scholars, there is variation in the likelihood of attrition across disciplines. For example, computer science and chemistry scholars are most likely to attrite with over 7% not completing Phase 2. There are several disciplines with 0% attrition rates (i.e., all satisfy commitment), such as civil engineering. There seems to be a relationship between length of service commitment and attrition such that scholars who have longer commitment lengths tend to be less likely to complete them. This is aligned with Ph.D.-level scholars who tend to have longer award lengths (i.e., many receiving awards of 3 years or more) having a higher attrition rate than BS and MS scholars who mostly had 2-year commitments.

Retention

Overall, there is a relatively high level of retention in the SMART Program such that 76.3% of all scholars who have started Phase 2 were still with the DoD, many of whom joined the Department more than 10 years earlier. When we restrict this to just the 1,844 scholars who satisfied their commitment and entered Phase 3 before 2022, there are 1,334 scholars who are still working for the DoD for a post-commitment retention rate of 72.3%. The outcome analysis for this report identified variables associated with retention. For example, RT scholars are more likely to be retained than the RC scholars, retention rates of 85% to 75%, respectively. This indicates that as a retention mechanism for current personnel, SMART is effective in keeping those scholars over the long-term. Retention rates also varied by disciplines, with some disciplines (e.g., civil engineering, naval architecture, and oceanography) having relatively high retention rates and some (e.g., computer science, mathematics, industrial engineering, and nuclear engineering) having lower retention rates. Additionally, scholars hired through a pay banding system (e.g., Science and Technology Reinvention Laboratory (STRL) Lab Demo) versus the general schedule (GS) system were more likely to be retained. For scholars hired at a GS level above what would be expected based on degree level, they were more likely to be retained versus if they were hired at the standard GS level. Finally, with limited data on DoD STEM professionals as a comparison, it appears that SMART scholars were a little more or equally likely to be retained (i.e., employed by the DoD in early 2022).

Contents

1. Introduction

A. SMART Program Overview

The Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service Program (hereafter referred to as the SMART Program) was piloted in 2005[2] and permanently established by the Department of Defense (DoD) in 2006 under the Program Element – National Defense Education Program.[3] The goal of the program is

> to provide financial assistance for education in science, mathematics, engineering, and technology skills and disciplines that, as determined by the Secretary, are critical to the national security functions of the Department of Defense and are needed in the Department of Defense workforce.[4]

The program was implemented to support the DoD's science and engineering (S&E) workforce at laboratories and facilities that choose to participate in the SMART Program; herein referred to as the sponsoring facilities (SFs). These SFs span all three Services (Army, Navy, and Air Force) and other DoD offices (i.e., the Fourth Estate). The SMART Program provides scholarships (tuition plus a stipend) for current and future scientists at the undergraduate and graduate levels (bachelor's, master's, and doctoral degrees) across 21 different science, technology, engineering, and mathematics (STEM) disciplines. The SMART Program also provides scholars with summer internships at their SF in order to prepare each scholar for a position and career as a DoD civilian employee. In return for the SMART award, the students commit to completing a year of paid employment at their SF for every year they received the scholarship. There are two types of scholars, based on their status as DoD employees at the time of application: recruitment (RC) scholars are not DoD employees at the point of applying to the program, and retention (RT) scholars are already DoD employees when they apply.

Although the SMART Program Office (SPO) maintains some contact with scholars during the service commitment and post-service commitment timeframes, the bulk of the SPO's oversight of the program is focused on:

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[2] See National Defense Authorization Act for Fiscal Year 2005 Report, Committee on Armed Services, United States Senate, S. Rep. No. 108-260, at 387 (May 11, 2004), https://www.congress.gov/108/crpt/srpt260/CRPT-108srpt260.pdf.

[3] The SMART Program is part of Program Element 0601120D8Z in the DoD's annual budget.

[4] 10 U.S. Code § 4093.

- Solicitation and compiling workforce needs as identified by SFs and components;
- Developing outreach plans to solicit applications from potential scholars to address these workforce needs;
- Supporting the SFs as they work through the process to select SMART awardees;
- Supporting scholars through their degree pursuits and internships; and
- Supporting the hiring of scholars by the SFs to begin their service commitments.

In addition to providing oversight over these SMART Program processes, the SPO is also responsible for general program oversight, records management, program adjustments, debt collection, and communicating with Congress and higher-level DoD leadership through the annual DoD Planning, Programming, Budget, and Execution (PPBE) process for resource allocation.

From 2006 to 2022, the SMART Program awarded 4,268 scholarships to bachelor's, master's, and doctoral students. These awards were distributed across 21 different disciplines,[5] with the percentages of each discipline shown in Table 1. The majority, approximately 60%, of awardees, were or are studying engineering, with electrical, mechanical, aeronautical, and civil each with at least 5% of the awards. The next most common discipline was computer science with approximately 20% of the awards.

Table 1. The list of disciplines for SMART scholarships awarded between 2006 and 2022. The second column is the discipline abbreviation that will be used throughout the report in graphs and tables to conserve space.

Discipline	Abbreviation	Percent of Awards
Aeronautical and Astronautical Engineering	Aero & Astro Eng	8.2%
Biomedical Engineering	Biomed Eng	0.2%
Biosciences	Biosci	2.2%
Chemical Engineering	Chem Eng	1.3%
Chemistry	Chem	1.9%
Civil Engineering	Civil Eng	5.1%
Cognitive, Neural, and Behavioral Sciences	Cog Neuro Behav Sci	1.7%
Computer and Computational Sciences and Computer Engineering	Comp Sci & Eng	19.7%

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[5] When this evaluation started there were 21 disciplines, but as of September 2023, SMART has added additional disciplines to bring the total to 24. Recently added disciplines include cybersecurity, data sciences and engineering, and software engineering.

Discipline	Abbreviation	Percent of Awards
Electrical Engineering	Elect Eng	20.9%
Environmental Sciences	Environ Sci	0.2%
Geosciences	Geo Sci	1.8%
Industrial and Systems Engineering	Ind Syst Eng	3.0%
Information Sciences	Inf Sci	1.5%
Materials Science and Engineering	Mater Sci Eng	2.7%
Mathematics	Math	4.5%
Mechanical Engineering	Mech Eng	17.3%
Naval Architecture and Ocean Engineering	Nav Ocean Eng	1.9%
Nuclear Engineering	Nucl Eng	0.6%
Oceanography	Oceanogr	0.8%
Operations Research	Oper Res	1.1%
Physics	Phys	3.4%

The scholars are spread out across the DoD, which complicates the overall management of the scholars in the program.[6] Some 266 different SFs have sponsored scholars between 2006 and 2022, and some facilities regularly use SMART to bring in new talent. SFs vary in the number of scholars they have supported over the years, with some SFs having sponsored 100 or more, while the majority have had 10 or fewer scholars over the history of the scholarship.[7]

- 6 SFs have sponsored 100 or more scholars
- 19 SFs have sponsored 50–99 scholars
- 24 SFs have sponsored 25–49 scholars
- 41 SFs have sponsored 10–24 scholars
- 167 have sponsored 10 or fewer scholars

Further, some SFs have a number of different locations that host scholars as part of the SMART Program that are counted separately. For example, the U.S. Army Corps of Engineers has sponsored 191 scholars across 42 locations from 2006 to 2022. On the other

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[6] An SF "sponsors" a scholar by selecting the scholar for the SMART Award, providing the summer internship (physical location, research tasks, oversight, mentorship, etc.), and hiring scholars for Phase 2, or the associated service commitment. The financial support of the scholar (i.e., tuition remission, stipend, internship payment) is provided by the SMART Program.

[7] The data regarding the number of scholars supported at each SF were derived from the SMART Support Contractor's, LMI, "Application to Award" dataset. As such, it is possible that SFs that at first glance appear to be distinct locations may be the same as one or more SFs listed due to differences in how the SFs' names were entered into the database or a change to an SF's name.

hand, several SFs may be co-located at the same location, and as such, a large number of SMART scholars can be located at a single location (e.g., military base or laboratory). For example, 251 scholars have participated in the SMART Program across 13 different SFs at the Aberdeen Proving Grounds in Maryland. Likewise, 231 scholars have participated in the program across 18 different SFs at Wright-Patterson Air Force Base in Ohio. Other locations with a large number of SMART scholars over the life of the program include Dahlgren, Virginia (139); Robins Air Force Base, Georgia (118); Kirtland Air Force Base, New Mexico (115); and Eglin Air Force Base, Florida (110).

B. SMART Evaluations

1. SMART 1.0 Evaluations

The SMART Program has evolved and grown since its inception in 2006. Due to the evolution of the program and dedication to continuous improvement, the DoD STEM Office within the office of the Under Secretary of Defense for Research and Engineering (USD(R&E)) plans to periodically evaluate SMART processes and outcomes to see how well changes are being implemented and their subsequent impact on program outcomes. As part of this continual evaluation, the DoD STEM Office requested that the Institute for Defense Analyses (IDA) conduct an evaluation of the SMART Program in 2015 (called SMART 1.0 in the current evaluation), resulting in two final reports published in 2018 (Balakrishnan et al. 2018a; Balakrishnan et al. 2018b). As the first detailed evaluation of the program, IDA examined how the program's goals were achieved (process evaluation) and the impacts of the program (outcome evaluation) for SMART 1.0. [8]

The SMART 1.0 process evaluation guiding questions[9] provided context for the SMART 1.0 outcome evaluation questions:

- To what extent did the SMART Program improve the quality of the civilian S&E workforce?
- To what extent did the SMART Program attract scientists and engineers who would not have normally worked at the DoD?
- To what extent did the SMART Program attract a more diverse set of S&E workers to the DoD as compared to the broader DoD S&E workforce?

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[8] The SMART 1.0 evaluations covered cohorts from the program's inception in 2006 through the 2015–2016 academic year, which summed to 2,021 scholarships to students attending 305 higher education institutions who were sponsored by 169 unique DoD facilities.

[9] The SMART 1.0 process evaluation questions were: 1) What are the goals of the SMART Program? 2) How does SMART scholar hiring fit into the larger hiring strategy at DoD facilities? and 3) What is the level of satisfaction of the SMART scholars with the SMART Program?

- To what extent does the SMART Program contribute to the retention of SMART scholars at the facilities post-service commitment?
- To what extent do SMART scholars who leave DoD employment join organizations that serve DoD interests (DoD contractors, Federally Funded Research and Development Centers (FFRDCs), etc.)?

Using a variety of data sources[10] and analytical methods, IDA identified six overarching findings of the SMART 1.0 outcome evaluation. The first was that per SFs, SMART scholars improve the quality of the DoD workforce by performing at a higher quality than DoD civilians hired under other mechanisms. Additionally, the SMART Program draws from applicant pools that are of higher quality than those from which DoD hires other S&E employees based on an analysis of the type of research institutions the applicants come from. It was also noted that despite this finding, SMART RC scholars were hired into civil service at lower salaries than their counterparts, an issue that the SPO has worked to rectify since 2014. Finding 2 was that the SMART Program attracted students who had not considered the DoD as an S&E employer prior to applying. Many RC scholars learned about the program through word of mouth, leading the SPO to develop new outreach efforts to improve awareness about the program. The third finding was that the program had greater gender diversity but less racial diversity than the DoD S&E workforce. Finding 4 showed the SMART Program appeared to not contribute to the retention of SMART scholars at DoD SFs post-service commitment, and in fact, seemed to be leaving the DoD workforce faster than their civilian S&E counterparts. This exodus from the DoD workforce by SMART scholars was due to low salaries, frustration with work culture and work experience, and issues related to working at SFs that are far from the scholars' homes. Finding 5 showed that despite the legislative goal of the SMART Program being to provide S&E talent to meet the needs of the DoD's missions, the execution of the program requires multiple goals, which contributes to the complexity of managing the program. Finally, the sixth finding showed a large portion of SMART scholars were satisfied with the program. These scholars were more likely to be retained, were more satisfied with their work, and more interested in serving the DoD's missions.

Based on the above findings to the SMART 1.0 Outcome Evaluation, IDA identified a set of recommendations. In order to continue the recruitment of high-quality scholars from a strong pool of applicants, IDA recommended that SMART build itself as a brand both within and outside of the DoD through the use of SMART alumni as recruiting agents for the program (Findings 1 and 2). Another approach to this recommendation included

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[10] Data sources for the SMART 1.0 process and outcome evaluations included SMART Program documentation, more than 150 interviews with stakeholders (including S&E managers and scholars), a scholar survey, programmatic data, longitudinal defense personnel data from the Defense Manpower Data Center (DMDC) for SMART scholars and a comparison group of DoD S&E employees, and bibliometric data for PhD SMART scholars and a comparison group of PhD-holding S&E employees.

educating faculty and university career officers about the SMART Program to expand beyond word-of-mouth knowledge about the program. Likewise, in order to build stronger ties between academia, the SMART Program, and DoD research priorities, IDA recommended that SMART create a pilot program to provide academic advisors to SMART scholars with research support to conduct research in line with the DoD's mission areas. A final idea to build up the SMART brand was to develop scholar networks at SFs and utilize these networks for program outreach at universities, conferences, and other locations.

IDA also made several recommendations regarding ways to improve the retention of SMART scholars within the S&E workforce. For example, ensuring that SFs met a standard of excellence regarding effective mentorship and training as well as work experiences that were in line with scholars' skills and interests could improve longer term retention of scholars in the DoD. Likewise, the SPO could create a pilot program that increased flexibility in placement at SFs through efforts such as allowing scholars to rotate between commands or Services during their internships. IDA also recommended that the SPO consider revising the SMART application to include metrics directed at evaluating scholars' interests in serving the DoD mission. Once an application has been awarded, however, IDA recommended increasing opportunities for scholars to receive recognition for their work. Finally, given that the retention of scholars both during the service commitment phase and beyond is outside of the management purview of the SPO, IDA recommended that the retention rate of scholars within the DoD workforce was an unfair metric to evaluate the SMART Program.

Given the issues discovered regarding starting salaries for SMART scholars, IDA recommended that the SPO investigate the hiring processes at SFs to ensure equity across hiring, particularly in the hiring of RC scholars. Further, IDA recommended that the SPO monitor salaries to ensure that scholar salaries were commensurate with their peers at all SFs. And although the SMART Program was found to be gender diverse, IDA recommended that the SPO continue their outreach focused at increasing the pool of qualified female applicants, but also suggested increasing efforts to increase the applicant pool from individuals from underrepresented minority groups. IDA determined that a contributing factor to the racial diversity issue faced by the program was the high rate of application non-completion or withdrawals from individuals identifying as an underrepresented minority. IDA recommended further investigation into the contributing factors to this issue and suggested piloting a mentoring effort during the application process for underrepresented minorities to see if such efforts increase the rates of completed applications from such groups. Likewise, IDA suggested increasing outreach efforts at Hispanic Serving Institutions and large academic institutions with substantial numbers of students identifying as underrepresented minorities.

Finally, in order to determine and prioritize an SF's need for SMART scholars by discipline, degree level, and skill level, IDA recommended that the SPO conduct a workforce demand analysis for components and SFs. The impetus for this recommendation was to improve outreach efforts for qualified applicants. Because the DoD workforce needs or demands are not ubiquitous across disciplines and degree levels, such an analysis would allow the SPO to engage in targeted outreach for those disciplines/degrees that are challenging for the DoD to recruit through non-SMART-related hiring mechanisms. This workforce demand analysis could also be used to determine if, and by how much, the SMART Program should expand and provide evidence for this expansion.

2. SMART 2.0 Evaluations

Since SMART 1.0, the program has implemented a number of changes regarding program management, technological updates to the application process and administration, and program implementation.[11] In 2021, the DoD STEM Office again requested that IDA conduct an evaluation of the SMART Program in order to examine how the program has evolved, how its procedures have changed over the 5 years since SMART 1.0, and to provide an analysis of data that did not previously exist (e.g., 5 years of new scholars, differences across STEM disciplines, diversity improvement efforts). This new evaluation is SMART 2.0 and has a similar structure to SMART 1.0 consisting of both a process evaluation, completed in 2021 (Belanich et al. 2021), and an outcome evaluation, the focus of this current report.

a. Purpose of SMART 2.0 Outcome Evaluation

As described in the SMART 2.0 process evaluation report, a distinction can be made between process and outcome evaluations. While process evaluations assess the structure of the program, resources needed and used to conduct specific program-related functions, and activities undertaken to achieve program objectives, outcome evaluations assess the achievement of objectives and the effects of those achievements (Belanich et al. 2021; Wholey, Hatry, and Newcomer 2010). For complex programs such as SMART, process and outcome analyses cannot be totally divorced, so some of the outcome analyses discussed in the SMART 2.0 process evaluation are referred back to throughout this report.

For the purposes of this outcome evaluation, we refer to the logic model (shown in Appendix A) described in the SMART 2.0 process evaluation (Belanich et al. 2021), with a focus on the following segments:

- *Applications to awards.* The period starts when the scholars complete their application to the scholarship. During this period, applicants are matched with

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[11] A review of the program management, technological evolution, and program implementation changes to the SMART Program can be found in the SMART 2.0 Program Evaluation (Belanich et al. 2021).

an SF, arrange for site visits, or participate in orientation sessions, but do not receive award funding. The SPO refers to this segment as Phase 0.

- *Degree pursuit.* This segment (Phase 1) starts with the formal award of the SMART scholarship and ends when scholars complete approved degree requirements and internships.
- *Hiring and Service commitment.* This segment (Phase 2) begins when scholars complete their academic and internship requirements and begin government service at their SF as a full-time employee. Phase 2 ends when the scholar completes their agreed upon commitment to the SF.
- *Retention Beyond Service commitment.* This segment (Phase 3) begins after scholars satisfy their commitment to the DoD, and may continue to work for their SF or may leave without incurring a debt.

b. SMART 2.0 Outcome Evaluation Study Questions

The guiding questions for the current outcome evaluation are based on the stated or explicit goals of the SMART Program, guiding questions for the SMART 1.0 outcome evaluation, and through conversations with program stakeholders regarding unstated or implicit goals of the program. The guiding questions for this SMART 2.0 outcome evaluation aim to address all phases of the SMART Program (from application to retention).

1) Awards to Scholars (*Logic Model Section: Applications to Awards)*

- To what extent do applicant factors such as scholar type (recruitment and retention), applicant demographics, and discipline of study affect the outcomes of the application-to-awards process (Phase 0)?
- To what extent do factors associated with applications such as grade point average, selection panel score, and university type affect the selection of applications for awards (Phase 0)?
- To what extent did the SMART Program attract a more diverse set of S&E employees to the DoD as compared to the broader DoD S&E workforce?

2) Scholars Pursuing Degrees (*Logic Model Section: Degree Pursuit)*

- To what extent do scholar factors such as scholar type (recruitment and retention), discipline of study, and scholar demographics affect the attainment of degrees in Phase 1?

3) Hiring and Retaining Scholars (*Logic Model Sections: Service Commitment and Retention Beyond Service commitment)*

- To what extent do scholar factors such as degree level and discipline of study affect hiring of scholars by SFs (Phase 2)?
- To what extent does the discipline (i.e., workforce need of the discipline, relationship between discipline of study and job category at the SFs) and hiring rates by the Service components affect Phase 2 outcomes?
- To what extent do scholar factors such as degree level, discipline of study, cohort year, and workforce need of the discipline affect post-Phase 2 retention (i.e., Phase 3)?

c. SMART 2.0 Outcome Evaluation Methodology

For the SMART 2.0 process evaluation, IDA reviewed a range of documentation including material published for the scholars to learn about how the SMART Program operates (i.e., Scholar Handbooks), policy documents that guide how the SMART Program runs, and documents generated by scholars and the SPO that relate to SMART practices (e.g., reports generated by scholars and SFs at different points during the SMART processes). A guiding policy document for SMART is Title 10, U.S. Code § 4093, that provides the authority for the SMART Program. Additionally, DoD Instruction (DoDI) 1025.09, SMART Defense Education Program, provides detail on the responsibilities, managerial structure, and oversight for the SMART Program. We used this knowledge as a basis for the current outcome evaluation.

The SMART Support Contractor, LMI, provided extensive data based on specific IDA requests along with several spreadsheets containing data that they had compiled for the SPO, including the “Application to Award” (July 2022), “Degree Attainment” (February 2022), and “Retention” (February 2022) datasets. The range of data analyzed included:

- Projections for workforce needs to be addressed through SMART
- Applications across multiple year cohorts
- Scholar and selection data across multiple cohorts
- Hiring and employment data across all cohorts

In addition to the SMART Program data, IDA also analyzed national data to understand the talent pool that the program applicants came from. These national data (Integrated Postsecondary Education Data System) provided a perspective on variance across STEM disciplines, racial/ethnic categories, gender, and geographical dispersion across the United States.[12] Additionally, IDA analyzed anonymized Defense Manpower Data Center (DMDC) information on the DoD S&E workforce to provide an understanding of the personnel context within which the SMART Program was operating. IDA also relied on additional information and access to the data from the Department of Education's National Center for Education Statistics.

d. Limitations to Methodology

One important consideration regarding the data used in this report is that IDA was not involved in the collection of the SMART Program applicant/award data and the hiring/employment data of the scholars, nor any comparative datasets. As such, IDA cannot know or comment on the accuracy of the data used in the outcome analyses. That being said, the data are what one might expect to see regarding the program and the DoD S&E workforce, and as such, IDA is working under the assumption that the data used here are accurate. In cases where the data do not exist (e.g., application data from periods earlier than 3 years from the date of the data request), we make note of the data limitations. Likewise, in cases where the external data were not clear (e.g., DMDC information on the S&E workforce), IDA made every effort to rectify inconsistencies and limited our analyses to only those data that appeared reasonable for the datasets used.

An important source of data for the SMART 1.0 outcome evaluation included both the in-depth interviews with SMART stakeholders (e.g., SF science and technology [S&T] mentors and supervisors) and the SMART scholar survey. Data collected from these interviews and survey provided insights regarding SF and scholar satisfaction with the SMART Program processes, stakeholder and scholar perspectives regarding satisfaction with the program, and future involvement with the SMART Program and DoD workforce. Given the rich information collected through these interviews and survey, the SMART 2.0 study team developed surveys to collect insights from SMART stakeholders and scholars. Because of stricter implementation of the Paperwork Reduction Act (PRA), which governs how federal agencies collect information from the American public, both surveys have been submitted to the Office of Information and Regulatory Affairs (OIRA) under the Office of Management and Budget (OMB) who has the authority to approve PRA clearances. The process to receive a PRA clearance is lengthy; thus, at the time of the writing of this report, IDA has not received final clearance for the two surveys. As such, the SMART 2.0 Outcome Evaluation does not include data from the surveys; however, the analysis of the survey data will be released as an addendum to the current report at a future date.

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[12] Additional information and access to the data from the Department of Education's National Center for Education Statistics can be found at https://nces.ed.gov/ipeds.

e. SMART 2.0 Outcome Evaluation Report Organization

The report structure is aligned with the study questions and therefore the logic model (see Appendix A). Chapter 2 discusses findings related to Phase 0, or the outcomes associated with the application-to-award process. Chapter 3 details findings associated with Phase 1, or the pursuit and completion of academic degrees by SMART scholars. Upon completion of their degrees, scholars are hired by SFs—the variables associated with hiring (or the start of Phase 2) are covered in Chapter 4 while Chapter 5 focuses on variables associated with retention beyond the completion of the service commitment (or Phase 3). Finally, Chapter 6 outlines the summary findings and recommendations for this SMART Program outcome evaluation.

2. Applications to Awards

A. Chapter Organization

This chapter reports on the outcomes from the entire application process, from the initiation of an application for a SMART scholarship to the receipt of a scholarship award. The chapter explores various factors that are at play and influence a person's application process, from applying to being offered an award. Throughout this section we present the landscape of the application process, and discuss applicant-specific variables that influence this process, including demographics, STEM discipline focus, and education history. Where necessary, we present the intersection of these variables. This chapter addresses three specific guiding questions regarding SMART Program outcomes:

- To what extent do applicant factors such as scholar type (recruitment and retention), applicant demographics, and discipline of study affect the outcomes of the application-to-awards process (Phase 0)?
- To what extent do factors associated with applications such as grade point average (GPA), selection panel score, and university type affect the selection of applications for awards (Phase 0)?
- To what extent did the SMART Program attract a more diverse set of S&E employees to the DoD as compared to the broader DoD S&E workforce?

This chapter is organized into four parts: in Section B we describe the major outcomes from the applications received by the SPO; Section C covers the factors that determine application outcomes, including award type, academic discipline, demographic factors, and the intersection of these factors; Section 0 describes the association of different variables to award outcomes, including college GPA, panel score, SF preference, and university type; and Section E summarizes the overall findings from this chapter.

B. Outcomes of the Application-to-Award Process

The SPO tracks progress of applicants through eight sequential stages of the application process. Applicants are tracked by recording the last stage that they completed. The eight stages are described as follows:

1. *In-Progress*: An individual interested in the SMART scholarship starts the application process by creating an account and entering information in the SMART portal, but has not completed all required application sections. The portal opens for application on August 1.

2. *Submitted*: Individuals have completed all required application sections and submitted their information in the portal for consideration by the SPO. The SPO is awaiting receipt of the individuals' letters of recommendation (i.e., the student's application paperwork has been submitted but is considered incomplete until the transcripts and letters of recommendation are submitted). All applications must be submitted by December 1.
3. *Withdrawn*: After submitting the information, individuals may elect to withdraw their application from consideration.[13]
4. *Completed*: The SPO determines that the applicant is eligible for the SMART scholarship and deems the individual's application to be complete (i.e., the application includes college transcripts, at least two letters of recommendation, and a personal statement; applicant is seeking a bachelor's degree [or higher] in one of the 21 STEM fields identified by the SPO, meets the minimum GPA requirement, and is a citizen of the United States, Australia, Canada, New Zealand, or United Kingdom at time of application) and ready for review by the initial selection panel.
5. *Semifinalist*: The SPO convenes an initial selection panel to review and rank score applications to identify a set of qualified applicants for the second round of assessments conducted by participating SFs. In February, applicants receive a notification of whether or not they are a semi-finalist.
6. *Finalist*: SFs evaluate the list of semifinalists and conduct applicant interviews to develop a final selection list of awardees.
7. *Offered*: SFs make award decisions, which are reviewed by the Component Liaisons, the Component Execution Leads, and the SPO to reconcile the selection of the same applicant by two or more SFs. In April, students are notified if they have been selected for the SMART Scholarship Program. The data on this step do not consider whether the applicant accepts the offer or whether the offer is subsequently rescinded. This group is referred to as offerees in the current report.
8. *Awarded*: As noted above, a small percentage of applicants who are offered scholarships will decline the offer while other offers are rescinded by the SPO. The *accepted* data refer to the actual number of SMART scholarships that are accepted by both the applicant and SPO such that the applicant begins their

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[13] For our data, the "Withdrawn" status was only available for Program Years 2020 and 2021. Individuals in withdrawn status were treated as "Completed"—that is, applicants who submitted applications but did not make it to the Semifinalist stage.

degree pursuit with SMART award support. This group is referred to as awardees or scholars in the current report.

Figure 1. Depiction of SMART Program application process. Note: the size of the applicant pool decreases at each step of the application process.

Upon the application due date (December 1 each year), the SPO reviews the submitted materials for completeness and eligibility (see "Completed" above). Incomplete applications are often missing letters of recommendation (LORs). The SPO asked IDA to examine the state of the science regarding LORs to identify best practices to improve the submission rates from evaluators and to increase the reliability and utility of such evaluations. Although ceiling effects and the incorporation of conscious and subconscious biases continue to be a lingering issue (Aamodt and Williams 2005), LORs can be a critical piece of information in the evaluation of applications. IDA recommends a number of actions that developers of LORs can take to try to improve the reliability and validity of such tools (see Appendix B for more information).

In July 2022, the SMART Support contractor, LMI, provided IDA a dataset of applications that were initiated in Program Years 2019–2021: the "Applications to Awards" data. The Program Year is the year in which individuals initiate their application, which is typically the year prior to the award decision (i.e., program year 2019-2021 applicants become awardees of the 2020-2022 cohorts). The 2019–2021 dataset tracked the progress of 28,877 individuals who created accounts in the SMART Portal, the first step of the application process. However, most of those individuals (20,391 or 70.6%) did not complete the next step and submit applications. Although the portion of individuals who started but did not submit their applications in 2019–2021 is relatively large (70.6%), it is smaller than those who started but did not submit applications in 2016–2017, which averaged 85.3% (Balakrishnan et al. 2018). Further, information on those who had only completed the "In-Progress" stage was very sparse. Therefore, the following analyses of application outcomes is based on those 7,259 individuals who completed the second step of the application process, i.e., submitted their applications. The data on submitted applications (7,259) indicate that the percent of eligible applicants who received award offers (1,577), which is defined herein as "offer rate," was 21.7%. This rate is higher than the offer rate for all U.S. college scholarships (12.5%), which includes both merit-based scholarships and need-based grants (Kantrowitz 2020).

As shown in Figure 2, Program Year 2020 saw an increase in the number of applications that were started and submitted (Stages 1 and 2, dark blue and red bars, respectively), but not completed (n = 590). This spike in 2020 applications may have been an unexpected result of the COVID-19 outbreak, and those numbers were somewhat lower in 2021. This increase also coincided with the initiation of webinars by the SPO focused on encouraging and guiding applicants to the program. The number of completed applications has steadily increased from 2,306 in 2019 to 2,398 in 2020, and to 2,555 in 2021 (green and purple bars in Figure 2).

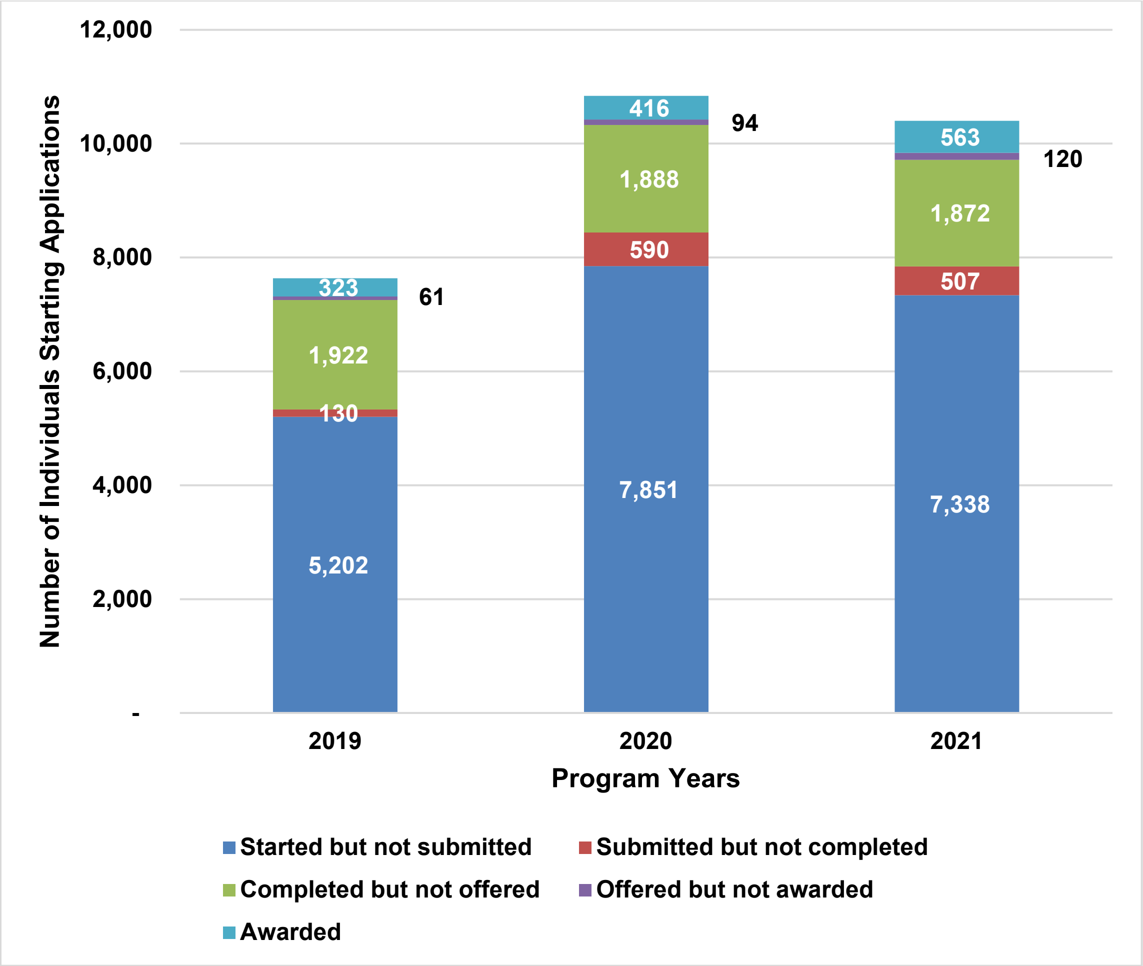

Figure 2. Number of individuals who started, submitted, and completed applications and were offered scholarships in Program Years 2019–2021. Dark blue bars indicate stage 1 'In progress,' red bars indicate stage 2 'submitted,' green bars indicate stage 4 or 'completed,' purple and light blue bars combined indicate stage 7 or 'offered, and light blue bars indicate stage 8 or 'awarded.'

The Program Years 2019–2021 application to awards data were supplemented with another dataset of 3,783 individuals who were accepted and participated in the program over the 16-year period from Cohort Year 2006 to 2021. Cohort Year is the year in which awards are determined and scholarships are initiated. This "Degree Attainment" dataset, received in February 2022, tracked the process of degree attainment of SMART scholarship awardees, and was used to determine the number of applications that were offered scholarships (see purple bars in Figure 2).

C. Factors in Applications, Offers, and Awards

This section describes some of the main factors that describe SMART applicants and offerees and variables that influence a person's trajectory through the eight stages of the application process. We focus on scholarships *offered* and not *awarded* in this section because these data reflect applications that were selected by SFs for award and that SPO intended to award. These variables include: awardee type, STEM discipline, and the demographics of applicants and offerees. This section concludes with an analysis that examines some of the intersections (or interactions) of these key variables.

1. Offeree Type

A fundamental way that applicants differ is whether, at the time of application, they were employed as civilian employees by one of the SFs. RT scholars are civil servants working at an SF who applies for and is awarded a SMART scholarship to pursue a degree in a STEM field. RC scholars, on the other hand, are not civilian employees of the DoD but are students enrolled in a STEM degree program. In the data we received, the variable "Offeree Type" distinguished between RC and RT scholars. For cohort years 2020–2022, this yielded 139 RT offerees and 1,438 RC offerees. The portion of individuals who applied for and were offered either recruit or retention scholarships in 2019–2021 is shown in Figure 3. Note that that RT applicants comprise only 2.7% of the completed applications. However, the offer rate (eligible applicants receiving an award offer) was 70.9% for RT applicants compared to 20.4% for RC applicants. In other words, individuals who apply for retention scholarships were nearly 3.5 times more likely to be offered a SMART scholarship than are those who apply as new students (i.e., RC scholarships). This difference in offer rates suggests that some SFs may be utilizing the SMART Program to give existing DoD employees opportunities to pursue higher levels of education.[14]

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[14] For the SMART 2.0 Program Evaluation, IDA spoke with stakeholders at a number of SFs. Although some SFs had existing programs in place to support the pursuit of higher levels of education for their employees, not all SFs reported having such programs. This report did not identify whether an RT scholar's SF had other avenues to support their employee's pursuit of furthering education.

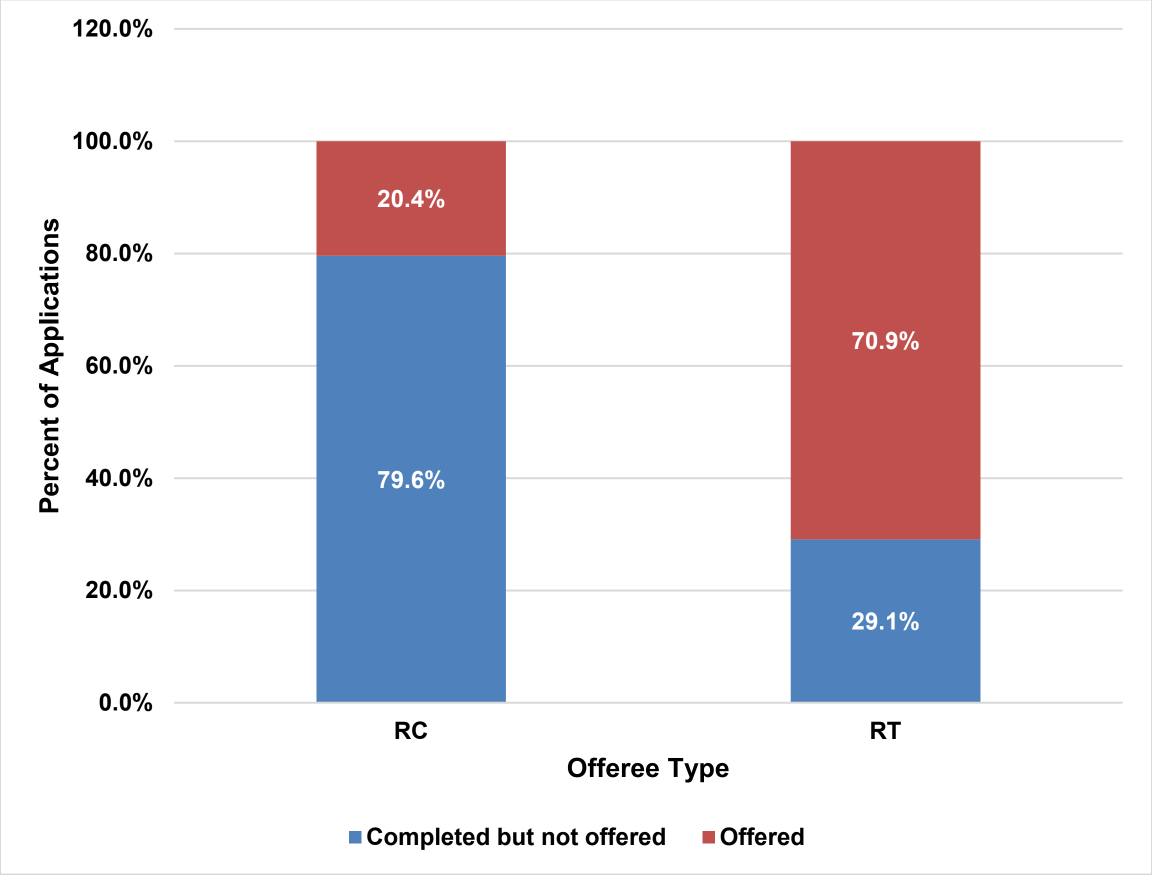

Figure 3. Percent of recruitment (RC) and retention (RT) scholars who completed applications and were or were not offered awards in program years 2019–2021. RT applicants comprise 2.7% of the entire applicant (RC + RT) pool. Note, of the 139 RT and 1,438 RC applicants who received offers, 121 RT and 1,181 RC scholars were ultimately awarded SMART Scholarships.

2. Academic Discipline

Figure 4 shows, for Program Years 2019–2021, the distribution of 7,259 individuals who completed applications and were deemed eligible for the SMART Program by the 21 STEM disciplines. The data show large differences in the number of applications in those disciplines—from over 1,000 applicants for computer and computational sciences/computer engineering and for mechanical engineering to fewer than 50 applicants for nuclear engineering, oceanography, and operations research. In terms of proposed degree, most applicants (59.7%) sought scholarships to attain bachelor's degrees, but a substantial proportion (39.9%) were after support for advanced post-baccalaureate degrees (master's or doctorate). A very small fraction (0.3%) sought support for associate-level degrees, and none of these applicants received scholarships; for these reasons, the applicants for associate degrees are not shown on the graph. The ratio of baccalaureate to advanced post-baccalaureate applicants was fairly consistent across disciplines except for some of the disciplines having fewer applicants: material sciences and engineering (75.6%

of applicants seeking support for advanced degrees), oceanography (82.1%), and operations research (75.0%).

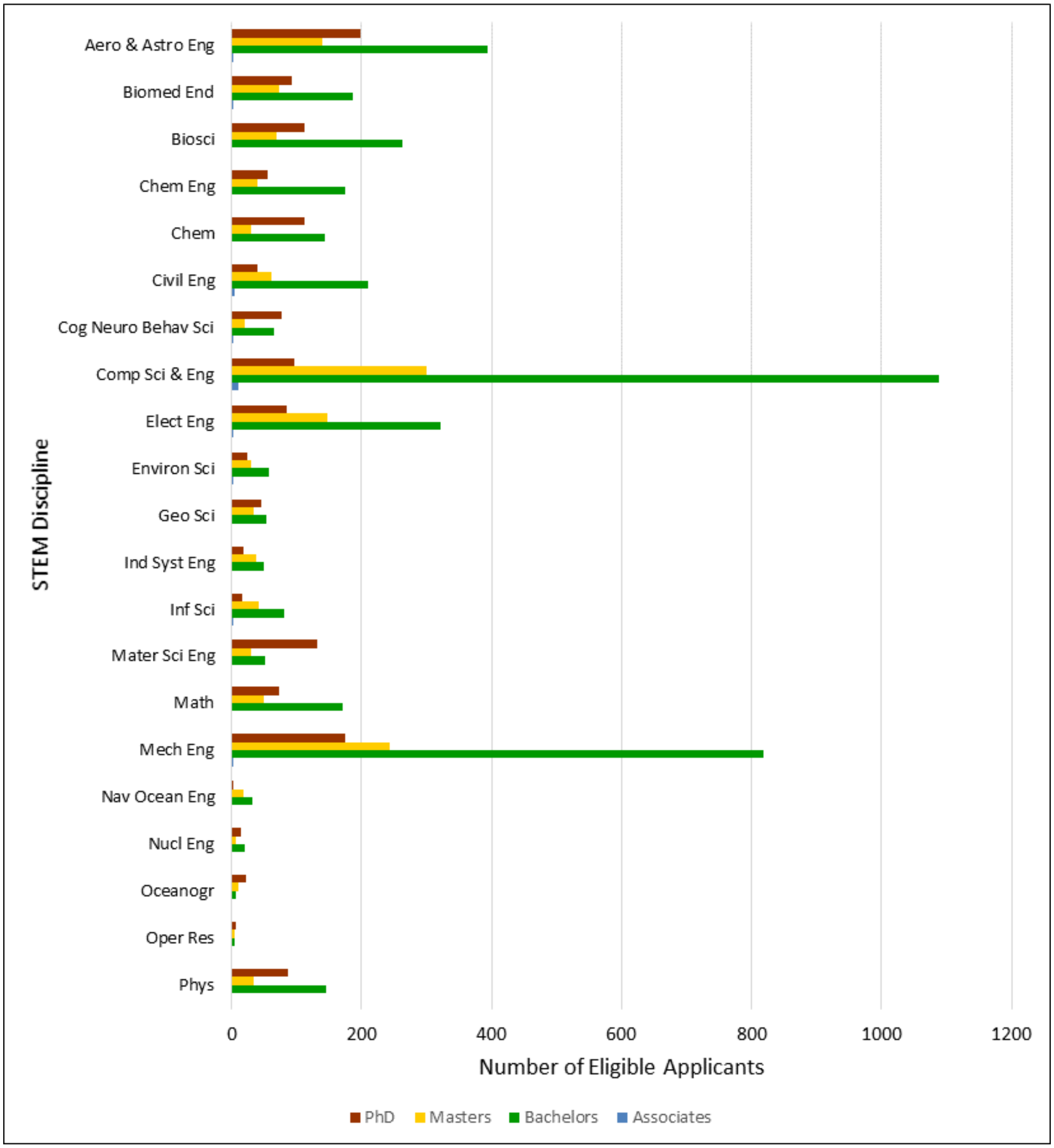

Figure 4. Academic disciplines of and degree level support sought by eligible applicants in program years 2019–2021.

Figure 5 examines SMART's selection statistics in relation to each of the 21 disciplines. For each discipline, the percentage of applicants given offers (i.e., the offer rate) was compared to the total number of awards given in that discipline. This analysis should provide insight into the relative supply and demand for scholars of each discipline.

In this analysis, it was expected that offer rate would be a reasonable proxy for the relative supply of applicants in that discipline. Disciplines with a high offer rate do not have enough applicants to be very selective, implying the relative supply is small (e.g., operations research). Those disciplines with a low offer rate can be selective, implying a relatively high supply. Likewise, disciplines with a high absolute number of offers have a relatively high demand for scholars with those skills, and those with low numbers have a relatively small demand.

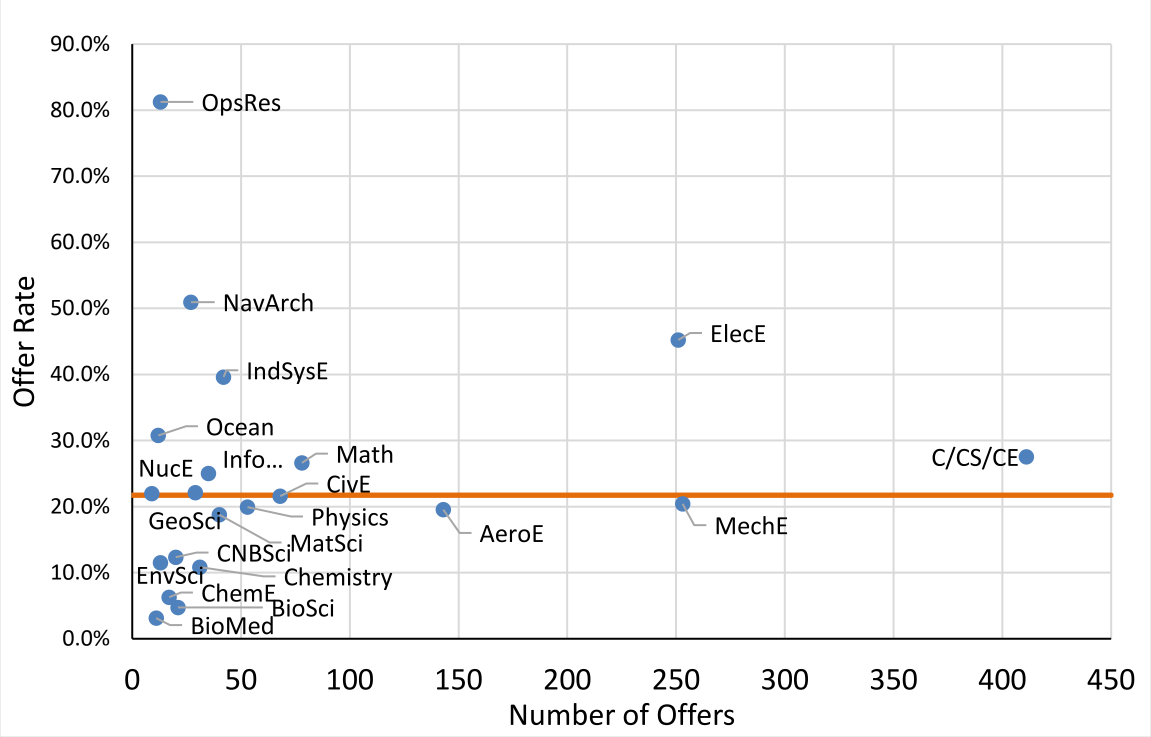

Figure 5. Scatter plot of percent of applicants offered versus number of offers given in that discipline, for 2019–2021 applicant classes. The orange horizontal line indicates SMART's overall offer rate at 21.7% from 2019 to 2021.

In Figure 5, the offer rate of applicants from each specific discipline over the 3-year period between application years 2019 and 2021 (i.e., applications for the 2020–2022 cohorts) is plotted against the number of scholarships awarded across those 3 years. As a reference point, the orange horizontal line indicates SMART's overall offer rate of 21.7% across those 3 years.

Of the 21 disciplines, there are two groupings that merit further discussion. The first cluster is the three disciplines with offer rates above 40%: operations research, naval architecture and ocean engineering, and electrical engineering. Such a high offer rate for these disciplines indicates that the number of SMART program applicants in these fields may be insufficient to match the program's needs. For the first two disciplines, this issue should come as no surprise. Analysis of the Integrated Postsecondary Education Data System (IPEDS) maintained by the U.S. Department of Education shows that these disciplines are among the smallest in the nation, approximately 700 graduates per year across the nation from each discipline. Furthermore, nearly 40% of these graduates come from the various Service academies, whose graduates are largely ineligible to apply to SMART. This means that the supply of students with expertise in these fields is exceedingly small, and there may not be much room to expand the applicant pool.

More surprising was the third discipline in this category: electrical engineering. Despite the fact that electrical engineering is the fourth most popular discipline among SMART applicants, 43% of these applicants are being given offers, a number far higher than other disciplines with similarly large applicant pools, like mechanical engineering and the computer sciences. This suggests that even though the electrical engineering applicant pool is comparatively large, there would still be value in expanding the number of electrical engineering applicants.

The second cluster of disciplines is those in the lower left of the graph. These disciplines are biomedical engineering; biosciences; chemistry; chemical engineering; and cognitive, neural, and behavioral sciences. Each of these disciplines gave out less than 25 offers across 3 years, and those awards went to between 2% and 7% of their applicants. This is the opposite situation as the electrical engineering case discussed above—the number of applicants far outstrips the number of scholars needed with these skillsets. This very low offer rate combined with the small number of offers given in these areas implies that SMART is perhaps not well suited for scholars with these skillsets. SMART is spending resources bringing in and managing applications from these fields, which combined made up nearly 20% of all applications, but just 5% of the offers. Those resources could perhaps be reallocated elsewhere, such as towards reaching out to students in the three discipline groups from the first cluster.

3. Gender

In the "Applications to Awards" dataset, men outnumbered women. Of the eligible applicants for Program Years 2019–2021, 4,437 applicants (61.1%) responded "Male" to the gender item, 2,729 (37.6%) responded "Female," and 93 (1.3%) indicated that they did not wish to respond. Figure 6 displays those figures broken down by degree level. Over all applicants, 60.1% of eligible applicants sought support for a bachelor's degree or less, whereas 39.9% were pursuing an advanced degree (i.e., master's or doctorate). The data indicate that, compared to females, males were somewhat more likely to be seeking support for advanced degrees: 41.6% of males sought scholarships for advanced degrees compared to 37.0% of females.

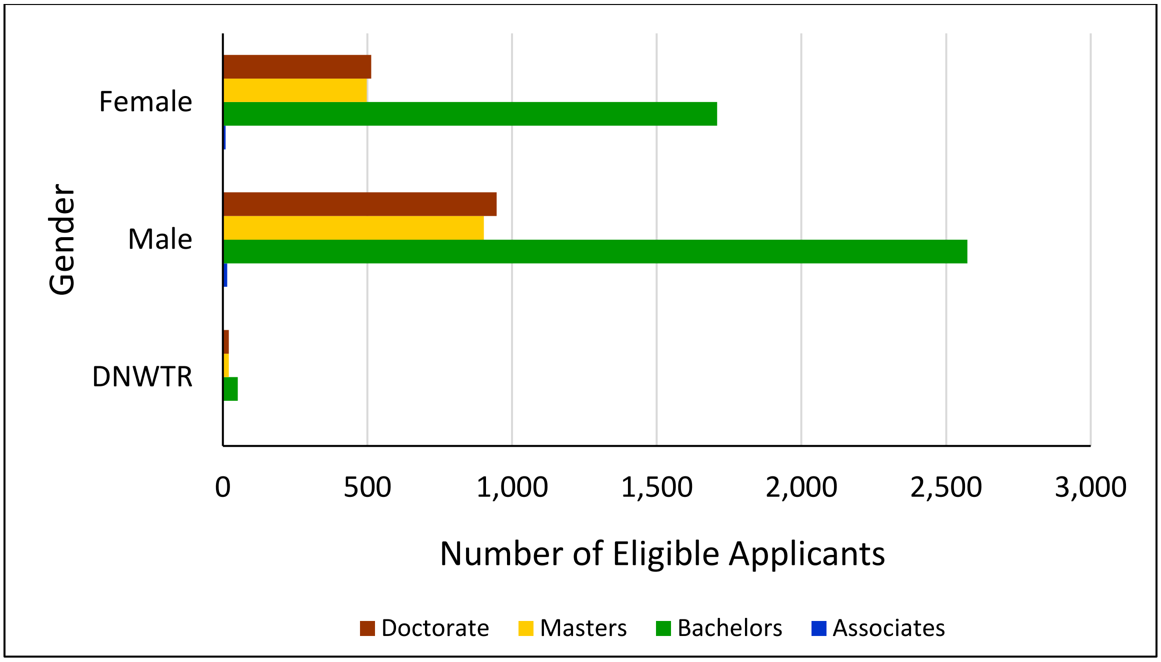

Figure 6. Gender breakdown of SMART applicants by degree level for program years 2019–2021. Women made up 37.6% of applicants, and men made up 61.1% of applicants.

Table 2 displays the offer rates for males, females, and those who did not wish to identify their gender (did not wish to respond (DNWTR)). The table indicates that the offer rates for both males (22.4%) and females (20.6%) were not much different than the overall offer rate (21.7%). This means that despite the larger proportion of male applicants, SMART offers both men and women scholarships at a similar rate.

Table 2. Offer Rates for Male, Female, and Individuals Who Did Not Identify Their Gender

Gender	Eligible Applicants	Percent of Eligible Applicants	Award Offers	Offer Rate
Female	2,729	37.6%	563	20.6%
Male	4,437	61.1%	992	22.4%
DNWTR	93	1.3%	22	23.7%
Total	*7,259*	*100%*	*1,577*	*21.7%*

Note: DNWTR means did not wish to respond.

Table 3 compares the gender diversity of the SMART eligible applicants in the 2019–2021 dataset to other related distributions. First, applicants are compared to the percent of scholarship offers. The data indicate that the gender diversity of the offerees, measured by the proportion of females, is somewhat less than the diversity of applicants; the percent of female offerees is 1.9% less than female applicants, and the percent of male offerees is 1.8% greater than male applicants. On the other hand, the gender diversity of SMART applicants and offerees in 2019–2021 is substantially greater than the diversity of the DoD S&E Workforce hired in Calendar Years 2016–2020; the percent of female offerees in 2019–2021 was greater (+14.3%) than females in the S&E Workforce, and the percent of male offerees was less than males in that workforce (-15.7%). (The Workforce data, obtained from the DMDC is described in Appendix C.) In agreement with findings from the SMART 1.0 evaluation (Balakrishnan et al. 2018), the selection and offer process continue to promote gender diversity in the DoD S&E Workforce.

Table 3. Gender Differences in SMART Scholarship Applications Submitted and Awards Offered in 2019–2021 Compared to the DoD S&E Workforce hired in 2016–2020

		SMART Program for Program Years 2019–2021		**DoD S&E Workforce Hired in 2016–2020**
Gender	**Statistic**	**Eligible Applicants**	**Scholarship Awardees**	**Employees**
Female	***N***	2,729	563	25,531
	%	37.6%	35.7%	21.4%
Male	***N***	4,437	992	93,701
	%	61.1%	62.9%	78.6%
DNWTR/ No Response	***N***	93	22	0
	%	1.3%	1.4%	0.0%

Note: DNWTR/No Response = Individuals indicated that they did not wish to respond (DNWTR) to the gender item or that their response could not be determined (i.e., blank).

To determine long-term trends in gender diversity of SMART scholars, we examined the database of 3,783 individuals who were awarded (i.e., offered and accepted) a scholarship and participated in the program over a 16-year span from Cohort Year 2006 to 2021. The data shown in Figure 7 indicate a steady increase in the percent of female participants, resulting in nearly a 9% increase in the proportion of female scholars, and a similar decline in male scholars over the interval from 2006 to 2021. These data suggest that while the SMART Program has not yet reached gender equity, it is continuing to make progress in increasing the gender diversity of SMART scholars. However, we note that there are a variety of factors that may contribute to this increase in gender diversity, some of which are outside the scope of the SMART Program (e.g., the rates of female vs. male enrollment at U.S. universities).

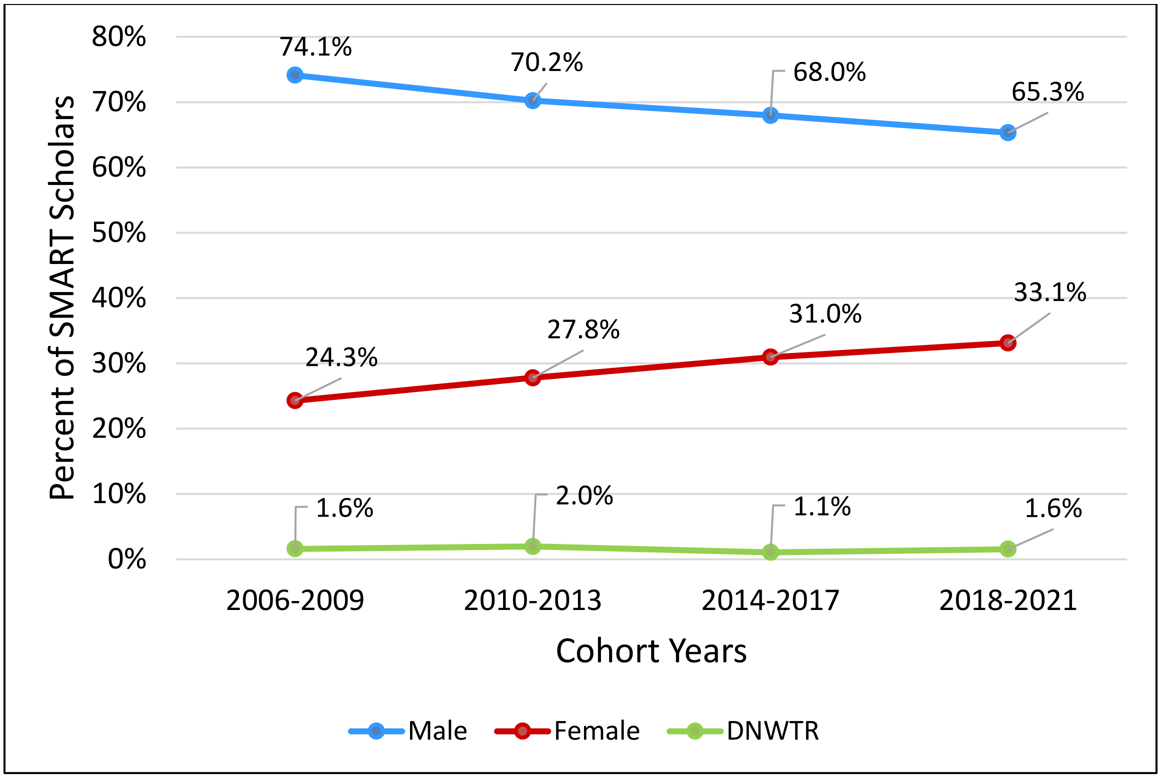

Figure 7. Gender of individuals awarded SMART scholarships from 2006 to 2021. (DNWTR means did not wish to respond.)

4. Race/Ethnicity

In our data, race and ethnicity items were combined into a single race/ethnicity response. With respect to ethnicity, individuals were classified into three mutually exclusive categories: those identifying as Hispanic or Latino, Non-Hispanic (NH), or those who did not wish to respond (DNWTR) to the ethnicity item. Those identifying as Hispanic or Latino were not broken down further. However, those responding NH to the ethnicity item were sorted into one of the following five racial categories (White, Black/African American, Asian, American Indian/Native Alaskan, or Native Hawaiian/Other Pacific Islander). Those who identified with more than one racial grouping were classified as "Multiracial," and those who responded DNWTR with respect to both ethnicity and race items were classified as providing "No response."

Figure 8 shows the distribution of applicants by these race/ethnicity categories and degree level. More than half of the applicants identified themselves as White (57.8% of the eligible applicants). The racial/ethnic identity of the remainder of the eligible applicants was: Black or African American (11.9%), Hispanic (11.5%), Asian (8.7%), and Multiracial (5.4%). Also, 4.4% of eligible applicants did not identify their racial or ethnicity background. In contrast, there was a relatively small number of American Indian/Alaskan Native and Native Hawaiian/Other Pacific Islander applicants, each comprising less than

1% of the 2019–2021 applications. As shown in the gender data, those seeking support for bachelor's degrees was the majority of applicants with less than half seeking support for either a master's or a doctoral degree.

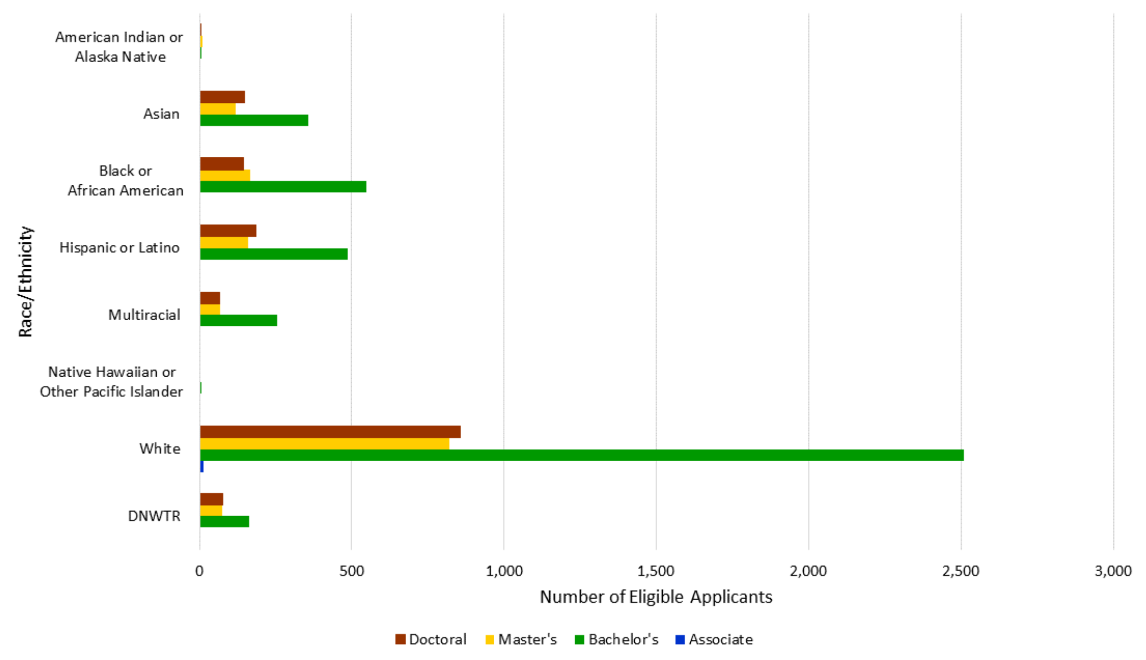

Figure 8. Racial/ethnic breakdown of SMART applicants by degree level for program years 2019–2021

Table 4 displays the offer rate (percent of eligible applicants who received award offers) for the seven racial/ethnic categories. The data indicate the racial/ethnic categories of applicants with offer rates higher than the overall rate (21.7%) included Native Hawaiian or Pacific Islander (28.6%),[15] "No Response" (24.1%), Asian (24.0%), and White (23.6%). Those categories below the overall rate included Hispanic or Latino (20.4%) and American Indian or Alaska Native (20.0%), but the lowest offer rates were seen in the Multiracial (18.0%) and Black or African American (12.9%) categories. Further research is needed to determine reasons why certain racial/ethnic categories of applicants are offered scholarships at rates well-below the overall offer rate.

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[15] The atypical offer rate in this group is likely a statistical anomaly related to the small number of applicants in the category (*N* = 7).

Table 4. Offer Rate of Racial/Ethnic Groups for Program Years 2019–2021

Racial/Ethnic Group	Completed Apps	Award Offers	Offer Rate	AR_{REG}- AR_{OVR} [a]
American Indian or Alaska Native	20	4	20.0%	-1.7%
Asian	629	151	24.0%	2.3%
Black or African American	863	111	12.9%	-8.9%
Hispanic or Latino	833	170	20.4%	-1.3%
Multiracial	389	70	18.0%	-3.7%
Native Hawaiian or Other Pacific Islander	7	2	28.6%	6.8%
White	4,199	992	23.6%	1.9%
No Response	319	77	24.1%	2.4%

[a] AR_{REG} - AR_{OVR} = Difference between the Offer Rate for a particular Racial/Ethnic Group and the overall award rate for all applicants in Program Years 2019–2021.

Table 5 compares the racial/ethnic diversity of the SMART applicants and offerees in the 2019–2021 dataset to employees in the DoD S&E Workforce hired in 2016–2020. The responses to the race and ethnicity items were first broken down into three responses: "White," "minority" (those responding with race/ethnicity other than White), and "No Response" denoting those whose race/ethnicity was blank or those responding "DNWTR." The minority category was further broken down into specific groups. Note that not all minority categories in the DMDC data are identical to SMART data; the NH Asian designation is a separate category in the SMART data, whereas it is combined with Pacific Islanders, which presumably includes Native Hawaiians, in the DMDC data. Also, the DMDC data do not include the Multiracial category. The SMART data do not include the "Other" category listed in the DMDC data. "Other" may refer to racial/ethnic groups not represented in the DMDC list and/or individuals who identify with more than one racial/ethnic group.

Table 5 indicates that the percent of offerees who identify as a minority is 5.5% less than the percent of minority applicants. This suggests that the distribution of 2019–2021 SMART offerees is less diverse than the corresponding distribution of the eligible applicants to the program, a conclusion that is consistent with findings in the SMART 1.0 evaluation (Balakrishnan et al. 2018). At the same time, the percent of SMART offerees is 9.6% greater than DoD S&E employees. This second comparison suggests that, despite offerees being less diverse than applicants, offerees are clearly more diverse than DoD employees, thereby providing evidence that SMART is continuing to support the program goal of increasing diversity in the S&E workforce.

The breakdown of the minority category in Table 5 reveals two notable results. First, about 11% of the SMART applicants and offerees identify as Hispanic or Latino, which is much greater than the 1.4% of Hispanic employees in the S&E Workforce. This suggests that SMART has been especially effective in recruiting Hispanic or Latino applicants into the program and the S&E Workforce. Second, Black or African American students comprise nearly 12% of the SMART applicants, but only 7% of the offerees. Further, the percent of Black/African American SMART offerees nearly equals the percent of Black employees in the S&E Workforce (6.5%). This finding implies that SMART may be less effective in recruiting Black or African American scholars into the SMART Program and into the S&E Workforce.

Table 5. Racial/Ethnic Differences in SMART Scholarship Applications Submitted and Awards Offered in 2019–2021 Compared to the DoD S&E Workforce Hired in 2016–2020

		SMART Program for Program Years 2019--2021		DoD S&E Workforce Hired in 2016–2020
Racial/Ethnic Group	**Statistic**	**Eligible Applicants**	**Scholarship Offerees**	**Employees**
White	N	4,199	992	91,293
	%	57.8%	62.9%	76.6%
Minority	N	2,741	508	26,932
	%	37.8%	32.2%	22.6%
Multiracial	N	389	70	---b
	%	5.4%	4.4%	
Native Hawaiian or Other Pacific Islander	N	7	2	---b
	%	0.1%	0.1%	
Hispanic or Latino	N	833	170	1,703
	%	11.5%	10.8%	1.4%
Black or African American	N	863	111	7,702
	%	11.9%	7.0%	6.5%
Asian	N	629	115	---b
	%	8.7%	9.6%	
American Indian or Alaska Native	N	20	4	946
	%	0.3%	0.3%	0.8%
Asian or Pacific Islander	N	---a	---a	12,653
	%			10.6
Other	N	---a	---a	3,928 3.3
No Response	N	319	77	1,007

[a] Category not included in the SMART data.

[b] Category not included in the DMDC data.

Figure 9 plots trends in the racial/ethnic diversity of SMART scholars (i.e., awardees) from 2006 to 2021 as derived from the "Degree Attainment" dataset. The top panel depicts the trends for three racial/ethnic categories: White, minority, and No Response. Comparing the first block (2006–2009) to the last (2018–2021), it can be seen that there has been a substantial increase in the portion of minority scholars in the SMART Program (+10.9%) and smaller decreases in the portion of both White scholars (-6.5%) and those who did not identify their racial or ethnic group (-4.4%). Thus, these data suggest that the pool of SMART Program scholars has become increasingly diverse over those 15 years.

The bottom panel of Figure 9 divides those identifying as minority into specific races or ethnicities. It appears that much of the increased diversity in SMART cohorts in recent years is due to gains in the proportion of Hispanic or Latino scholars who showed the largest gains from the first to the last block (+6.5%). The next group showing substantial growth were those identifying as Multiracial (+3.1%). Smaller growth is noted for those identifying as Black or African American (+1.3%) and Asian (+1.4%). The two smallest racial/ethnic groups (Native Hawaiian/Other Pacific Islander and American Indian/Alaska Native) showed virtually no change from 2006 to 2021.

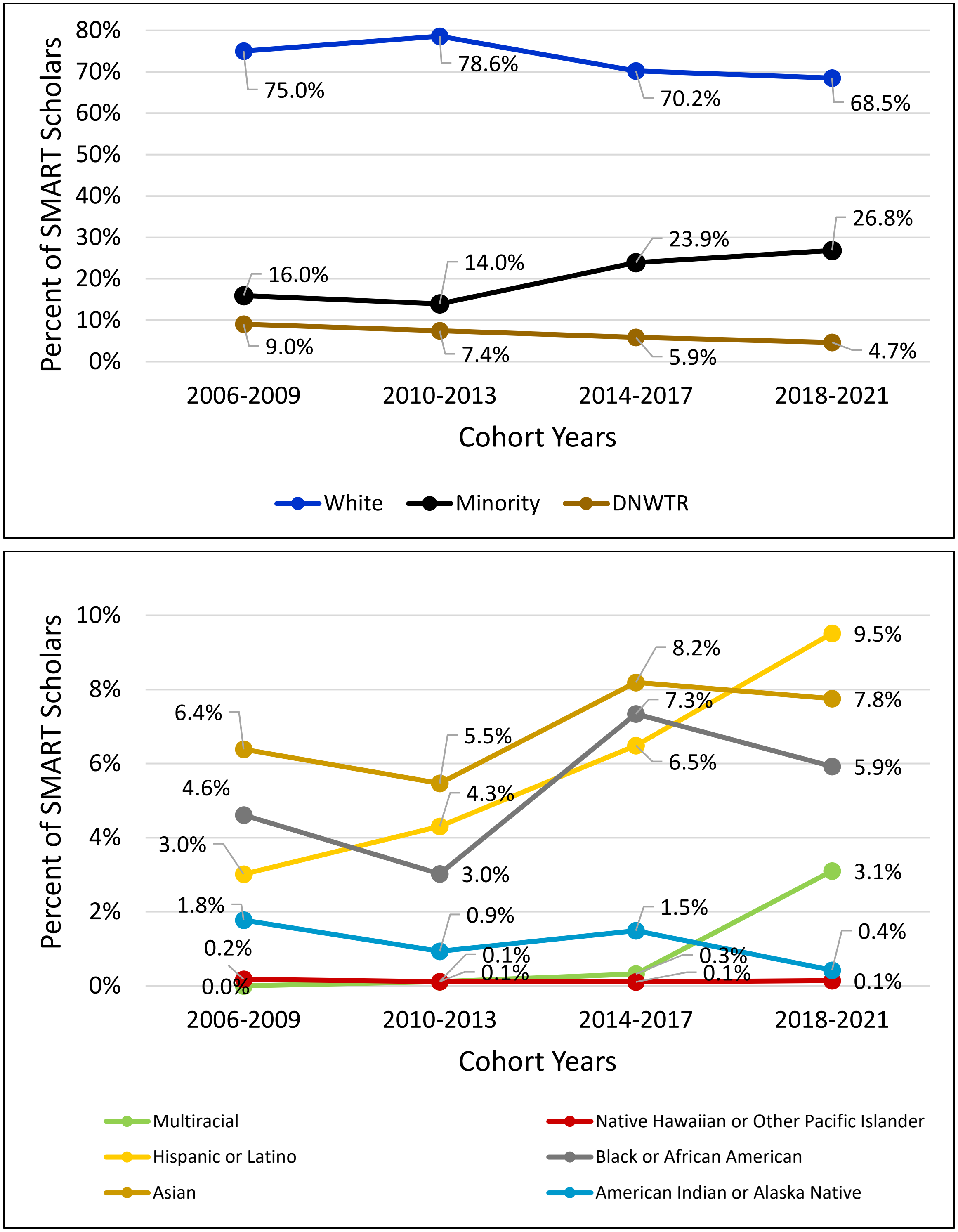

Figure 9. Distribution of racial/ethnic groups of SMART scholars from 2006 to 2021. Top panel shows results for those identifying as White or minority, or those not identifying with a racial or ethnic classification. Bottom panel breaks down minority scholars into specific racial/ethnic groups.

5. Intersections

To provide some deeper insight into the previously described factors, we describe some of the more significant intersections between factors.

a. Offeree Type X Demographics

In this section, we explore how RC and RT offerees differ in terms of key demographics, gender, and race/ethnicity. Figure 10 contrasts the two offeree types (gender and race/ethnicity) by the number of eligible applicants and by the number of award offers for Program Years 2019–2021. These data reveal three notable trends. First, the pool of RC applicants is more gender diverse (in terms of percent females) and more racially and ethnically diverse (in terms of percent minorities) than RT applicants. This difference may be attributable to the fact that the RC applicants are drawn from students in academic STEM programs, which is a more diverse population than is the population of current DoD employees in STEM jobs from which RT applicants are selected. Second, the pool of RC offerees is less diverse in both gender and race/ethnicity than RC applicants. This mirrors the effects observed in the overall data described earlier, and findings from the SMART 1.0 outcome evaluation (Balakrishnan et al. 2018). Third, in contrast to the trend in applications to awards in the RC population, the pool of RT offerees is more diverse than the RT applicants in both gender and race/ethnicity. This can be seen in Figure 10 by the higher percentage of female and minority RT applicants being offered a SMART award.

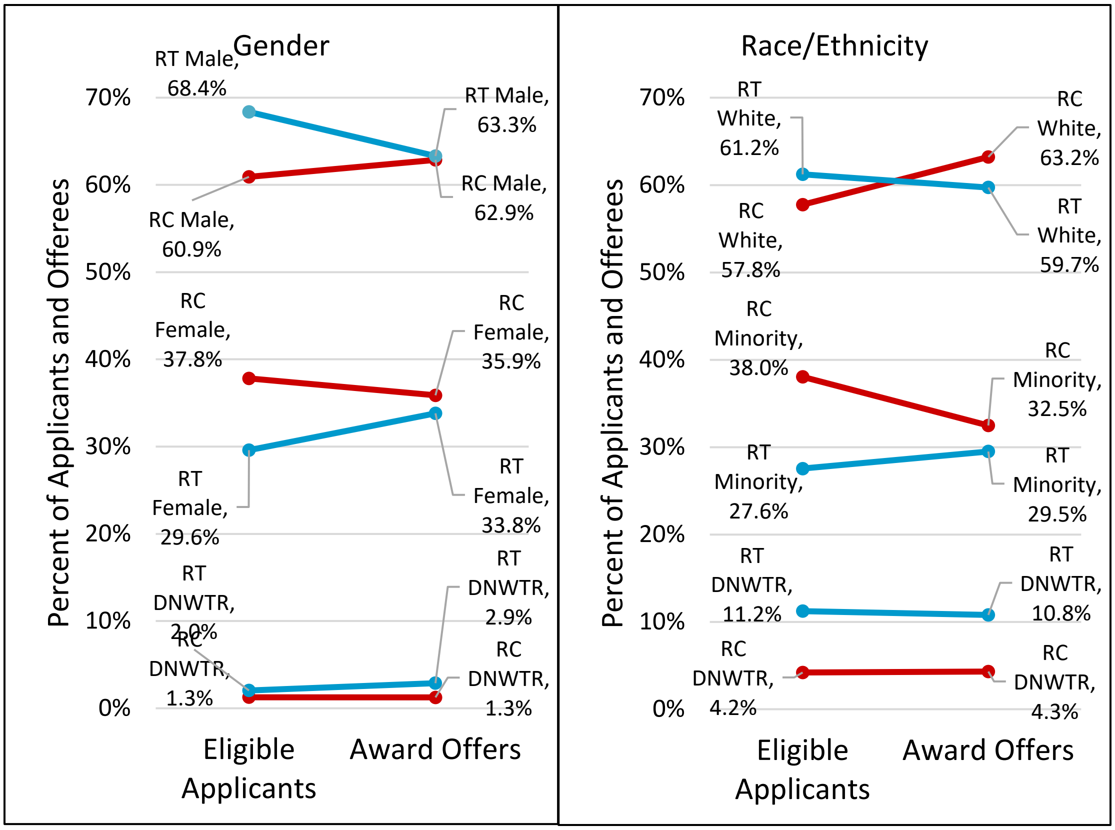

Figure 10. Demographics of RC versus RT populations at the application and award stages for program years 2019–2021. RC Results Are Shown in Red and RT in Blue. The increased diversity of RT offerees can be seen by the higher percentage of female and minority RT applicants receiving SMART awards.

In summary, it appears that the RC applicants are more diverse than their RT counterparts. However, whereas the RC pool of applicants becomes less diverse through the application-to-offer process, the RT pool becomes more diverse. At the end of this process, the RT and RC pools are similar in diversity.

b. Gender X Discipline

The data presented in Table 3 suggest that the SMART Program continues to make steady progress in promoting gender diversity by acquiring a greater proportion of female applicants and by offering an increasing proportion of SMART scholarships. However, this progress has been uneven across STEM disciplines. It is well-established that women are more represented in some STEM fields than others (e.g., Cheryan et al. 2017). This is mirrored by the percent of female applicants to the SMART Program. As illustrated on the x-axis of Figure 11, the portion of female applicants varies widely for the STEM disciplines, ranging from a low of 21.3% for aeronautical and astronautical engineering to a high of 71.8% for biosciences. At the same time, as shown by the y-axis of Figure 11 the total number of offers also differs across disciplines from a low of only 9 awards for nuclear engineering to a high of 411 for computer and computational sciences and computer engineering. Furthermore, Figure 11 reveals a negative relationship between the percent of female applicants and total offers; as the percentage of females within a discipline increases, the total number of SMART scholarship offers declines. The figure indicates that the four largest disciplines (see red circles around computer and computational sciences and computer engineering, mechanical engineering, electrical engineering, and aeronautical and astronautical engineering) were all fields where female applicants were in the minority (30% or less). In contrast, females were in the majority for 9 disciplines with having 50 or fewer awards (see green circles around biomedical engineering; biosciences; chemical engineering; chemistry; cognitive, neural, and behavioral sciences; environmental sciences; nuclear engineering; oceanography; and operations research). This suggests that even greater gains in gender diversity could be achieved if SMART engages new SFs who employ these eight latter disciplines to participate in the SMART Program.

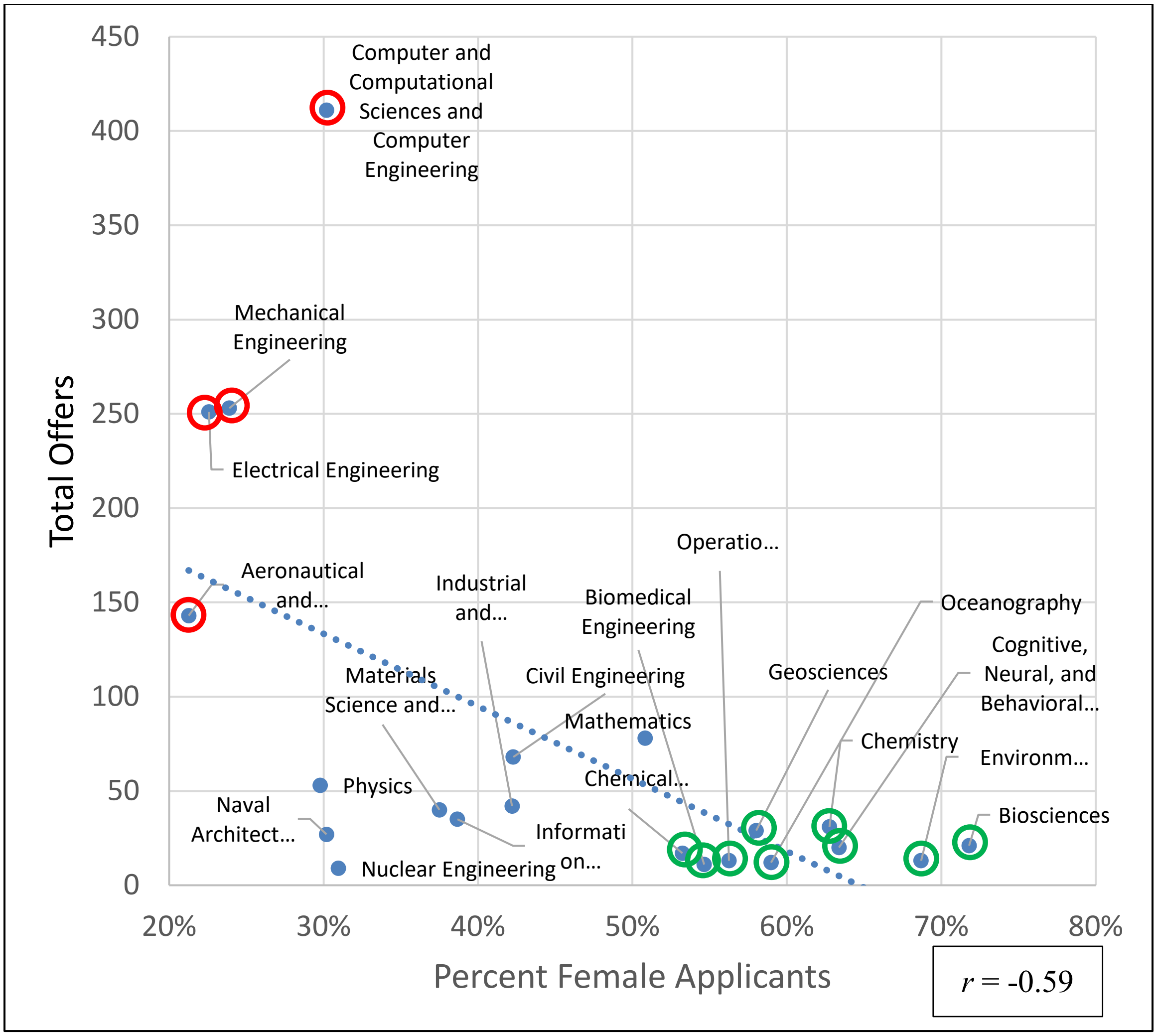

Figure 11. Relationship Between Total Scholarship Offers and Percent Female Applicants for STEM Disciplines Represented in the SMART Program for Program Years 2019–2021. The blue dotted line indicates the regression line showing the relationship between number of offers and percent of female applicants for SMART disciplines. The red circles indicate the highest offered disciplines and green circles indicate lowest offered disciplines. The disciplines with the largest number of offers are associated with the lowest percentage of female applicants (red circles) while the disciplines with the smallest number of offers are associated with the highest percentage of female applicants.

D. Variables Associated with Offers and Awards

In addition to the factors associated with the selection of an application for an offer (e.g., awardee type, academic discipline, gender, and race/ethnicity), we examined the relationship between certain application variables (e.g., an application's aggregate scorecard score and veterans preference and military dependent status) and variables associated with the applicant's university (e.g., which universities have received the largest number of SMART awards by discipline and university designation) and offer or award rate.

1. Scorecard Scores

a. Aggregate Scorecard Scores

As described in the SMART 2.0 Process Evaluation report, the SPO convenes an initial selection panel to review and rank score applications. These scores are used by the SPO to identify applications for the semi-finalist round in the review process. The review panel consists of members from the SFs as well as academics from the 21 STEM disciplines eligible for the SMART award. As part of their evaluation, the review panel calculates a score for each application based on criteria outlined by the SPO. The SPO has noted that producing these scores for every applicant is a lengthy, resource-intensive process and at this time, its utility to the award selection process is unknown (i.e., it is unclear if the scores provide any additional information beyond the SFs' evaluation of the applications to determine the SF's preference for selection to warrant the continuation of the score assignment process). For the 2022 application year, the SPO will still require the review panel to generate scorecards for each application, however, they will not be used to limit the pool to semifinalists that can be reviewed by SFs. Thus, instead of using scorecard scores to gatekeep those applicants allowed to move to the semi-finalist round, all applications with scorecard scores will move forward to the SFs for their review.

The SPO originally created scorecards as a means to identify which applications should move from the completed into the semifinalist pool. In disciplines with sufficient numbers of applicants, the SPO used the scorecard scores to move roughly the top half of the applicant pool of that discipline into the semifinalist pool. For disciplines without enough applicants, most or all of the applications moved onto the semifinalist round, regardless of their scorecard score. This can be seen below in Figure 12, a box and whisker plot[16] detailing the scorecard scores of all applicants to the program from 2019 to 2021, segregated by the highest phase they achieved.

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[16] Each box contains 50% of the data points for that group, also called the interquartile range (IQR), with the center line showing the median distance. The upper and lower edges of the boxes represent the third and first quartiles, meaning that 75% of the data fall below the upper edge and 25% of the data fall below the lower edge. The whiskers, or lines that extend above and below the box, show maximum and minimum values up until the point that is 1.5 times greater than the IQR. Anything beyond that whisker limit is considered an outlier for the purposes the graph, and is shown instead as a dot.

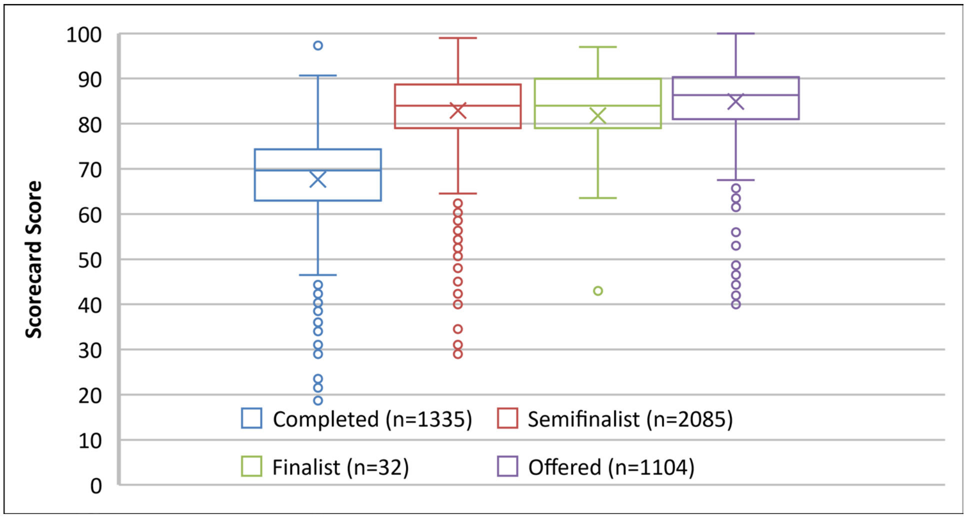

Figure 12. Box and Whisker plot of the scorecard scores of SMART applicants from 2019 to 2021. Note that X denotes the mean value of the distribution and the bubbles above and below the whiskers denote outlier values. The line that intersects each box is the median value.

As expected, the scorecard scores for applications that failed to reach the semifinalist pool are lower than the scores of those that did. On the other hand, our analysis revealed that scorecard scores for applications that reached the semifinalist stage and beyond (semifinalists, finalists, and offered) did not differ from each other (i.e., the scorecard scores for semifinalists, finalists, and offered are similar). Although the SPO reports that the scorecard scores are also a part of the applicant selection process by the SFs (at least prior to 2023), the lack of score discrimination between the categories of selection suggests that it has little or no effect on the SFs' decisions.

It will be interesting to see what the distribution of scorecard scores looks like for the 2023 applicant class. Because all of next years' applications will move onto the semifinalist stage, and the progress of applications to awards will be almost completely based on the decisions of the SFs, the presence or absence of a discernable difference between the semifinalist and offered stages will better inform the analysis regarding the value of the scorecard score for filtering applications to move forward.

As a comparison, we examined how well the scholars' GPA correlated with their scorecard score. If there is a strong correlation, the scorecard score could plausibly be dropped in favor of GPA, which can simply be pulled from the scholar's official transcripts. Table 6 shows the relationship between GPA and scorecard score.

Table 6. Quality of linear fit for scorecard score vs. GPA for SMART applications from 2019 to 2021 by application stage

Application Stage	R2
Completed	0.0256
Semifinalist	0.0686
Finalist	0.0254
Offered	0.0799

It is clear that there is not a correlation between scorecard score and GPA. A brief statistical analysis was conducted and the results upheld the lack of correlation.

b. Scorecard Scores by Discipline

We performed a second analysis on the scorecard score stage distributions examining the differences between disciplines, building on the application progressions as described above. For discussion purposes, we analyzed the scorecards for mechanical engineering and naval architecture and ocean engineering as the former is a discipline associated with many awards while the latter is associated with few awards. The first analysis on mechanical engineering, characterized by many awards granted, is displayed in Figure 13.

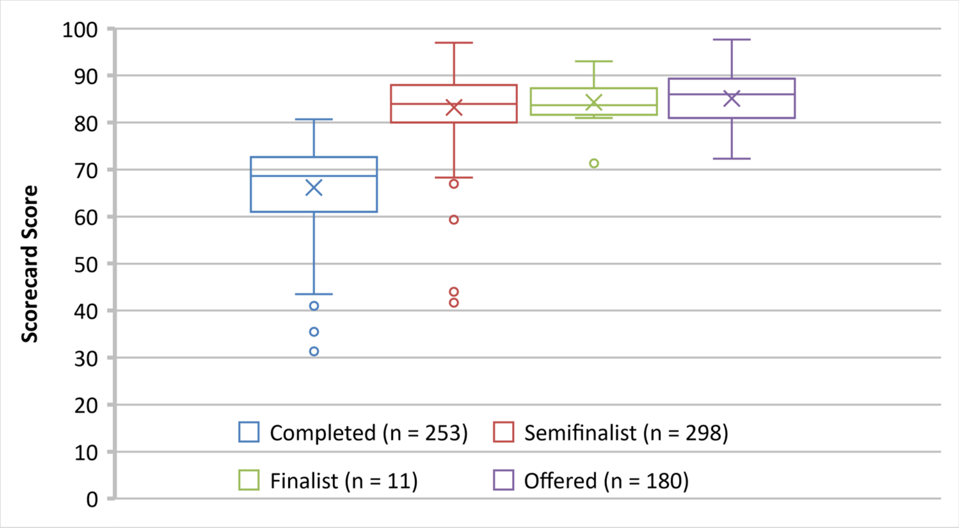

Figure 13. Box and whisker plot of scorecard scores of mechanical engineering applicants.

As shown in Figure 13, the increase in scores between the completed stage and the semifinalist stage is large. Since mechanical engineering required the selection of many scholars from a large pool of applicants, the scorecard scores seemed to provide value for SFs selecting awardees.

The opposite effect was seen in the disciplines with a high award rate and a low number of applicants such as naval architecture and ocean engineering. In this discipline, all applicants moved forward (i.e., no applicants were in the "completed" only group since all were essentially semifinalists) to the semifinalist stage, and the scorecard scores of the semifinalists, finalists, and scholars is indistinguishable, as can be seen in Figure 14.

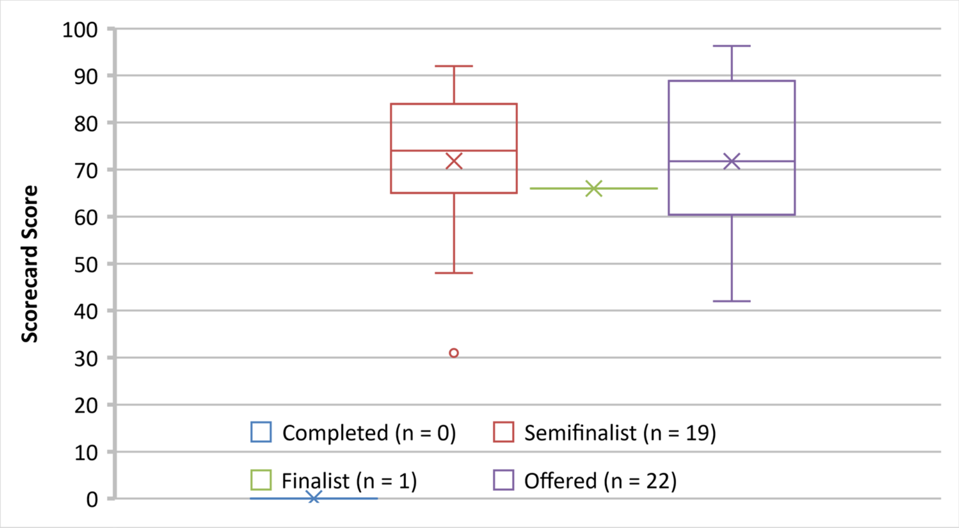

Figure 14. Box and whisker plot of scorecard scores of naval architecture and ocean engineering applicants.

c. Implications for the Use of Scorecard Scores

In general, it appears that the higher the award rate was for a discipline, the lower the overlap was between applications that did and did not make it to at least the semifinalist round. Part of this discrepancy is simply due to the use of the scorecard scores to determine which applications move forward to the semifinalist round, but it is also an indication of how scorecard scores relate to awards offered. Our analysis shows there is some evidence in favor of the scorecard scores as a filtering tool when there are many applications.

2. Universities and Colleges

The SMART Program awards scholars attend a large number of universities across the United States and its territories. For example, from the "Degree Attainment" dataset, 1,904 scholars were selected for awards from 2018 to 2022, representing 421 unique undergraduate and graduate degree-granting institutions. Looking across the lifespan of the program (2006–2022), the 3,834 scholars receiving awards represented 461 different undergraduate and graduate universities and campuses. The number of universities from which applicants hail has varied over the life of the program as the SMART Program has undertaken targeted outreach programs, academic advisors familiar with the program have turned over, and for a number of other reasons.

Accordingly, when examining the distribution of scholar universities by the 21 STEM disciplines eligible for SMART awards over a 10-year period (between 2012 and 2022), the SMART Program generally awarded scholarships to only one student per discipline per year per university. We used a 10-year-span for this analysis to show longer-term trends and account for any single-year anomalies that might have occurred. In a handful of these STEM fields, however, the program selected more than one or two scholars per year per university. These fields and the universities those scholars came from are listed in Table 7.

From the data in Table 7, it is clear that at many universities, scholars who receive SMART awards are concentrated in just a few disciplines, with relatively few awards elsewhere (see Table 1 for the percent of SMART awards by discipline). For example, in 2018–2022, 22 of the 74 (29.7%) SMART awards given to students at Virginia Tech were in computer and computational science and computer engineering, 13 of the 74 (17.6%) in aeronautical and astronautical engineering, and 12 of 74 (16.2%) in mechanical engineering. These three disciplines constituted 47 of 74 (63.5%) of the SMART awards given to students at the university. Likewise, at Florida Institute of Technology, seven SMART awards were given to scholars in naval architecture and ocean engineering in 2018–2022, consisting of half of the total number of SMART awards given during that time frame with the other seven awards distributed piecemeal across the other disciplines.

Table 7. Universities with Multiple SMART Scholars for the 2018–2022 Cohort by Discipline

University	**Aero & Astro Eng**	**Comp Sci & Eng**	**Elect Eng**	**Ind Syst Eng**	**Mech Eng**	**Nav Archit Ocean Eng**	**Phys**	**Other STEM Disciplines (14)**	**Total Awards for University**
Virginia Tech	13	22	7	7	12	3	2	8	**74**
U of Maryland - College Park	3	15	9	-	16	-	1	7	**50**
Georgia Inst. of Tech	11	10	7	-	4	-	-	7	**39**
U of Florida	8	6	8	2	7	-	-	6	**37**
U of Michigan – Ann Arbor	3	7	3	-	5	13	-	6	**37**
North Carolina State	6	2	3	2	10	-	1	11	**35**
Purdue	9	7	2	1	2	-	-	6	**27**
Penn State	7	4	2	1	5	-	-	7	**26**
U of Alabama – Huntsville	6	5	7	-	5	-	-	2	**25**
Auburn University	6	4	4	2	4	-	-	4	**24**
Arizona State	3	7	8	1	1	-	-	1	**23**

University	Aero & Astro Eng	Comp Sci & Eng	Elect Eng	Ind Syst Eng	Mech Eng	Nav Archit Ocean Eng	Phys	Other STEM Disciplines (14)	Total Awards for University
Ohio State	2	3	7	-	3	-	-	8	**23**
George Mason Univ.	-	8	2	3	1	-	-	6	**20**
U of Maryland - Baltimore County	-	10	2	-	1	-	-	5	**18**
Clemson	-	6	1	3	6	-	-	1	**17**
Embry-Riddle AU – Daytona Beach	9	3	-	1	3	-	-	1	**17**
Stevens Institute of Tech	-	6	1	-	4	2	-	2	**15**
Worcester Polytechnic	2	4	6	1	-	-	1	1	**15**
Embry-Riddle AU – Prescott	9	-	1	-	4	-	-	-	**14**
Florida Institute of Tech	-	-	1	-	-	7	1	5	**14**
Michigan Tech	-	-	8	-	2	-	2	2	**14**
U of Arizona	-	-	2	1	-	-	6	5	**14**
Carnegie Mellon	-	7	1	-	2	-	-	3	**13**
U of Central Florida	1	1	7	1	2	-	1	-	**13**
Cal Tech, Pomona	6	2	-	-	3	-	-	1	**12**
U of Alabama	3	1	-	-	6	-	-	-	**10**
Total number of awards per discipline	**165**	**489**	**341**	**50**	**329**	**34**	**61**	**435**	
Total number of unique universities with awards in specified discipline	**55**	**225**	**228**	**31**	**158**	**9**	**43**		

Note: At the time of writing, university data for 32 scholars were missing from the 2022 cohort data, therefore could not be included in the awards counts in this table. The highlighted values indicate cases in which more than two scholars, on average, received an award in the specific discipline across the 5 years.

The Gini coefficient is another metric to measure the distribution of schools within each degree field. Most commonly used to measure income or wealth, the Gini coefficient is an index of the inequality of the distribution of values among many participants, with 0 indicating perfect equality (i.e., all participants have the same value), and 1 indicating perfect inequality (i.e., one participant holds all the value and everyone else has none). For reference, the proverbial 80-20 rule (where 80% of the value resides in just 20% of the participants) implies a Gini coefficient of at least 0.60.

We calculated the Gini coefficient for each of the 21 STEM disciplines to measure how concentrated the contributing schools were to the field (i.e., to assess if the SMART awards in a given discipline were awarded to scholars at a small number of universities or if the awards were dispersed across a number of universities for any given discipline). Table 8 presents these data, along with the average number of scholars in each field from each school.

Table 8. Gini Coefficients per STEM Disciplines for 2018–2022

STEM Disciplines	***Gini Coefficient***	***Average # of scholars per school (2018–2022)***
Aero & Astro Eng	0.47**	2.93
Biomed Eng	0.00	1.00
Biosci	0.07	1.08
Chem Eng	0.14	1.19
Chem	0.09	1.12
Civil Eng	0.21	1.33
Cog Neuro Behav Sci	0.10	1.13
Comp Sci & Eng	0.40*	1.08
Elect Eng	0.37*	2.07
Environ Sci	0.00	1.00
Geosci	0.15	1.24
Ind Syst Eng	0.30	1.61
Info Sci	0.09	1.11
Mater Sci Eng	0.18	1.29
Math	0.18	1.30
Mech Eng	0.39*	2.04
Nav Archit Ocean Eng	0.46**	3.78
Nucl Eng	0.20	1.33
Oceanogr	0.00	1.00
Oper Res	0.15	1.25
Phys	0.24	1.42

Note: * indicates that SMART awards in the discipline were given to scholars at a small number of universities. ** indicates that SMART awards in the discipline were given to scholars at an even smaller number of universities (i.e., SMART awards for that discipline are concentrated at a very small number of universities). Gini coefficient: 0 indicates perfect equality and 1 indicates perfect inequality.

Most of the STEM disciplines have a Gini coefficient less than 0.30, which indicates that SMART awards in these disciplines are widely distributed across universities such that on average, the university received less than 1.5 awards for that discipline over the period of 2018–2022.

However, there is a group of disciplines with comparatively large Gini coefficients, fields in which the SMART Program awards scholarships to a relatively large number of scholars at a small number of schools. This group consists of five disciplines: aeronautical and astronautical engineering, computer and computational science and computer engineering, mechanical engineering, electrical engineering, and naval architecture and ocean engineering, each of which have Gini coefficients around 0.40. These Gini scores indicate that the SMART Program awards scholarships in these disciplines to scholars at a very small set of universities (i.e., SMART awards are relatively highly concentrated at a few universities for these disciplines). This finding is evident in the awards listed for aeronautical and astronautical engineering in Table 4. Although scholars at 55 different universities received SMART awards in these disciplines, 90 of the 161 awards (55.9%) were awarded to scholars at 11 different universities. Among these top awarded universities and aeronautical and astronautical engineering, Virginia Tech was awarded 14.4% of the SMART scholarships indicating a high concentration of awards for scholars at that university in that discipline. Likewise, scholars at 9 different universities received SMART scholarships for naval architecture and ocean engineering;[17] however, 20 of the 24 awards (83.3%) were awarded to scholars at 2 universities. Of these two universities, one (University of Michigan, Ann Arbor) was awarded 65.0% of the awards in naval architecture and ocean engineering.

Interestingly, the Gini coefficient of the SMART Program as a whole is rather high, at 0.58, which indicates a rather high level of concentration (i.e., awards given to scholars at a small number of universities), a metric which contrasts with the low Gini indices of each individual field. Analysis of the data on Table 7 indicates that this may be because the largest schools contribute large numbers of scholars to several different SMART disciplines, such as Virginia Tech, University of Maryland at College Park, Georgia Institute of Technology, or University of Florida, each of which have more than five scholars in four different fields. Schools with a smaller number of scholars, however, appear to generally contribute scholars concentrated in one discipline or in several related disciplines.

These analyses provide some insights for the SMART Program's outreach efforts. Clearly, the program has broad reach in terms of solicitation of applications for awards across the 21 STEM disciplines that are relevant to the needs of the DoD. The breadth of universities that the applications represent translates into a similarly broad university distribution of SMART Program scholars. Interestingly, however, there seems to be a greater concentration of SMART scholars in certain disciplines at specific universities. For niche disciplines, such as naval architecture and ocean engineering, the high concentration of awards at a small number of universities might be explained by the combination of variables associated with the discipline such as the limited number of universities offering

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[17] We note that there are 13 degree-granting institutions in the United States in naval architecture and ocean engineering.

degrees in this field (which leads to a concentration of students in this field at these universities), the academic strength of the program, the academic strength of the students (as evidenced by the acceptance rates into the program), and by the high graduation rates of students from the program. From an outreach standpoint, the SPO should continue recruiting scholars from these programs to fill niche workforce needs for the DoD. For other disciplines, however, the SPO might want to consider broadening its outreach efforts to increase the diversity of universities represented in the SMART Program. For example, although both computer and computational science and computer engineering and mechanical engineering are disciplines in which the SMART Program offers the greatest number of awards, a deeper look into the universities where scholars received awards between 2018 to 2022 reveals that scholars were concentrated in specific geographic areas. The three top universities for awards in computer and computational science and computer engineering during this time were located in the National Capital Region (i.e., Maryland, Virginia, and Washington, D.C.). Although there is a larger distribution of universities with scholars receiving awards to pursue degrees in mechanical engineering, again the top three universities for awards were located in the National Capital Region/mid-Atlantic corridor (see Table 7 for details). Many universities across the nation have programs or departments offering degrees in these fields, therefore the SPO could extend their outreach efforts to a broader range of universities for applicants in these non-niche disciplines.

In addition to the reasons stated above, there may be additional contributing factors for the concentration of awards at specific universities. For example, the SFs may prefer scholars from these select universities/programs. Alternatively, these universities may have academic advisors who are familiar with the SMART Program and/or additional DoD scholarship or internship programs, which could contribute to an increase in applications from those universities and possibly to the strength of the applications themselves. Likewise, given that the top two universities with the highest concentration of SMART scholars are in the National Capital Region, it may be that scholars applying for and receiving awards at these universities are familiar with the DoD and/or the SFs and their missions (such as through family member ties to the DoD/SF). A deeper understanding of the factors contributing to the increased selection of scholars from specific university programs may provide some insights for SMART Program outreach efforts. For example, if a small number of SFs select scholars for awards, then perhaps it would be best to transition outreach efforts from the SMART Program to these SFs. Doing so could help to strengthen the relationships between the SFs and these select universities. Additionally, moving outreach to these universities to the SFs themselves may also free up SMART Program resources for outreach at other locations and for other STEM disciplines.

Another potential outcome of this finding relates to strengthening relationships between scholar cohorts. One example of this could be the 13 scholars in naval architecture and ocean engineering at the University of Michigan who received SMART scholarships between 2018 and 2022. This is a large number of scholars in a single department. The SPO can tap these scholars to serve as SMART representatives at the university to promote the program both within the scholars' academic division and across other STEM divisions. Additionally, given that the alumni network at the University of Michigan is quite robust,[18] the SPO can again involve SMART scholars in Phases 2 and 3 to leverage these alumni relationships to strengthen the SMART alumni network, which could also serve as a low-effort outreach mechanism for the program.

3. Applications and Awards to Scholars from HBCU and MSIs

Increasing awardee diversity has been a long-standing goal of the SMART Program. One way to increase the interest of a diverse student body in the SMART Program is to conduct outreach to Historically Black Colleges and Universities (HBCUs) and Minority Serving Institutions (MSIs). As noted in the SMART 2.0 Program Evaluation Report, the SMART Program has engaged in several outreach efforts at HBCU and MSI universities and through a variety of other means (e.g., targeted outreach at professional organizations focused on minority members). Although these efforts have led to an increase in the number of applications received by the SMART Program from applicants who identify as minorities, to date, very few scholars from HBCUs have received awards. For example, from the program's inception from 2006 through 2022, North Carolina A&T University has generated the largest total number (13) of SMART awardees of all the HBCUs. However, upon closer inspection, during the 2020–2022 award seasons,[19] only 30 completed applications (or 0.41% of the total applications) had been submitted by potential scholars from this university, resulting in 3 awards (0.19% of awards during this period). Likewise, the University of Maryland at College Park, a non-HBCU MSI, generated the largest number of SMART awardees (a total of 115 across the life of the program). During the 2020–2022 awards seasons, however, 132 completed applications (or 1.82% of the total applications) had been submitted by potential scholars at this university, resulting in 28 awards (or 1.78% of the awards). The total number of awards for the remaining top SMART scholar-producing HBCUs and MSIs and overall top-awarded universities is listed in Table 9 (for 2006–2022 data).

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[18] As of July 2023, the University of Michigan Alumni Association has nearly 669,000 members.

[19] The SMART Program holds application data for the 3 years prior to the current year. As such, these analyses are based on completed applications submitted to the SPO in 2019, 2020, and 2021, which corresponded to the 2020, 2021, and 2022 cohorts, respectively.

Table 9. Top Producing Universities for SMART Scholars

Top-awarded HBCUs	Total Awards 2006–2022 (Percent of Total Awards)	Top-awarded MSIs	Total Awards 2006–2022 (Percent of Total Awards)	Top-awarded University (Overall)	Total Awards 2006–2022 (Percent of Total Awards)
North Carolina A&T	13 (0.34%)	U Maryland College Park	115 (2.70%)	Virginia Tech	153 (3.59%)
Jackson State	8 (0.19%)	U Central Florida	43 (1.01%)	Georgia Tech	128 (3.00%)
Hampton University	6 (0.14%)	U Arizona	29 (0.68%)	U Maryland, College Park	115 (2.70%)
Norfolk State	5 (0.09%)	U Texas at Austin	28 (0.66%)	U of Florida	98 (2.30%)
Tuskegee University	5 (0.09%)	Cal State, Pomona	21 (0.49%)	U Michigan, Ann Arbor	87 (2.04%)
Howard University	4 (0.09%)	U Maryland Baltimore Co.	21 (0.49%)	Penn State	80 (1.88%)
Spelman College	4 (0.09%)	U of New Mexico	20 (0.47%)	NC State, Raleigh	71 (1.66%)
Tennessee State	3 (0.07%)	New Mexico State	19 (0.45%)	Texas A&M	63 (1.48%)

Note: The median number of awards at HBCUs is 2; at non-HBUC MSIs is 3; and at top-awarded universities is 3.

To put this in context, across the 46 HBCUs from which students have applied for the SMART award, the SPO received 195 completed applications during the 2019–2021 application period. Thus, applications from HBCUs made up only 2.69% of the 7,259 completed applications received by the SPO during that time period. These applications resulted in 31 scholars at 15 different HBCUs receiving a SMART award out of the 1,577 awards given over this period (i.e., 1.97% of the awards given by the program went to scholars at HBCUs). Further, 863 students who identified as Black/African American submitted completed applications between 2019 and 2021, and the SFs selected 111 for SMART awards. Only 26 (or 23.42%) of these awards went to students attending an HBCU (see Table 10). This means that 76.6% of Black/African American SMART scholars did not attend an HBCU while participating in the program. Another interesting finding is in regards to the rate of selection of applications for awards. Over the 2019–2021 application period, the SFs selected 21.7% of completed applications for SMART awards. However, the application selection rate for scholars at HBCUs was lower at 15.9% while at universities not designated as HBCUs or MSIs, the selection rate was 22.6%. Based on these analyses, the SFs are not selecting applications from HBCUs for awards at the same rate as they are from other universities. The DoD's January 2023 announcement regarding the first university-affiliated research center (UARC) sponsored by the Air Force at Howard University (an HBCU), could be an opportunity for outreach by the SPO to increase the completed application rate from potential scholars at HBCUs. As a UARC, Howard University will receive DoD funding to support STEM research and will lead a consortium of other HBCUs that will participate in the UARC. Although the selection of scholars for the SMART award ultimately falls on the SFs, the increased awareness of the SMART Program by students at this new HBCU UARC, combined with the direct ties that their education and research have to DoD missions, might increase the likelihood that applicants from the UARC HBCUs are selected for SMART offers and subsequent awards.

There seems to be a relationship between degree level and discipline for SMART award rates for scholars at HBCUs. For example, the application to award rate is greatest for master's degree students and lowest for doctoral students, a pattern that differs for MSIs (where doctoral scholars have the highest application rate) and non-HBCU/MSIs (where master's scholars have a slightly higher award rate than doctoral scholars) (see Table 11 for details). In fact, the award rate for doctoral applicants from MSIs and non-HBCU/MSIs is more than twice that of the award rate for HBCU doctoral applicants. The different application to award rates could be accounted for by the differing application rates (see Table D-4 in Appendix D). Simply put, the SPO receives far fewer applications from students at HBCUs than from other universities. Although there are a smaller number of HBCU-designated universities, the SMART Program should, in theory, receive the number of applications that are on par with the relative number of Black or African American identifying students pursuing S&E degrees at HBCUs. For example, national data from 2018 show that 11.5% of Black or African American students pursuing either S&E degrees were doing so at an HBCU (see Table E-1 in Appendix E for more information).[20]

By examining the applicant disciplines and SMART award disciplines, we can understand more about the application to award rate at HBCUs. The application to awards rate varies considerably by degree and discipline. For example, the acceptance rate is 33.3% for doctoral scholars pursuing degrees in mechanical engineering, however, no scholars at the bachelor's and master's level were selected for award in this discipline despite it being the field with the second highest number of applications submitted by scholars at HBCUs.

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[20] Note that these data include the following disciplines identified as S&E in the NCSES data: biological and biomedical sciences; computer and information sciences; geosciences, atmospheric sciences, and ocean sciences; mathematics and statistics; physical sciences; psychology; aerospace, aeronautical, and astronautical engineering; bioengineering and biomedical engineering; biological and biosystems engineering; chemical engineering; civil engineering; electrical, electronics, and communications engineering; engineering mechanics, physics, and science; industrial and manufacturing engineering; mechanical engineering; metallurgical and materials engineering; mining engineering; nanotechnology; nuclear engineering; petroleum engineering; and engineering not elsewhere classified (National Center for Science and Engineering Statistics 2021).

Table 10. Self-reported Ethnic and Racial Identities of SMART Applicants and Scholars at HBCUs, non-HBCU MSIs, and Other Universities (award years 2020–2022)

SMART Application Race Selection Options	HBCU Applicant Count (% of total applications by racial group)	HBCU Scholar Count (% of total awards by racial group)	Non-HBCU MSI Applicant Count (% of total applications by racial group)	Non-HBCU MSI Scholar Count (% of total awards by racial group)	Non-HBCU or MSI Applicant Count (% of total applications by racial group)	Non-HBCU or MSI Scholar Count (% of total awards by racial group)	Total awards (% of awards)
American Indian or Alaskan Native	0 (0.0%)	0 (0.0%)	2 (10.0%)	0 (20.0%)	18 (90.0%)	4 (100.0%)	4 (0.25%)
Asian American	2 (0.32%)	1 (0.66%)	134 (21.5%)	27 (18.2%)	487 (78.2%)	120 (81.1%)	148 (9.39%)
Black or African American	165 (19.3%)	26 (23.4%)	120 (14.1%)	9 (8.11%)	568 (66.6%)	76 (68.5%)	111 (7.04%)
Hispanic or Latino	7 (0.84%)	2 (1.18%)	270 (32.4%)	47 (27.7%)	556 (66.8%)	121 (71.2%)	170 (10.8%)
Multiple races	10 (2.56%)	1 (1.43%)	61 (15.6%)	11 (15.71)	313 (80.3%)	58 (82.9%)	70 (4.44%)
Native Hawaiian or Other Pacific Islander	0 (0.0%)	0 (0.0%)	1 (16.7%)	0 (0.00%)	5 (83.3%)	1 (100.0%)	1 (0.06%)
White	5 (0.12%)	0 (0.0%)	488 (11.7%)	102 (10.3%)	3672 (88.2%)	884 (89.7%)	986 (62.5%)
Do not wish to respond / no data listed	6 (0.80%)	1 (1.15%)	48 (12.8%)	7 (8.05%)	321 (85.6%)	79 (90.8%)	87 (5.17%)
Total	195	31	1124	203	5940	1343	1577
Application Selection Rate (overall rate is 21.7%)		15.9%		18.1%		22.6%	

Note: The data represent applications submitted in 2019, 2020, and 2021 for all awards offered in 2020, 2021, and 2022 (some awardees declined the SMART award offer). University data from 157 applications were missing, therefore these applications are counted in the non-HBCU/MSI applications. The percentages listed represent the percent of the total number of completed applications submitted or SMART awards given per racial group. Consistent with the Department of Education, if an applicant or scholar reported identifying as Hispanic or Latino, they were counted in this ethnic/racial category and not included in the other racial categories.

These application and award statistics are different for scholars at non-HBCU MSIs. Students from 221 unique MSIs submitted 1,124 (or 15.5%) of the 7,259 completed applications received by the program during 2019–2021. Of the 1,577 SMART awards given across this period, SFs awarded 203 (or 12.9%) to scholars at 73 different non-HBCU MSIs. We should note that this does not mean that all applications (and subsequent awards) were submitted by minority students as MSIs are defined as accredited institutions that exceed a certain percentage of undergraduate enrollment for a particular minority or institutions that qualify as an HBCU or a Tribal College or University (20 USC § 1067q).[21] As such, some applicants (and awardees) from MSIs may not identify as minorities. We examined the racial and ethnic backgrounds of SMART applicants and scholars at non-HBCU MSIs for the 2020–2022 cohort years. In terms of ethnicity, 270 applicants from MSIs identified themselves as Hispanic or Latino compared to 556 applicants from non-MSIs or HBCUs. In other words, the SMART Program receives almost twice as many applications from students who identify as Hispanic or Latino from schools not designated as MSIs or HBCUs.[22] Not surprisingly, a similar pattern emerges when looking at the ethnicity of SMART scholars. Of the 203 scholars at MSIs, 47 (or 23.2%) identified as Hispanic or Latino, 7 did not wish to respond, and 149 (or 73.39%) did not identify as Hispanic or Latino. Across all awards given during this 3-year timeframe, 170 scholars identified as Hispanic or Latino, thus, 123 (or 72.4%) Hispanic or Latino scholars did not attend an MSI (or HBCU). We also examined how applicants from and scholars at these MSIs identified in terms of race (see **Table 10**). The data show that 32.8% of completed applications received by the SPO from MSIs were from minority-identifying students. However, the application selection rates for awards (18.1%) are below the overall selection rates from non-MSI/HBCU universities. Further, 65.8% of scholars from MSIs identified as White, suggesting that more than half of SMART awardees from MSIs do not identify as minorities. Again, there seems to be a relationship between degree level and discipline for scholars at MSIs. For example, the application to award rate is greatest for doctoral degree students and lowest for bachelor's students while at non-HBCU/MSIs; master's scholars have a slightly higher award rate than doctoral scholars (see Table 11 and Table D-5 in Appendix D for details).

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[21] The benchmark for qualification for each individual minority group was defined in the Higher Education Act of 1965 or one of its several amendments. The specific minimum percentage of enrollment to qualify for MSI status for each minority group (20 USC §1059d-g, 1067q, 1101a) is as follows: Black/African American 40%; Hispanic 25%; Alaskan Native 20%; Asian American 10%; Native American 10%; Native Hawaiian 10%; and Native Pacific Islander 10%.

[22] None of the students applying from HBCUs identified themselves as Hispanic or Latino.

Table 11. Completed Application to Award Rate for HBCUs, MSIs, and non-HBCU/MSI Universities by Degree Level

SMART Application Race Selection Options	HBCU Award Rate	Non-HBCU MSI Award Rate	Non-HBCU or MSI Award Rate
Bachelor's	15.4%	15.1%	18.4%
Master's	21.2%	21.1%	29.3%
Doctoral	12.5%	25.5%	28.5%

Given that increasing awardee diversity has been a long-standing goal of the SMART Program, the findings described above provide some important insights regarding outreach efforts. Because the SPO does not select scholars for awards (this is the role of the SF), it is important to consider the classifications of universities where the largest number of completed applications are submitted from. Our analyses show that minority-identifying scholars submit a significantly larger percentage of completed applications (and receive subsequent awards) from universities not designated as HBCUs or MSIs than scholars at universities with those designations. For example, Black/African American identifying students at HBUCs submitted only 165 out of 6,869[23] (or 2.40%) of completed applications while the same demographic of students affiliated with non-HBCU universities submitted 688 of 6,869 (or 10.0%) of completed applications. In other words, the SPO received more than four times the number of completed applications from Black/African American identifying students at non-HBCU institutions than from those at HBCUs. Likewise, minority-identifying students at MSIs submitted only 588 out of 6,869 (or 8.56%) of completed applications received by the SPO while minority-identifying students from non-MSI/HBCU universities submitted 1,947 of 6,869 (28.3%, or more than three times as many) completed applications.

These findings suggest that although the SPO has made significant efforts to engage with students at HBCUs and MSIs, most of the applications submitted by minority-identifying students come from other universities. The data do not provide any explanation for why this might be the case; however, a contributing factor may be simply the total number of minority-identifying students at HBCUs and MSIs compared to other universities. For example, the fall 2020 total student enrollment in 4-year degree programs

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[23] Although the SPO received 7,259 applications between 2019 and 2021, 390 applicants did not provide information regarding their racial demographics. Thus, the rates of submission of completed applications by race excludes these cases, leaving the total number of completed applications where race was indicated at 6,869.

at U.S. undergraduate institutions was 13.3 million,[24] of which 1.7 million (or 12.9%) students identified as Black/African American (U.S. Department of Education, National Center for Education Statistics 2021). This includes the 198,635 students enrolled in a 4-year program at an HBCU in the fall of 2020 who identified as African American. In other words, only 11.6% of Black/African American college students enrolled in a 4-year degree program at an HBCU in 2020.[25]

To better understand the proportion of minority students pursuing S&E studies at different universities, we examined two sets of data from a 2021 National Science Foundation report (National Center for Science and Engineering Statistics 2021). The first set of data identified the types of universities where Black or African American, Hispanic or Latino, and American Indian or Alaska Native students earned S&E bachelor's degrees in 2018 (see Table E-2 in Appendix E for details). For each of these minority-identifying groups, the data show the number of bachelor's degrees earned at the MSI designated for that race or ethnicity (e.g., HBCU, high-Hispanic enrollment institutions (HHE),[26] TCUs). These data show that Hispanic and Latino students earned 71.8% of S&E bachelor's degrees at HHEs and that a larger proportion of Hispanic or Latino students earned science (76.8%) than engineering (44.0%) degrees at these MSIs. The data also show that less than one-quarter (22.4%) of Black or African American students earning an S&E bachelor's degree in 2018 did so at an HBCU. Again, a larger proportion of Black or African American students earned science (23.3%) than engineering (15.7%) degrees at HBCUs. Finally, only 6.5% of American Indian or Alaska Native students earned an S&E bachelor's degree at a TCU. A larger proportion of these students earned science (7.3%) than engineering (1.4%) degrees at TCUs.

The second set of data from the 2021 National Science Foundation report provided information on the number of Black or African American students pursuing master's or doctoral S&E (also discussed above) degrees in 2018 by the number of students enrolled at HBCUs and all other institutions (National Center for Science and Engineering 2021). The data show that although 11.5% of Black or African American students pursuing graduate degrees in S&E were enrolled at an HBCU in 2018, 88.5% were enrolled in other

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[24] These data exclude 84,8700 non-U.S. resident students who would be ineligible to apply for a SMART award.

[25] Based on the U.S. Department of Education data, 24.2% of students enrolled at an HBCU in the fall of 2020 did not identify as Black or African American. Further, 11.9% of all students (or 6.20% of students identifying as Black or African American) enrolled at an HBCU in the fall of 2020 pursued a 2-year degree. Although the SMART Program has supported some scholars pursuing 2-year degrees, it is exceedingly rare.

[26] The Department of Education defines high-Hispanic-enrollment institutions as nonprofit public and private institutions of higher education whose full-time equivalent enrollment of undergraduate students is at least 25% Hispanic, which qualifies them for MSI status.

universities. The data only examined enrollment at HBCU and all other universities, and as such, some of these “other” universities may be designated as MSIs.

The findings from these two datasets indicate that at the bachelor’s level, outreach to HHEs will allow the SPO to engage with a large percentage of S&E Hispanic or Latino students. Further, the data suggest that the SPO has an increased likelihood of engagement with Black or African American, American Indian, and Alaska Native-identifying students pursing S&E degrees at universities other than HBCUs or TCUs. This is not to suggest that the SPO change their level of engagement with HBCUs or TCUs to solicit applications for the program. Instead, the SPO may want to increase outreach to minority-identifying students through connections with other universities in order to increase completed application rates from these student populations. In other words, from a purely return-on-investment standpoint, focused engagement with and outreach to minority-identifying students outside of HBCUs and TCUs by the SPO might increase the number of applications submitted to the program for non-Hispanic or Latino minority-identifying students.

Similarly, of the 13.8 million students enrolled in a 4-year degree program at U.S. undergraduate institutions in the fall of 2020, 7.8 million students identified as female and 5.4 million identified as male. Of these students, 832,600 males and 1.55 million females identified as Black or African American, including 68,528 male and 130,046 female students who were enrolled in a 4-year program at an HBCU. Finally, 1.4 million male and 2.2 million female students who identified as Hispanic were enrolled in a degree-granting postsecondary institution in the fall of 2020.[27] We also examined the gender breakdown of Black or African American students enrolled in graduate S&E programs in 2018 using National Science Foundation data (National Center for Science and Engineering Statistics 2021).. The data show that only 11.5% of S&E graduate students who identified as Black or African American were enrolled at HBCUs. Also, while females made up 60.9% of the S&E graduate student body at HBCUs, these students only accounted for 12.4% of all female graduate S&E students (see Table E-1 in Appendix E for details).

We can compare these enrollment rates to the SMART Program application and award rates at different universities (U.S. Department of Education, National Center for Education Statistics 2021). As shown in Table 12, of the 195 applications the SPO received from scholars at an HBCU, 112 (or 57.4%) were submitted by females, which corresponded to 18 (or 58.1%) awards to scholars at HBCUs. An interesting finding is that females from HBCUs both submit applications and are awarded SMART scholarships at a

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[27] The data reported here include male and female Hispanic students enrolled in both 2- and 4-year degree programs. The U.S. Department of Education data note that 2.39 million Hispanic students were enrolled in a 4-year degree program in the fall of 2020, however, the number of male and female students in these programs is not provided.

higher rate than their male counterparts. Although the overall rate of awards for female Black or African American SMART scholars mirrors the rate of applications received by the SPO from this demographic, it is important to note that the award rate for these scholars (16.1%) still falls well below that of female scholars from non-HBCUs and MSIs (21.5%) as well as the overall award rate for all scholars (at 21.7%). Additionally, female applications from HBCUs make up only 4.1% of all eligible applications submitted to the SPO. The data also show that females make up only 37.3% of applications from non-HBCU MSIs; however, their overall award rate (15.9%) is less than that for female applicants from HBCUs. Further, while females from non-HBCUs or MSIs submit applications at the same rate (37.8%) as female applicants from MSIs, these former applicants fare better in terms of overall award rates (at 21.5%). Taken together, these data show an interaction between gender and university designation such that despite the SPO's significant efforts to engage with students at HBCUs and MSIs, most of the applications submitted by female students come from other universities (80.9%). A significant contributing factor to this finding might simply be the sheer number of students of either gender who attend HBCUs or MSIs, versus other universities. For example, only 8.23% of all Black or African American identifying male students and 8.39% of all Black/African American identifying female students were enrolled in a 4-year degree program at an HBCU in 2020. The fact that the majority of Black/African American identifying students of ether gender attend universities not designated as HBCUs suggests that these universities do not contribute to the gender, ethnic, and racial diversity sought after by the SPO's outreach efforts.

Table 12. Self-reported Gender Identities of SMART Applicants and Scholars at HBCUs, non-HBCU MSIs, and Other Universities (award years 2020–2022)

Gender	HBCU Applicant Count	HBCU Scholar Count	Non-HBCU MSI Applicant Count	Non-HBCU MSI Scholar Count	Non-HBCU or MSI Applicant Count	Non-HBCU or MSI Scholar Count
Female	112 (4.1%)	18 (3.2%)	416 (15.1%)	66 (11.7%)	2229 (80.9%)	479 (85.1%)
Application Selection Rate	16.1%		15.9%		21.5%	
Male	83 (1.9%)	13 (1.3%)	700 (15.7%)	135 (13.6%)	3670 (82.4%)	844 (89.1%)
Application Selection Rate	15.7%		19.3%		23.0%	
Do not wish to respond / no data listed	0 (0.0%)	0 (0.0%)	8 (8.6%)	2 (9.1%)	85 (91.4%)	20 (90.9%)
Total	195	31	1124	203	5984	1343

4. Veterans Preference and Military Dependents

In this section, we examine the designation of whether applicants claim veterans' preference points and whether they are military dependents, and the relationship of these designations to SMART scholarship offers. As summarized below, these analyses show that the relationships differed for those individuals applying for RC as opposed to RT scholarships.

Regarding veterans' preference, only 2.0% of RC applicants claimed preference points compared to 10.2% of RT applicants. Claiming veterans' preference points was associated with higher award rates for RC applicants, whereas this relationship was not seen with RT applicants. A possible explanation for this difference is that the SFs are appropriately considering veterans preference in hiring RC applicants, but perhaps discounting those points in RT applicants because they had already been considered in their initial hire.

Only a small proportion of applicants claimed to be military dependents. Whereas 2.7% of RC applicants were military dependents, an even smaller proportion of RT applicants (1.0%) were so designated. For the RC applicants, being a military dependent was negatively associated with award rates although the effect was quite small; those claiming military dependency had an award rate of 16.2% compared to 20.5% for those who did not make this claim. For the RT applicants, the relationship between military dependency and award rate is not clear because there were only two applicants who made that claim.

E. Overall Findings for the Application-to-Award Outcomes

Of the 28,877 individuals who started applications for Program Years 2019–2021, only 7,259 applicants completed their applications and were deemed eligible for the SMART scholarship program. Approximately 21.7% of the eligible applicants received scholarship offers, a statistic we define as "award rate."

We found a few factors that impact award rate. First, individuals applying for RT scholarships are nearly 3.5 times more likely to receive an award than those seeking RC scholarships. The large difference in award rates suggests that RT scholars may represent a group of employees who were already identified as valuable and likely to benefit from further academic education in STEM disciplines. Second, award rate also differs with respect to the supply of applicants and demand for STEM workers in particular academic disciplines. Those disciplines with high demand for STEM workers and a low supply of applicants (e.g., operations research, naval architecture and ocean engineering, and electrical engineering) are associated with high award rates, whereas those with low demand and high supply (e.g., biomedical engineering; biosciences; chemistry; chemical engineering; and cognitive, neural, and behavioral sciences) show low award rates. Third, award rates differ with respect to gender and race/ethnicity. In agreement with findings from the SMART 1.0 report (Balakrishnan et al. 2018), we found that the distribution of SMART awardees was less diverse that the distribution of SMART applicants, both in gender and in racial/ethnic backgrounds. Nevertheless, the scholarship awardees were substantially more diverse in gender, race, and ethnicity than the overall DoD STEM Workforce. Furthermore, long-term trends show that the SMART Program awardees are increasingly demographically diverse. Finally, we examined two of the more significant intersections between these factors. The first intersection (Awardee Type × Demographics) indicated that RC applicants are clearly more diverse in both gender and racial/ethnic identity than their RT counterparts. Whereas the RC pool of applicants becomes less diverse through the application-to-award process, the RT pool becomes more diverse. As a result, the RT and RC awardee pools are remarkably similar in diversity. The second (Gender × Discipline) pertained to variations in gender diversity by STEM discipline. The data indicate that the four largest disciplines (e.g., computer and computational sciences and computer engineering) were all fields where female applicants were in the clear minority (30% or less). In contrast, females were in the clear majority for 9 disciplines, having 50 or fewer awards (e.g., cognitive, neural, and behavioral sciences). This suggests that gains in gender diversity could be achieved if SMART engages STEM organizations who employ these more gender-equitable disciplines to participate in the SMART Program.

We also examined other variables that were potentially associated with award offers. The first was the scorecard score, which is produced by a selection panel to help filter applications. Our data indicated that, on aggregate, the scorecard scores were not different for individuals in different stages of the application process, suggesting that these scores have little or no effect on the SFs' decisions. However, we also found that the higher the award rate was for particular disciplines (e.g., mechanical engineering), the lower the overlap was between applicants that did or did not make it to at least the semifinalist round. Thus, there is some evidence in favor of the scorecard scores as an important filtering tool in this particular case. The second variable was the university or college that the applicants attend or plan to attend and their discipline of study. The data indicate that the SMART Program has broad reach in terms of solicitation of applications for awards across the 21 STEM disciplines that are relevant to the needs of the DoD. The breadth of universities that the applications represent translates into a similarly broad university distribution of SMART Program scholars. However, there seems to be a greater concentration of SMART scholars in certain disciplines at specific universities. A deeper understanding of the factors contributing to the increased selection of scholars from specific university programs may provide insight for SMART Program outreach efforts. The third variable was SMART Program efforts to increase the diversity of SMART applicants and scholars by conducting outreach to HBCUs and MSIs. These findings suggest that although the SPO has made significant efforts to engage with students at HBCUs and MSIs, most of the applications submitted by minority-identifying students came from other universities. Finally, another consideration in the award process was whether applicants claimed veterans' preference points and whether they were military dependents. Regarding veterans' preference, only 2.0% of RC applicants claimed preference points compared to 10.2% of RT applicants. Claiming veterans' preference points were associated with higher award rates for RC applicants, whereas this relationship was not seen in RT applicants. A possible explanation for this difference is that the SFs are appropriately considering veterans preference in hiring RC applicants, but perhaps discounting those points in RT applicants because they had already been considered in their initial hire. An even smaller proportion of applicants claimed to be military dependents, and no association could be detected.

3. Degree Pursuit

A. Chapter Organization

A key feature of SMART is the financial assistance provided to aid scholars in their pursuit of a college degree. As such, the attainment of degrees is a primary outcome of the SMART Program. This chapter describes the outcomes relevant to the pursuit of a SMART-supported degree by scholars (i.e., Phase 1). Specifically, this chapter addresses the following guiding question:

- To what extent do scholar factors such as scholar type (recruitment and retention), discipline of study, and scholar demographics affect the attainment of degrees in Phase 1?

In order to address this question, we analyzed data regarding the 3,783 SMART scholars that were awarded scholarships from 2006 to 2021 from the "Degree Attainment" dataset.

B. Degree Pursuit Outcomes

This chapter reports on SMART Program outcomes that are relevant to pursuing and attaining a degree in one of the 21 identified STEM fields (see Table 1). The overarching outcome for this section is attaining a degree, but there are additional relevant variables for describing the program outcomes, to include:

- *Degree level* – the type of degree (bachelor's, master's, doctoral) acquired by the scholars.
- *Scholar type* – differentiating degree attainment by RC and RT scholars. With RC scholars, these are people who are encouraged to join the DoD workforce by offering them the opportunity to gain a degree. With RT scholars, these are existing DoD employees who are encouraged and supported in their effort to gain further education (i.e., degree) through SMART.
- *Discipline* – analysis across disciplines allows for a deeper assessment of the areas of study, and reveal differences across those disciplines.
- *Demographics* – this analysis builds off the analysis of the award data, to show how people within demographic groups move through the program towards attaining a degree.

- *Incompletions* – not all awardees continue with SMART to the attainment of a degree. The data we analyzed do not provide a clear understanding of why a person may have left the program prior to attaining a degree, but the analysis of the likelihood of some variables (e.g., discipline, degree level, trends over time) provides some insight into what may be influencing those to complete (or not) their degrees through the SMART Program.
- *Time* – the analysis in the chapter will include the data over time, whether by years over the life of the program or by 4-year cohort groups when analyzing data with relatively low N/group (combining data in 4-year cohorts enables us to still look at trends over time, but increases the N per unit of analysis).

C. Degree Pursuit

A primary objective of SMART is to facilitate attaining a degree through financial assistance to the awardee. Over the course of the SMART Program, there have been a total of 2,870 degrees (covering 2007–2021) that have been facilitated by SMART.

1. Degrees Supported by the SMART Program by Year

Of the 2,870 degrees supported by the SMART Program since 2006, 1,412 were for bachelor's (BS) degrees, 752 were master's (MS), and 706 were doctorates (PhDs). Figure 15 shows the number of degrees attained by SMART awardees in each year, broken down by degree level. Also, the budget for the program is depicted by the black line that is measured against the right-hand axis.

The number of graduates in a given year fluctuated over time, with the number of graduates steadily increasing over the first few years of the program. The first year of the program was 2006, and no scholars graduated because all of the initial cohort was still attending school during calendar year 2006. A few (six scholars) graduated in 2007, and that number steadily increased over the first few years. There is an initial peak in the number of graduates that occurred in 2011–2013, then it decreased for a few years (2014–2017), before increasing again from 2018 to 2021. This appears to fluctuate with changes in the budget as seen in Figure 15, with approximately a 2–3-year lag between where budget trends changed (i.e., decrease in 2012 after increases up to 2011; increases in 2016/2017 after decreases up to 2015). The time lag is logical in that the budget influences how many new awards can be made, and it takes approximately 2 years from when an award is made until the awardees graduate.

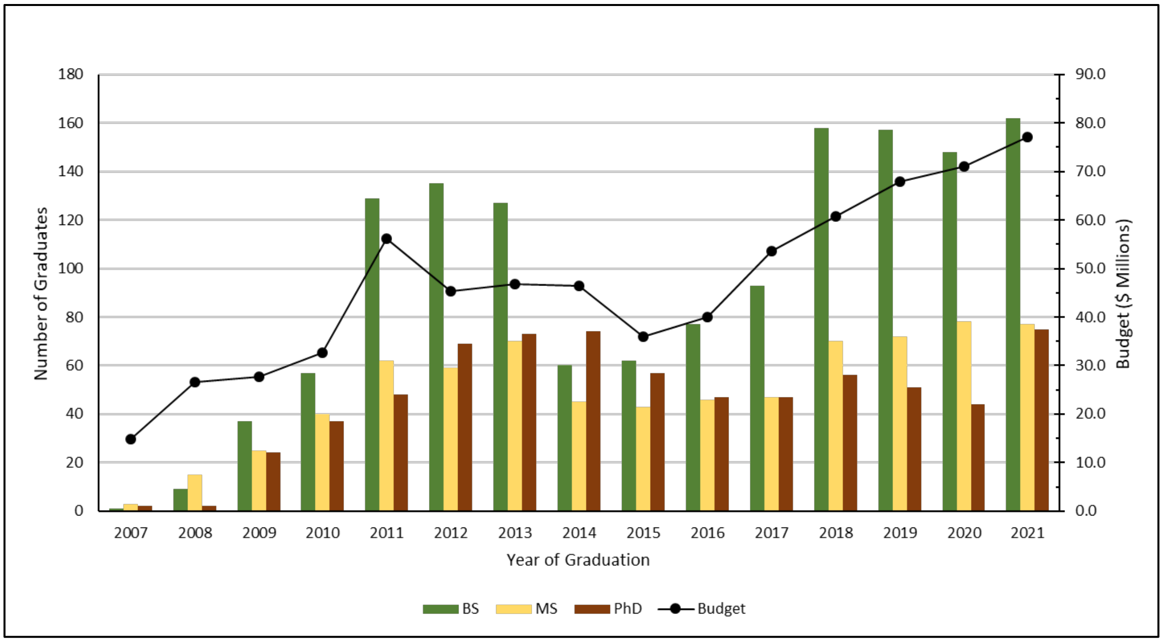

Figure 15. The number of degrees facilitated by SMART over the years. The colored bars indicate the degree level, and the line shows the budget for a given year. Note that number of graduates increase with increased budget.

Through the program's history, there was a fluctuation in the number of degrees attained at the BS, MS, and PhD levels. During the first peak in graduations, about half of the degrees attained by SMART scholars were at the BS level with a quarter of the degrees being at each of the MS and PhD levels. When the dip in graduation rates occurred in 2014–2015, the decrease in degrees was most dramatic at the BS level. Then, as the overall number of degrees attained increased around 2018, the rates of BS attainment increased more so than the rates of MS and PhD degrees.

2. Service Commitment Length by Degree Level

A further set of analysis was conducted to better understand the patterns of SMART service commitment length for the different degree levels (see Table 13). The length of a scholar's service commitment is equivalent to the length (number of years) of support (tuition plus stipend) the SMART Program provided to the scholar to attain their degree.[28] The commitment length data were calculated based on the start and end dates for Phase 2 and did not necessarily round to whole numbers; therefore, they are presented in ranges. In general, the shorter commitment lengths (i.e., less than 3.5 years) are associated with scholars pursuing BS degrees while longer commitment lengths (e.g., greater than 3.5

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[28] Note: Depending on degree requirements, SMART scholarships are awarded for a minimum of 1 year to a maximum of 5 years of funding. Additionally, the SMART award is associated with a one-for-one commitment such that for every year of degree funding, the scholar commits to working for a year with the DoD as a civilian employee.

years) are associated with scholars pursuing a PhD. The most common service commitment length ranged from 1.5 to 2.5 years, with nearly 40% of scholars falling into that range (see Table 13). Additionally, about 25% of scholars received awards associated with service commitments of less than 1.5 years while approximately 20% of scholars received awards with service commitments between 2.5 and 3.5 years. Only a little more than 10% of scholars had commitments between 3.5 and 5 years, with less than 5% of scholars having commitments of over 5 years. From the data we received, it was not clear if the larger service commitments (e.g., greater than 5 years) were associated with scholars who received more than one SMART award.

Table 13. The Service Commitment Length of SMART Scholars by Degree Level

	Commitment Length in Years				
	1.5 Years or Less	Between 1.5 and 2.5 Years	Between 2.5 and 3.5 Years	Between 3.5 and 5.0 Years	More than 5.0 Years
BS	345 (53%)	598 (58%)	254 (47%)	22 (8%)	4 (4%)
MS	248 (38%)	287 (28%)	101 (19%)	39 (13%)	8 (7%)
PhD	56 (9%)	138 (13%)	181 (34%)	232 (79%)	96 (89%)
Total Awards	645	1,023	536	304	108

Note: The number in parenthesis indicates the percent of scholars in the support range that received a particular degree level.

3. Scholar Type (Retention and Recruitment Scholars)

Most of the degrees facilitated by SMART between 2007 and 2021[29] were earned by RC scholars who received 2,559 degrees during this period. RT scholars, on the other hand, earned 311 degrees over the same period. Figure 16 shows the number of RC (blue bars) and RT (red bars) scholars who earned degrees for each year of the program. The black line shows the percent of degree earners that were RT, which averages 10.8% over all of the years. As with the overall number of graduates displayed in Figure 15, there is a dip in the number of graduates in 2014 due to the budget decrease in 2011 (see Section 3.C.1 for analysis between budget and awardees). This dip in graduates appears to be primarily affecting RC, with an approximate 40% drop of RC graduates from 2013 to 2014. There is no corresponding drop with the RT scholars at that time period. This indicates that when there is a budget decrease, it is most likely to affect the number of RC scholars that come into the program, subsequently limiting the number of new talent hired in subsequent years.

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[29] Because the inaugural SMART cohort received awards in 2006, the earliest a SMART scholar graduated from their program (or earned a degree) was 2007.

Figure 16. Number of degrees earned by recruitment and retention scholars by year as indicated by the bar graph, along with percent of RT scholars as shown by percent of retention scholars as depicted with the line and using the right-hand axis.

The fluctuation of degrees earned over the years is greater for RC scholars versus RT scholars, in that from 2011 to 2021 (i.e., after the program's initial years of ramping up) the mean number of RC scholars earning degrees in a year was 212.2 (standard deviation = 53.3), while RT scholars averaged 25.8 degrees (standard deviation = 2.5). A useful metric for comparing the degree of variation from one data series to another, even if the means of those data are drastically different, is the coefficient of variation (cv). The cv is calculated as the standard deviation divided by the mean. For RC degree earners, the cv = 25.1% indicating that the variation of one standard deviation from the mean was approximately one-fourth of the value of the mean. For RT degree earners, the cv = 9.8% indicating that the variation of one standard deviation from the mean was approximately one-tenth of the value of the mean. This suggests that the year-to-year variation is more volatile for RC scholars attaining degrees than for RT scholars. This highlights an issue with fluctuating budgets from year to year, as was shown in Figure 15, in that when the budget fluctuates, the SMART Program's ability to bring in new talent (RC scholars) for the DoD is erratic.

4. Degrees by Discipline

The number of degrees earned for each discipline is shown in Figure 17 (BS = green, MS = gold, and PhD = brown). There are three disciplines that dominate the SMART Program with regards to degree attainment: electrical engineering (22.3% of all SMART degrees), mechanical engineering (18.0% of SMART degrees), and computer and computational sciences and engineering (16.9% of SMART degrees). All other disciplines were well below 10%. As would be expected, the pattern of disciplines where many/few degrees were attained matches the awards across disciplines, as shown in Chapter 2 of this report as well as the SMART 2.0 Process Evaluation Report (Belanich et al. 2021).

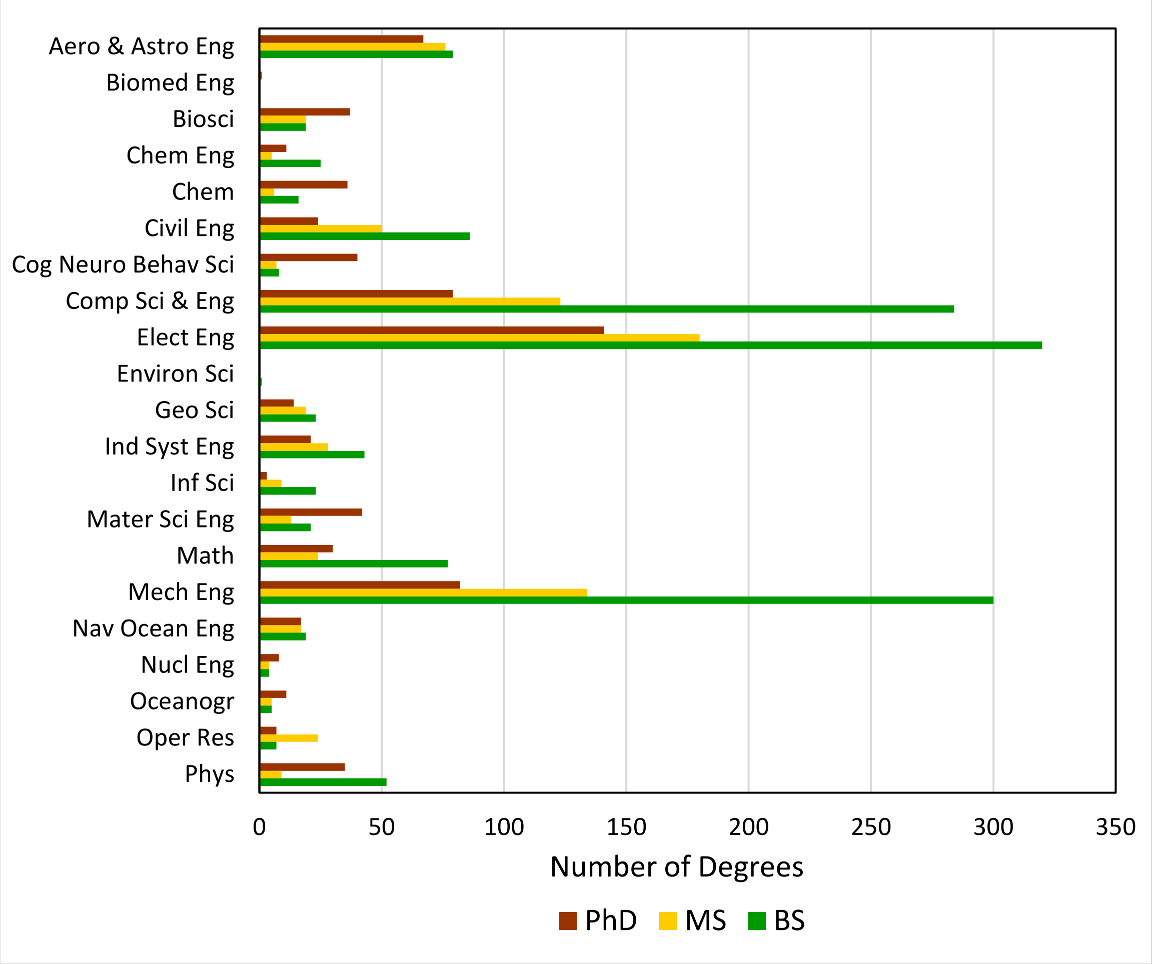

Figure 17. Number of degrees facilitated by SMART, broken down by discipline and degree level from 2007 to 2021.

Overall, BS degrees accounted for 49.2% of all SMART-supported degrees with MS and PhD degrees accounting for 26.2% and 24.6% of degrees, respectively. For many of the disciplines (chemical engineering, civil engineering, computer science, electrical engineering, industrial and systems engineering, information sciences, mathematics, mechanical engineering, and physics), the pattern followed where the most common degree level, accounting for approximately one-half or more of all degrees supported for that discipline, was a BS degree. Operations research was the only discipline where an MS degree was the most common. For PhD degrees, several disciplines (oceanography, nuclear engineering, material science and engineering, cognitive, neural, and behavioral science, chemistry, and bioscience) were the most common with MS and BS degrees accounting for a combined less than half of all degrees supported in that discipline. For some disciplines (aeronautical engineering, geosciences, and naval architecture), the percentages of degrees were relatively even across the three degree levels.

5. Degrees by Gender

Of the scholars that attained degrees and started Phase 2 before the end of 2021, there were a total of 744 (29.6%) females, 1,726 (68.7%) males, and 41 (1.6%) who did not wish to identify their gender. The percentage of female scholars completing degrees with support from the SMART Program has increased some over the years, with 27.6% of the graduates in 2006–2009 being female while that has increased to 32.5% for the 2018–2021 group of graduates (see Figure 18). The percent of male graduates has decreased in a complimentary manner to females, while the percent of scholars that selected “do not wish to respond” fluctuated, but in no clear direction over the years.

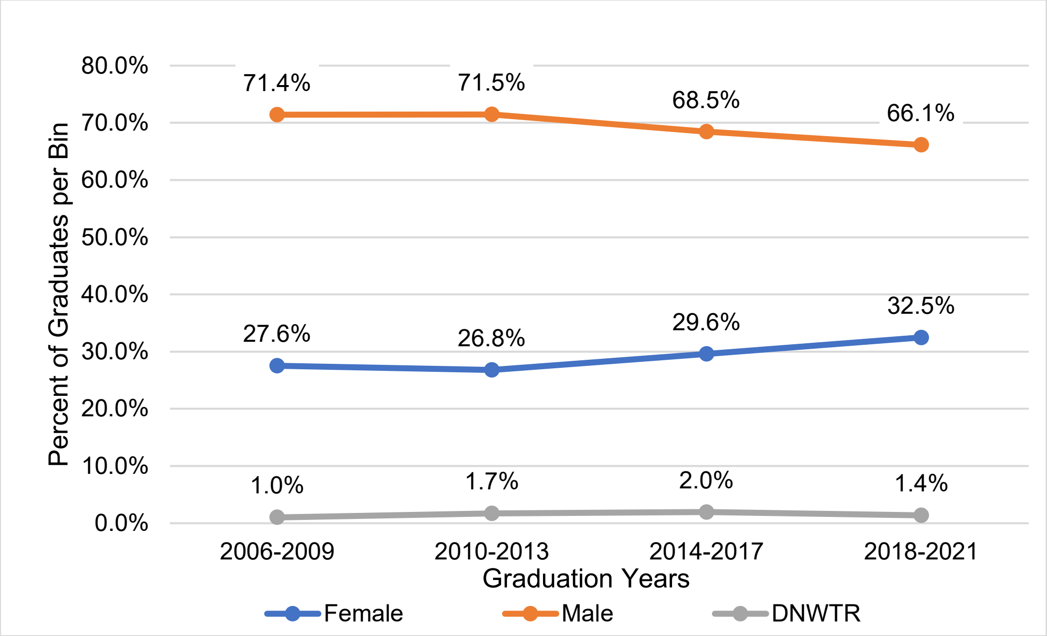

Figure 18. The percent of graduates by gender over the years, binned in 4-year groups. Over the years, there is a slow trend towards a more balanced distribution across genders.

6. Degrees by Race/Ethnicity

Of the scholars that graduated and started Phase 2 before the end of 2021 (see Table 14), degrees were attained by a total of 32 Native American, 166 Asian American, 114 Black/African American, 135 Hispanic, 3 Pacific Islander, and 1,894 White scholars. Additionally, there were 160 scholars that chose not to identify their race/ethnicity and 14 who identified as Multiracial. Over the years, the percent of scholars completing degrees with support from the SMART Program who identify as minority race/ethnicities has fluctuated, with the largest increase being for Asian Americans followed by those who identify themselves as Hispanic. The percentage of those who identify as White has decreased over the years, but remains at over 70% of graduates.

Table 14. The percent of graduates grouped by racial/ethnicity categories, binned by 4-year groups. The columns for each cohort group are percentages that sum to 100% (with rounding error) and the total numbers of graduates are in the "Grand Total" column to the far right and row to the bottom.

	Graduate Years				
Race/Ethnicity	**2006–2009**	**2010–2013**	**2014–2017**	**2018–2021**	**Grand Total**
American Indian	0.0%	1.4%	1.8%	0.9%	32
Asian	2.8%	5.8%	5.7%	8.3%	166
Black	5.6%	3.1%	3.6%	6.3%	114
Hispanic	4.6%	3.4%	5.8%	6.9%	135
Mixed	0.0%	0.1%	0.2%	1.3%	14
No Response	9.3%	8.2%	6.5%	4.4%	160
Pacific Islander	0.0%	0.1%	0.2%	0.1%	3
White	77.8%	77.9%	76.3%	71.9%	1894
Grand Total	108	833	617	960	2518

D. Leaving SMART Before Degree Completion: Phase 1 Incompletion

Though over 90% of SMART scholars attain their expected degree as part of the SMART Program, some scholars leave the program before completion of Phase 1 (i.e., they leave the program before they attain their degree). The data provided to IDA did not consistently include data regarding why scholars left during Phase 1, whether through their own volition (e.g., decided to take another scholarship offer, decided not to complete their degree) or were dismissed (e.g., failed to maintain an adequate GPA). As such, we were unable to analyze why scholars left the program during Phase 1. The analyses presented in this section included scholars who left for any reason, producing a total Phase 1 attrition rate. Scholars who receive scholarship and stipend funds but do not complete a service commitment are required to repay the SPO for their award, thus, the decision to leave the program early should not be one that scholars take lightly.

1. Degree Incompletion Over Time

The first analysis focused on scholars who received awards but did not earn degrees through the SMART Program; the data are grouped in 4-year cohorts (see Figure 19). The overall attrition rate of scholars that did not complete their degree while in the SMART Program is relatively steady at 8.7%–8.8% over the first three cohort groups, then decreases to 4.9% in the most recent cohort group. It should be noted that some in this last cohort group may still be in school and have not yet completed their degree but are still participating in SMART and therefore are not considered an incompletion; some of these scholars may still leave the program before the end of their Phase 1 so that percentage may go up.

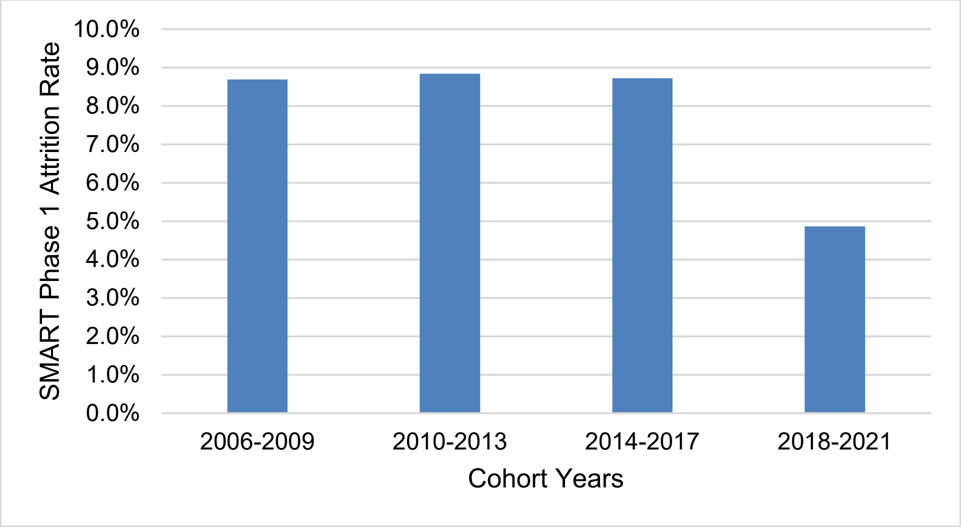

Figure 19. Percentage of scholars that left the SMART Program during Phase 1.

These results suggest that a very high percentage, over 90%, of the SMART scholars who are awarded a scholarship completed their degree. This finding that SMART scholarship awardees are very likely to attain their degree is in alignment with other findings that indicate that scholarships and grants to students increase the likelihood that they will ultimately graduate (Millea et al. 2018).

2. Degree Incompletion by Discipline

To better understand factors associated with attrition during Phase 1, it is important to examine scholar attrition rate by discipline. These data, shown in Figure 20, include attrition data by discipline for scholars (all scholars from 2006–2021 cohorts) who left SMART during Phase 1. The attrition rate varied from 11.1% for industrial and systems engineering degree seekers to 0.0% for biomedical engineering and environmental science students, though the number of awards (and therefore scholars) for this latter group was quite small. Of the three highest frequency disciplines selected for awards, which included well over half of the scholars, the attrition rate was relatively high for scholars pursuing degrees in computer science and computer engineering (10.6%), while near the overall SMART attrition rate for electrical engineer scholars (8.6%), and below the SMART average for mechanical engineers (5.2%).

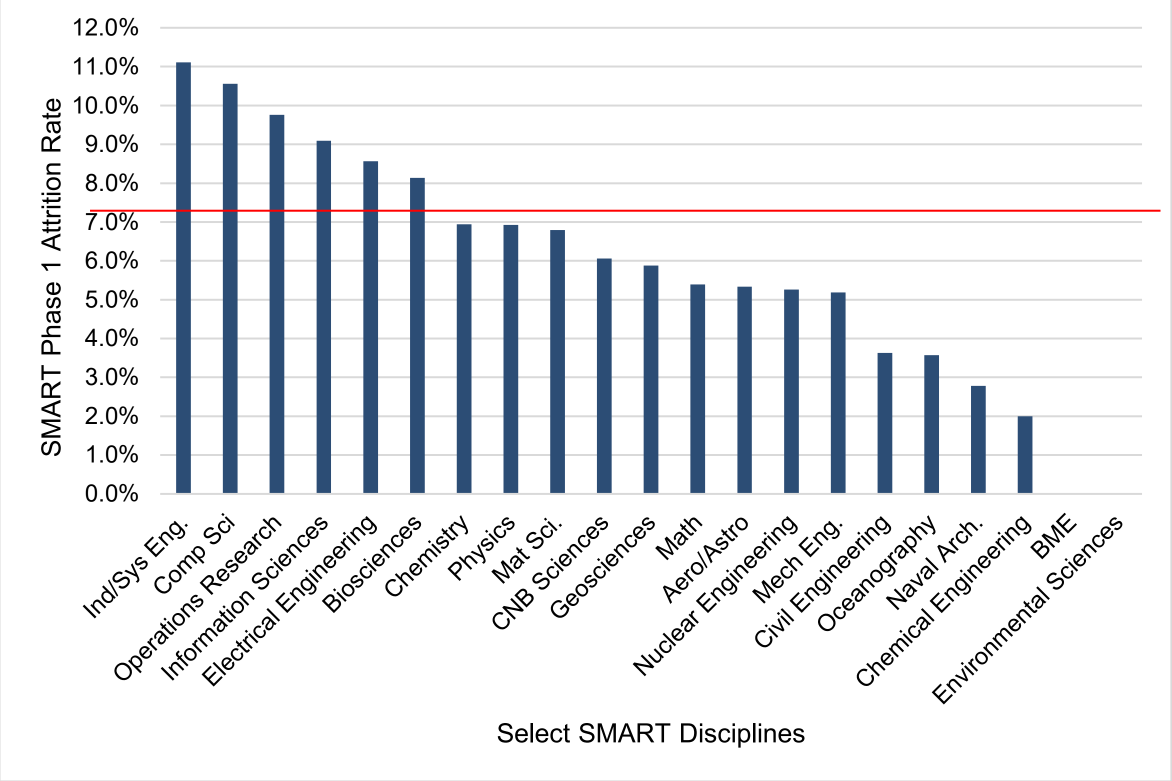

Figure 20. The percentage of SMART scholars in particular disciplines that do not graduate while part of the SMART Program. The red line indicates the average attrition rate for the SMART Program (approximately 7.3%) for all scholars from the 2006–2021 cohorts.

3. Degree Incompletion by Degree Level

The analysis of Phase 1 attrition by degree level provides additional insights into the issue of scholars who do not successfully complete the SMART Program. As shown in Figure 21, the attrition rate for scholars pursuing BS degrees was equal to the overall SMART average at 7.3%. The attrition rate for scholars pursuing MS degrees was lower than the overall SMART attrition rate (at 5.4%), while the attrition rate for doctoral students was higher (9.2%) than the SMART overall rate.[30]

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[30] To put this number into context, the average attrition rate of doctoral students is 40%–60% across all disciplines (Hurt, Ways, and Holmes 2022).

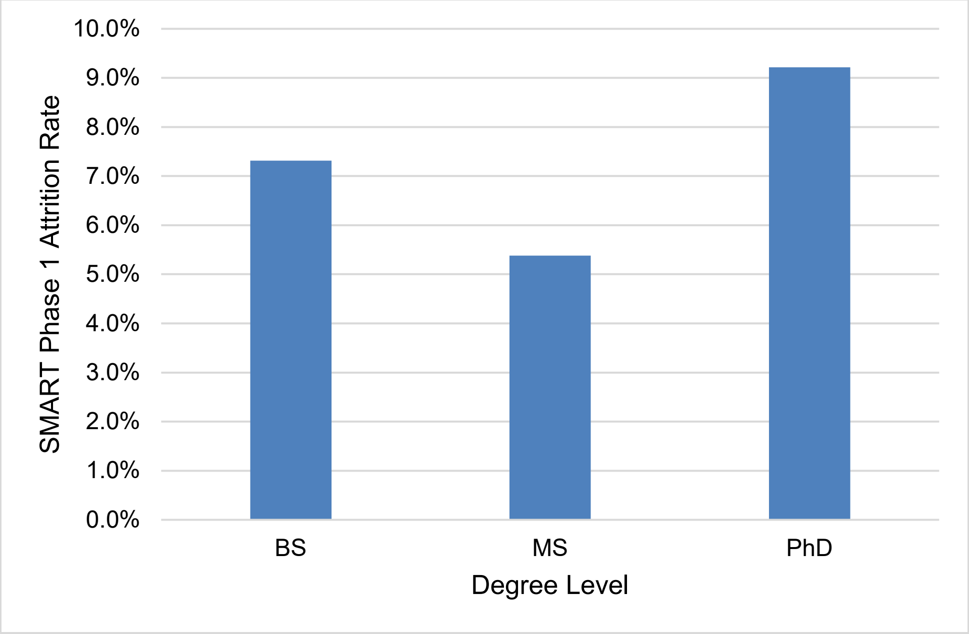

Figure 21. The percentage of scholars who leave the SMART Program before graduating, by degree level.

While direct comparisons of SMART completion rates cannot be clearly made against other scholarship programs, the completion rates of other programs can be used to provide context of how likely SMART scholars are to successfully complete Phase 1. For example, the percent of SMART scholars who left the program before attaining a PhD (9.2%) is lower than the number of doctoral candidates supported by the National Defense Science and Engineering Graduate (NDSEG) Fellowship, where over 15% of students did not attain a PhD within 10 years of receiving their award (Belanich et al. 2019). Likewise, approximately 17% of the National Science Foundation Graduate Research Fellowship Program Fellows did not complete a PhD within 10 years of receiving their award (NORC 2014, 75). According to the National Center for Education Statistic's (NCES) Baccalaureate and Beyond longitudinal dataset (U.S. DOE 2005), only about half of the students who stated an initial intention to attain a PhD actually attained one within 10 years. These data can be further examined by students who did or did not receive financial assistance such that 78% of those receiving assistance completed a doctoral degree while only 29% of those who did not receive assistance did so.

E. Overall Degree Pursuit Findings

A primary objective of the SMART Program is to facilitate completion of STEM degrees by scholars by providing financial assistance (tuition remission plus a stipend). The annual number of awards offered fluctuates with the SMART budget; however, graduation rates are affected by budgetary changes 2–3 years after those changes are implemented. Since its inception, the SMART Program has supported scholars to attain a total of 2,870 degrees. Although the number of graduates in a given year fluctuated over time, the number of graduates is steadily increasing over the first few years of the program such that the program has supported twice as many scholars attaining bachelor's degrees than master's or doctoral degrees (though the number of scholars receiving an MS or PhD are similar). Additionally, the SMART Program has supported a larger number of RC scholars than RT scholars over the life of the program. Therefore, our analysis shows that yearly fluctuations in SMART's budget have a significant impact on the program's ability to bring in new talent (i.e., RC scholars) for the DoD.

The service commitment lengths associated with SMART awards generally follow the length of time it takes to complete a degree with shorter commitment lengths associated with scholars pursuing BS degrees and longer lengths for scholars pursuing PhDs. As such, most scholars receive awards (and subsequently commitment lengths) for 1–2.5 years. In the most frequently awarded disciplines (chemical engineering, civil engineering, computer science, electrical engineering, industrial and systems engineering, information sciences, mathematics, mechanical engineering, and physics), a majority of scholars pursue and complete BS degrees; however, more than half of scholars pursued MS or PhD degrees in select other disciplines (oceanography, nuclear engineering, material science and engineering, cognitive, neural, and behavioral science, chemistry, and bioscience).

In terms of diversity, the percentage of female scholars completing degrees with support from the SMART Program has increased over the years while the percent of male graduates have decreased in a complementary manner. Further, the percent of scholars completing degrees with support from the SMART Program who identify as minority races/ethnicities has fluctuated. However, Asian American and Hispanic scholars have shown the largest overall increase.

Just as it is important to examine the number of scholars who successfully complete a degree though the SMART Program, it is also important to consider the students who leave the program, whether of their own volition or though administrative dismissal. Although our attrition analysis was limited for the 2014–2017 and 2018–2021 cohorts as many were still completing Phase 2 at the time of data collection, it appears that the attrition rate decreases with each cohort cluster. Further (limited) analysis suggests that scholars who exit the program during Phase 2 do so up to 70% through their service commitments. Analyses also suggest an interesting relationship between discipline and Phase 2 attrition whereby two high-frequency disciplines, computer and computational sciences and computer engineering and civil engineering show divergent attrition rates, with 7.5% and 0%, respectively. Although it appears that the low-frequency disciplines have better Phase 2 retention rates, civil engineering is an anomaly to this finding with no attrition during Phase 2 across the life of the program. Finally, attrition rates seem to be associated with the length of service commitments where PhD-level scholars leave the program at higher rates than BS and MS scholars; the latter with shorter commitment lengths than the former.

Although these findings provide insights into attrition rates during Phase 2, as noted earlier, the analyses are limited by the completeness of the data. For a more thorough analysis, we recommend that the SPO update their record-keeping procedures to identify the exact date and reason for their departure.

4. Hiring and Service Commitment

A. Chapter Organization

After scholars attain their degrees (i.e., after they have completed Phase 1 of the SMART Program), they are hired by SFs that had selected them for a SMART scholarship; this SF is also where the scholar completed their summer internship, if required. Hiring by the SF is the first step in completing the service commitment (or Phase 2) of a SMART award. This chapter highlights outcome data associated with the hiring of SMART scholars by SFs. Specifically, this chapter addresses the following guiding questions:

- To what extent do scholar factors such as degree level and discipline of study affect hiring of scholars by SFs (Phase 2)?
- To what extent does the workforce need of the discipline, relationship between discipline of study and job category at the SFs, and hiring rates by the Service components affect Phase 2 outcomes?

The final section of the chapter covers analyses regarding scholars who left the SMART Program before completing Phase 2. While the previous chapter focused on SMART scholars as they maintained matriculation and earned their intended degrees, the focus of the current chapter is on those scholars who successfully enter Phase 2. The analyses in this section were based on the “Degree Attainment” and “Retention” datasets.

B. Hiring and Service Commitment Outcomes

This chapter reports on SMART Program outcomes that are relevant to scholars starting Phase 2, which is where the scholars work for their SF to satisfy the commitment they took on while receiving the SMART scholarship. There are three main outcomes for SMART that occur during Phase 2:

1. RC scholars are hired into full-time positions by their SFs, representing new talent for the DoD. Since the start of the SMART Program in 2006, there have been 2,235 RC scholars hired into government service (entered Phase 2 by 2022); this group represents the new talent that has come to work for DoD through the SMART Program.
2. RT scholars are already employed by their SF but must now transition from student back to full-time employee for Phase 2. Those 283 RT scholars represent employees that have attained advanced degrees through the SMART Program.

3. For both RC and RT scholars, they must work for their SF for 1 year for each year they received their scholarship to satisfy their service commitment. Of the 1,921 scholars started and were expected to complete Phase 2 by 2022, 96.0% (1,844 Scholars) of them satisfied their commitment.

The following additional variables are relevant to the program for describing the program outcomes:

- *Degree level* – the type of degree (bachelor's, master's, doctoral) that the recently graduated scholar brings to the DoD workforce.
- *Scholar type* – RC scholars become new employees of their SF when they start Phase 2, growing the DoD STEM workforce. RT scholars are already DoD employees so they are not included in the hiring analysis.
- *Discipline/occupation* – with the focus of this section on the scholar working at an SF, their occupation (job title or code) is of particular interest. While there is a strong pairing between degree disciplines and occupations, there is also some analyses to show how strong a relationship that is and how it differs across disciplines.
- *Incompletions* – not all SMART scholars who graduate and start Phase 2 fully satisfy their commitment. The data we analyzed do not provide a clear understanding of why a person may have left the program during Phase 2, but the analysis of the likelihood of particular variables (e.g., discipline, degree level, trends over time, and their length of commitment) provides insight into what may be influencing those to satisfy (or not) their work commitment to their SF.
- *Time* – the analysis in the chapter will include the data over time to show trends throughout the program's life, whether by years or by 4-year cohort groups when analyzing data with relatively low N/group (combining data in 4-year cohorts enables us to still look at trends over time, but increases the N per unit of analysis).

C. Hires New to DoD

Of the two types of scholars in the SMART Program, only RC scholars are hired after their graduation. RT scholars were already government employees prior to applying for a SMART scholarship, and as such, return to their place of employment upon graduation to complete their service commitment. Because RC scholars are officially "hired" by the DoD as part of the SMART award, we will focus the current analysis on them. Since the start of the SMART Program in 2006, there have been 2,235 RC scholars that have entered Phase 2 (i.e., hired into government service). The SMART Program supported a majority of these

RC scholars as they earned their bachelor's degrees (1,202 or 53.8% of RC awardees). One-fourth of SMART scholars earned a master's degree (539 or 24.1% of awardees) while the remainder earned doctoral degrees (494 or 22.1%). Figure 22 shows the number of RC scholars who were hired by their SFs after graduating with their SMART-supported degrees since the start of the program.

There is a considerable fluctuation in the number of scholars hired into the DoD over the life of the program, as shown in Figure 22. The black line shows the SMART Program budget for each year, which also fluctuates, but there is a lag between budget fluctuation and hiring. This is due to the time it takes for a scholar to be awarded the scholarship, attend school to attain their degree, and then be hired. We highlight this to show how budgeting of the program should continue to be considered in a long-term strategy (not just single year) in that the budget expended in a particular year will have its positive influence (new hire) on average about 2 years later. Another aspect of this relationship is that because students are usually funded for more than 1 year, there is a continuing cost for students beyond just the year they are awarded the scholarship. This funding tail leads to an amplified reaction of reducing the number of new scholars that can then enter the program and who may graduate a few years later. For example, the 10% drop in budget in 2012 led to a nearly 40% drop in new hires in 2014.

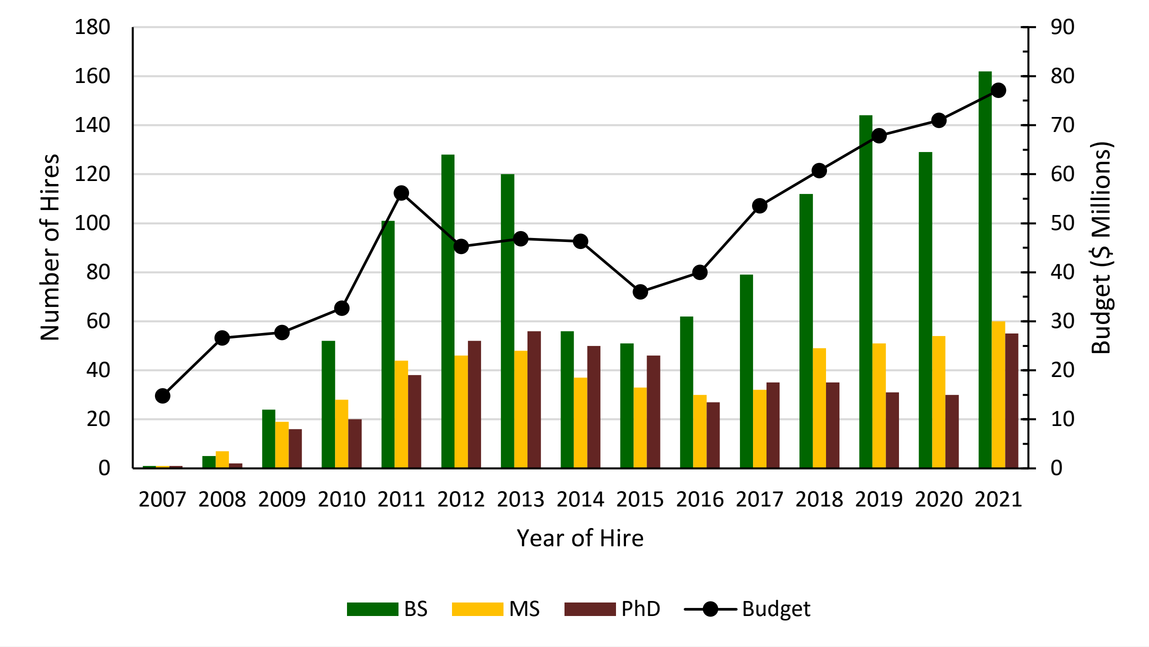

Figure 22. Number of new hires (recruitment scholars only) by degree level from 2007 to 2021.

1. Hiring by Discipline and Degree Level

The STEM workforce generated by SMART can be described by looking at the number of hires with particular discipline degrees and/or by their degree level. The discipline distinction provides insight into the skill sets these new hires bring to the DoD (e.g., skills in engineering, physics, computer science) as expected from particular disciplines. Likewise, the depth of knowledge and skill in a particular discipline can be surmised by the degree level that the scholars attain. Figure 23 shows the total number of RC scholars who were hired by the DoD over the life of SMART, broken down by both discipline and degree level. Over the life of the program, the SFs have had a larger need for bachelor's level scholars with degrees in mechanical engineering, electrical engineering, computer and computational sciences and computer engineering, and civil engineering. These disciplines align with those where the SMART Program receives the greatest number of applications and awards the greatest number of scholarships. On the other end of the spectrum, the SFs' workforce needs for scholars with doctoral degrees has been the greatest in oceanography; materials science and engineering; cognitive, neural, and behavioral sciences; chemistry; and biosciences. This difference in degree level and discipline may be due, in part, to the differences in what is considered a terminal degree for each discipline. For example, in computer and computational science and engineering, graduates with a bachelor's-level terminal degree may be sufficient to meet requirements for employment; however, other disciplines may require that an individual gains advanced laboratory experience though a master's or doctoral degree in order to meet the requirements for employment in that field (e.g., cognitive, neural, and behavioral sciences). In spite of this, many of the disciplines where a PhD is preferred or required by the SFs are also the ones that are associated with the fewest applications and also awards the fewest SMART awards.

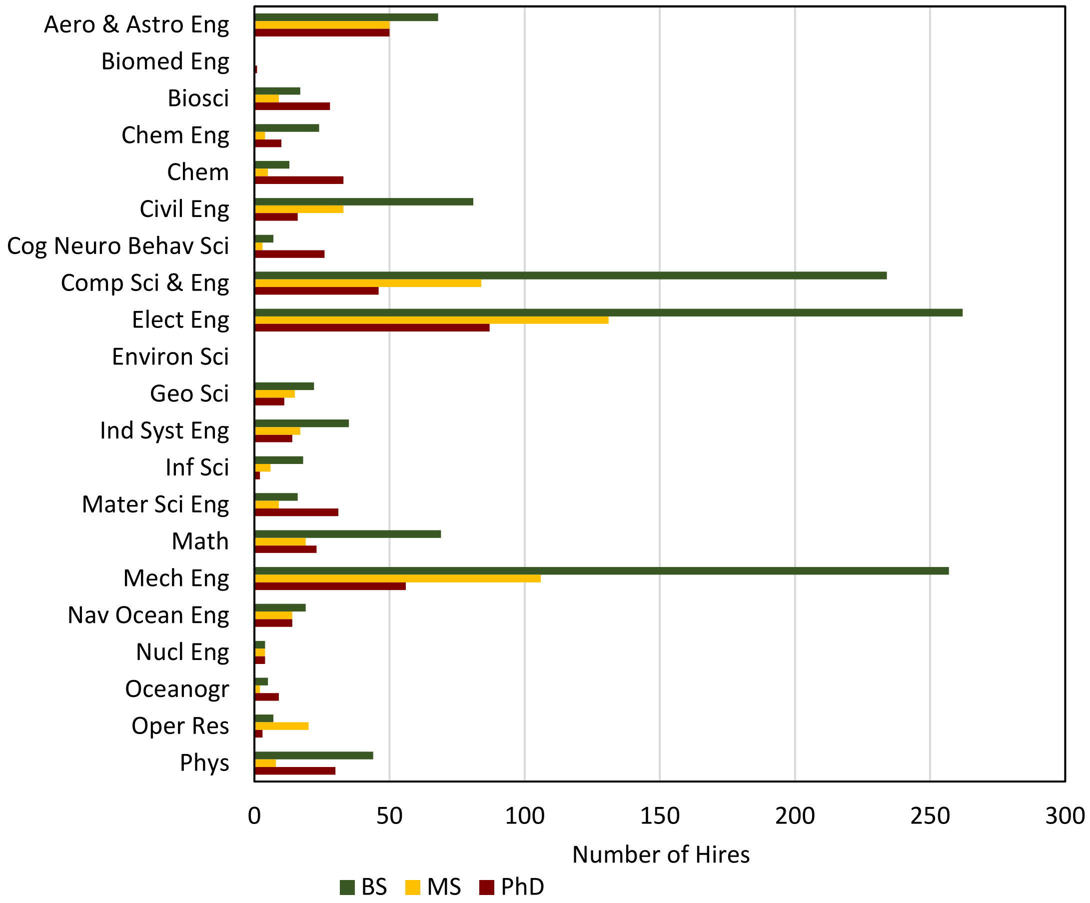

Figure 23. The number of recruitment scholars who were hired into government service after graduating (started Phase 2), organized by disciplines from 2007 to 2021.

The hiring data are further examined by the number of hires (RC scholars who began Phase 2), broken down by discipline and cohort year groups. For data presentation, we divided the disciplines into three groups: those disciplines with relatively few scholars across the entirety of the program (i.e., less than 50 in cohorts 2006–2021), mid-frequency disciplines (i.e., those with between 50–100 scholars), and high-frequency disciplines (i.e., over 100 scholars). Figure 24, Figure 25, and Figure 26 depict the number of RC scholars who were hired by the DoD (i.e., began Phase 2) by low, medium, and high scholar disciplines. It is important to note that these hiring data do not distinguish between either degree level or years of support received from the SMART Program. Further, the data for the 2020 and 2021 cohorts are incomplete in the sense that there are scholars from these cohort years who are still progressing through their degrees and Phase 1, so they are not included in these figures. Thus, the drop in the number of hires for the 2018–2021 cohorts is not a true drop in the total number of hires as these values will increase with the completion of Phase 1 by some in these cohorts.

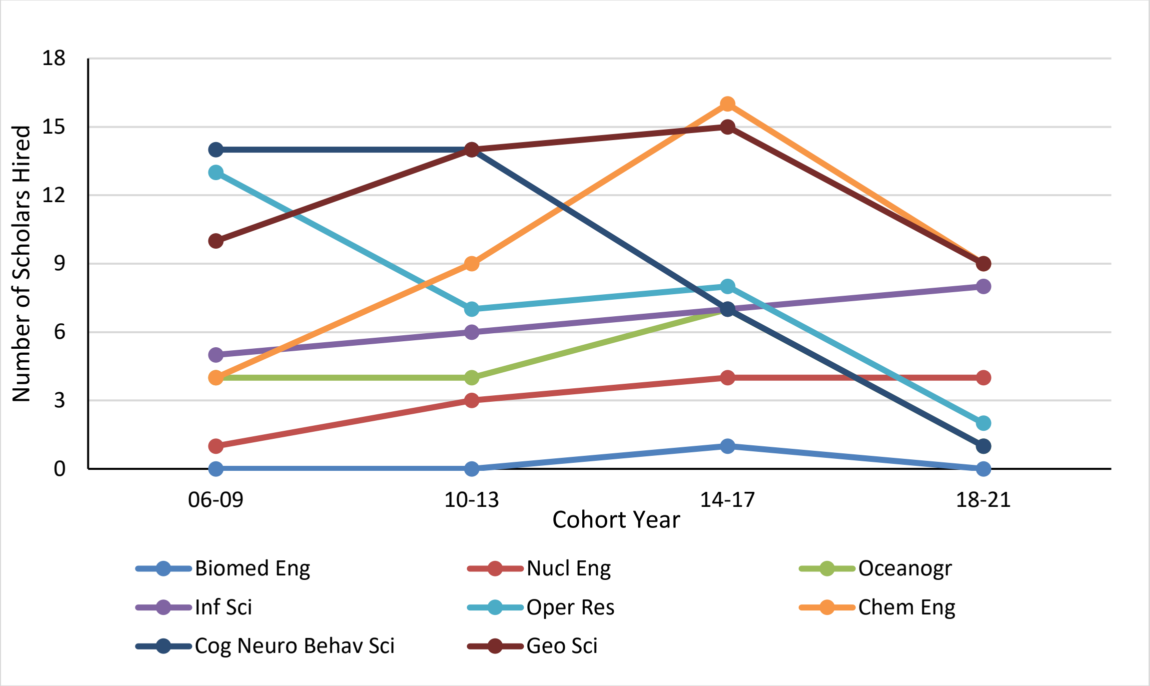

Figure 24. Number of scholars who were hired (entered Phase 2), by discipline. This graph only includes low-frequency disciplines (less than 50 total scholars) and they are grouped by 4-year cohort bins.

The hiring data for scholars with degrees in low-frequency disciplines show some interesting trends. At the beginning of the SMART Program, scholars from the cognitive, neural, and behavioral sciences made up the largest group of hires with 14 from the 2006–2009 cohorts, but the number of hires was cut in half (to 7) in the 2014–2017 cohorts. Likewise, the hiring of scholars with degrees in operations research dropped from 13 from the 2006–2009 cohorts to 8 in the 2014–2017 cohorts. The opposite trend is seen regarding the hiring of scholars with a degree in chemical engineering. Four chemical engineering scholars were hired from the 2006–2009 cohort while the number of chemical engineers hired in the 2014–2017 cohorts quadrupled. The number of hires in the other low-frequency disciplines either increased slightly or remained the same across the cohorts (and years), suggesting a low, but steady need for scholars in these disciplines.

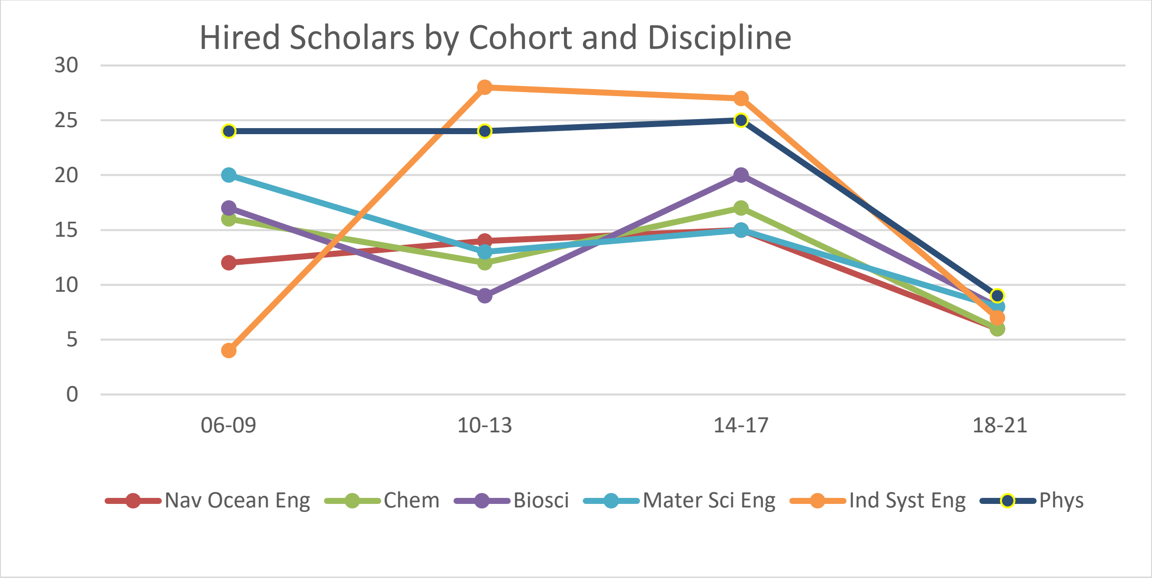

Figure 25. Number of scholars who were hired (entered Phase 2), by discipline. This graph only includes mid-frequency disciplines (50–100 total scholars) and they are grouped by 4-year cohort bins.

In terms of the mid-frequency disciplines, scholars with degrees in physics made up the largest group of hires with 24 from the 2006–2009 cohorts; this number has stayed consistent through the 2014–2017 cohorts (with 25 hires). The hiring of scholars with degrees in many of the other mid-frequency disciplines varied slightly across cohorts (and years) with the hiring of scholars in certain disciplines dropping over a 4-year period and then rising again (e.g., biosciences, chemistry, materials science and engineering). These fluctuations in the hiring of scholars with degrees in mid-frequency disciplines can be understood as a reflection of the SFs' workforce needs—although the SFs (and DoD more broadly) has a consistent need for expertise in these disciplines, the actual need varies from year to year. The largest jump in hiring is seen for scholars with degrees in industrial and systems engineering. Of the 2006–2009 cohort, there were only four hires in this discipline, however, there were 28 hires in the 2010–2013 cohorts and 27 hires in the 2014–2017 cohorts.

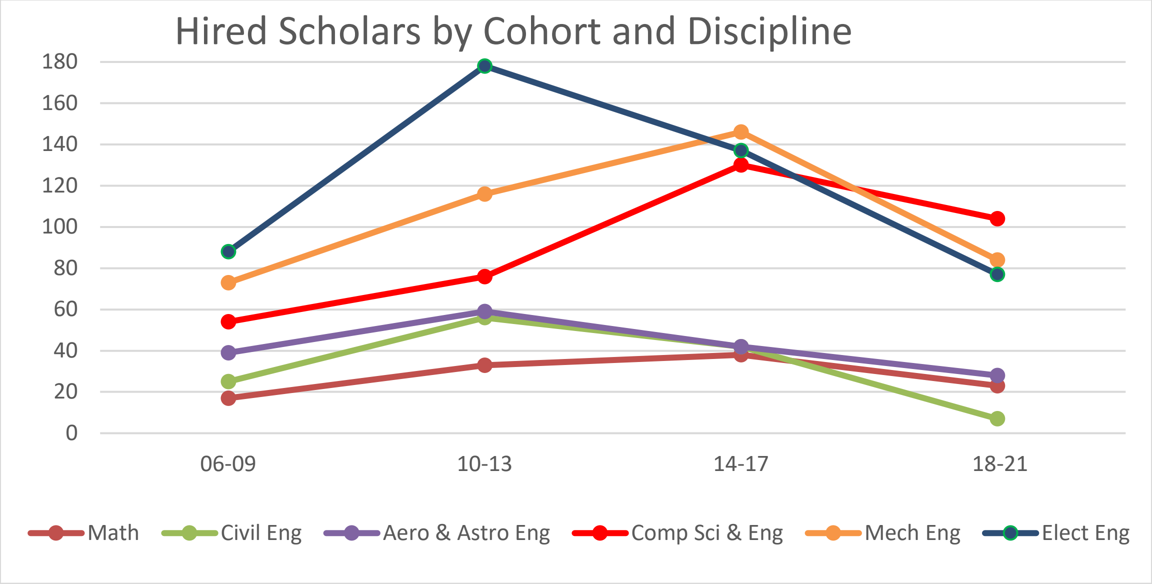

Figure 26. Number of scholars who were hired (entered Phase 2), by discipline. This graph only includes high-frequency disciplines (more than 100 total scholars) and they are grouped by 4-year cohort bins.

Finally, for the high-frequency disciplines, scholars with degrees in electrical engineering made up the largest group of hires with 88 from the 2006–2009 cohorts, but jumped to 178 for the 2010–2013 cohort, and dropped slightly to 138 for the 2014–2017 cohort. Scholars with degrees in mechanical engineering and computer and computational sciences and computer engineering have seen a significant increase in hiring, indicative of the increased need for this expertise at SFs. The remaining disciplines saw a less dramatic increase in hiring across cohort bins with a slight drop in hiring for the 2014–2017 cohort.

2. Disciplines to Jobs

The SMART Program awards students by the discipline, or college major, that they are pursuing, but they are hired into positions at the SFs as needed. For the majority of scholars, the disciplines in which they attained their degree are represented in their job titles. Figure 27 shows the mapping of scholars from the discipline they received their degree on the left-hand column compared to their jobs on the right-had column. For the high-frequency disciplines, such as electrical engineering, mechanical engineering, computer science, aeronautical engineering, and civil engineering, scholars are most likely to enter jobs with titles similar to their discipline name, as indicated by the thick lines from like titles from left to right. However, there are some scholars that go into positions that don’t perfectly align with their discipline name. This appears to be due to the difference in naming conventions between college disciplines and job titles, in that they do not always follow the same naming conventions. Also, the distinctions between disciplines or the distinction between job titles is not definitively clear in that many share skill sets; for example, a mechanical engineer and an aeronautical engineer may take many similar courses in college, have many overlapping skill sets, and may perform many similar job competencies.

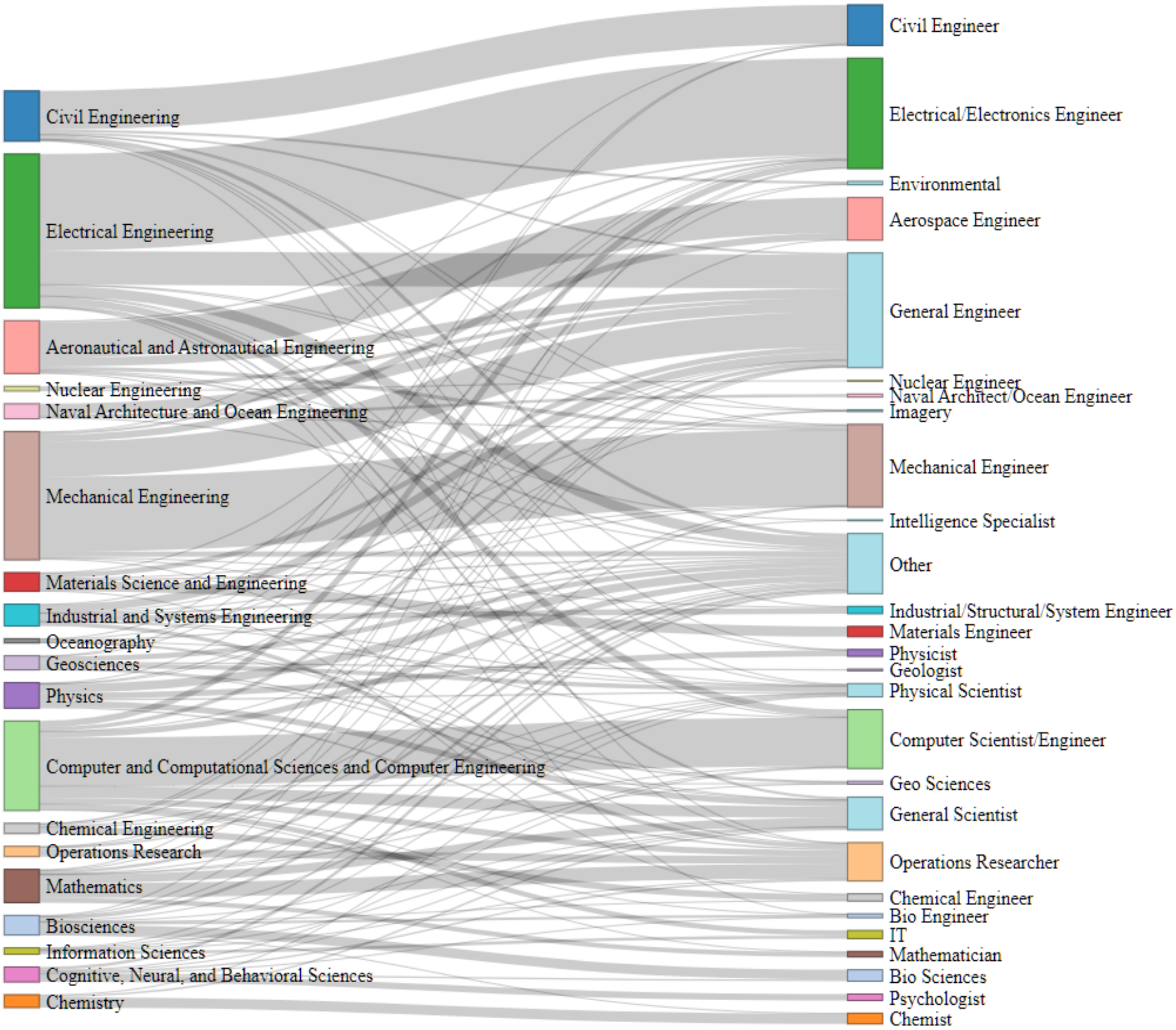

Figure 27. A mapping of scholar disciplines (degree major) on the left to the jobs/occupations the scholars are hired into on the right. The thickness of the lines indicates the number of scholars in a particular discipline who are hired into a particular job category.

3. Hiring by Service Components

Of the 2,235 RC scholars offered employment at an SF from 2006 to 2021, 726 were hired by the Army, 677 by the Navy, 705 by the Air Force, and 127 by Fourth Estate agencies (see Figure 28). To put these numbers into context, the DoD employs approximately 950,000 civilians across 675 occupations (Department of Defense, n.d.). The Army Civilian Corps reports a workforce of over 330,000 civilian employees, the Air

Force Civilian Service has approximately 170,000 employees, and the Navy reports more than 195,000 civilian employees (U.S. Army, n.d.; U.S. Air Force, n.d.; U.S Navy, n.d.). The total workforce at the Services include all occupations, and therefore, include staff across all levels of education and all disciplines not just the 21 STEM disciplines relevant to SMART.

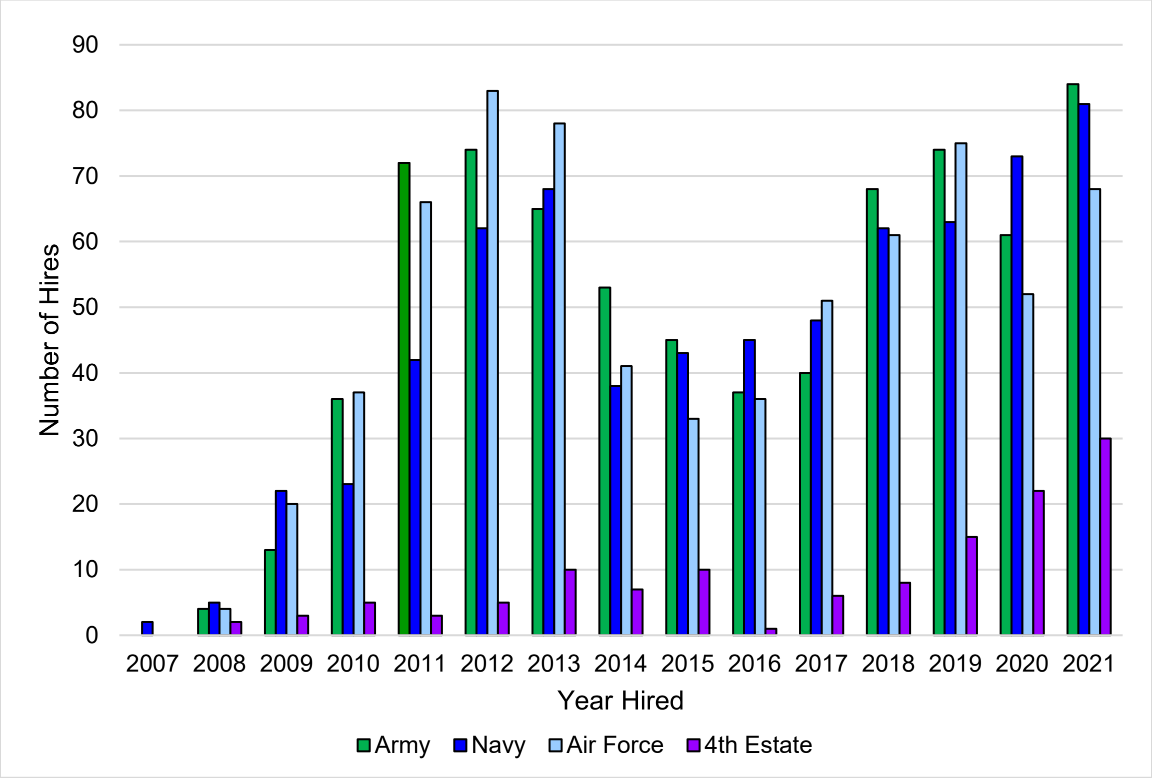

Figure 28. Hiring of scholars starting Phase 2 by Services and Fourth Estate across the life of the SMART Program.

D. Service Commitment Incompletion

Just as it is important to understand retention through the completion of the service commitment (Phase 2) portion of the SMART Program, it is also critical to understand factors associated with scholars who leave the program prior to their completion of Phase 2. Scholars who do not complete their service commitments are required to repay the SPO for their award, thus, the decision to leave the program early is not one that scholars take lightly. This category includes both scholars who left the program of their own volition and of those who were dismissed or fired from their SFs. A challenge we encountered in the SMART data was the lack of consistency in updating scholar information with reasons for the scholar's departure from the program. As such, we were unable to conduct group-level analyses on why scholars were no longer with the program. Instead, the analyses presented in this section were conducted on scholars who left for any reason, producing a total Phase

2 attrition rate. Based on the limited information available, it appears that of the scholars that left the program, more than 75% of the scholars that did so in Phase 2 left at their own accord (i.e., resigned their position and withdrew from the program), therefore, this perspective drives much of the analysis in this section. Note that because award length is equivalent to service commitment and Phase 2 length, all three are used interchangeably in this section.

For each 3-year cohort group (e.g., 2006–2009), the number of scholars who left the program during Phase 2 was compared to the total number of scholars during those cohorts who had at least begun their Phase 2 service commitment as of the creation of the dataset in early 2021.[31] Figure 29 shows how the rates of scholars leaving the program during Phase 2 has changed over time.

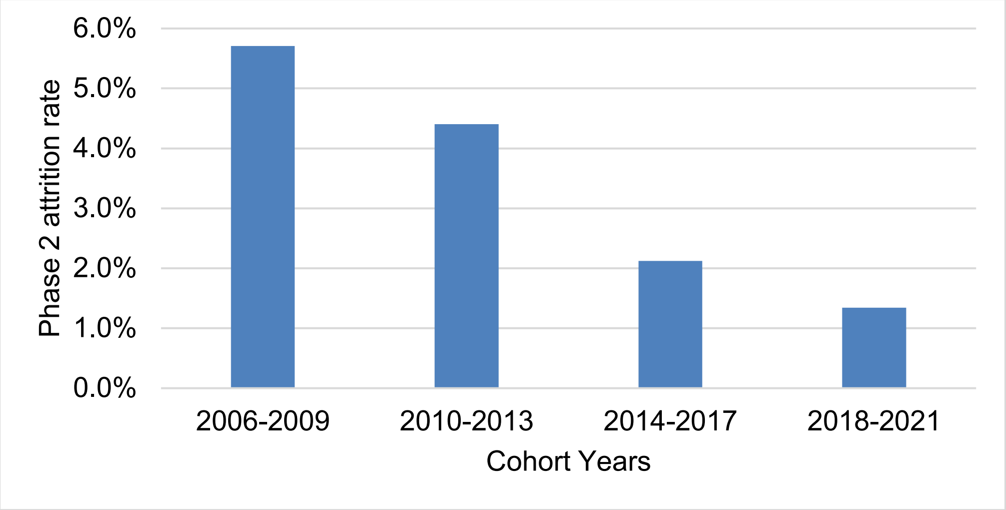

Figure 29. Percentage of scholars leaving program during Phase 2 by cohort. Note: the data for the 2018–2021 cohorts are incomplete in the sense that there are scholars from these cohort years who are still progressing through Phase 2. As such, the attrition rate for these scholars may increase over time.

Scholars from more recent cohorts had a lower attrition rate in Phase 2. This decrease may be due to several factors that the SPO has engaged in with SFs to reduce attrition. For example, the SPO has collaborated with the SFs to improve the quality of information the SFs share about the work that takes place there to allow for potential scholars to make more informed decisions regarding their desired SF placement. The SPO has also supported scholar satisfaction by working with the SFs to improve scholar selection by the SFs based on future workforce needs, again leading to better scholar-SF matches. The SPO has also worked on fostering productive mentoring environments at SFs and has developed opportunities for scholars to explore other opportunities within other command divisions

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[31] An analysis of Phase 1 retention is described in Chapter 3.

and departments as a means to increase retention within the program and though Phase 3 and beyond. Finally, the SPO has worked with the SFs to utilize a variety of authorities to enhance compensation beyond the minimum requirements set by the Office of People Management or specific SF regulations. This effort has led to adjustments in the salaries of Phase 2 scholars to better match the salaries of their non-SMART colleagues. In fact, the SMART 1.0 assessment found that SMART recruitment scholars were hired into civilian service at salaries that were lower than their counterparts in the DoD S&E workforce, leading to the recommendation for the SPO to investigate the starting salary differences and to work with SFs to understand the cause of the salary disparities (Balakrishnan et al. 2018). Another reason for this decrease is anecdotal in nature and is in regards to the DoD not having a mechanism to recoup funds from those who did not satisfy their commitment in their initial years, but then developing a procedure and starting to require repayment.

This analysis, however, does not account for the fact that scholars still in Phase 2 at the time the dataset was created for this analysis may still choose to leave the program before the completion of their service. For example, by early 2021 (when the dataset was created), all scholars from the 2006–2009 cohort had either completed or left during Phase 2, as had 97% of the scholars from 2010 to 2013. However, only 73% of the 2014–2017 scholars and 19% of scholars from 2018–2021 cohorts had completed Phase 2 in early 2021. Therefore, it's likely that the attrition rate of the 2014–2017 and 2018–2021 cohorts will increase, though a simple linear extrapolation suggests the 2014–2017 cohort will still have a lower attrition rate than the previous cohort cluster. The most recent cohort group (2018–2021) had too few scholars in Phase 2 and not enough who had completed that phase to be able to conduct a similar analysis, though it is possible that the attrition rate of this group may come to be higher than the previous groups as a consequence of the COVID-19 pandemic.

To better understand attrition during Phase 2, we conducted an analysis to examine at what point during Phase 2 scholars leave the program. This was done by comparing the "inactive date" of the 86 scholars[32] who did not complete Phase 2 with their phase start and end dates to determine their commitment completion percentage. As shown below in Figure 30, few scholars leave early in their Phase 2 commitment, with the first exit at approximately 9% of the way through the completion of their service commitment. The number of scholars leaving the program during Phase 2, however, rises linearly with the duration of Phase 2, with the plurality of scholars leaving in the last 20% of their commitment.

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[32] As mentioned earlier, not all of the scholar data that IDA received in the data pull had been updated. As such, this analysis was limited to just those 86 scholar datapoints with inactive dates. Scholars who left the program but did not have an inactive date in their data could not be included in this analysis.

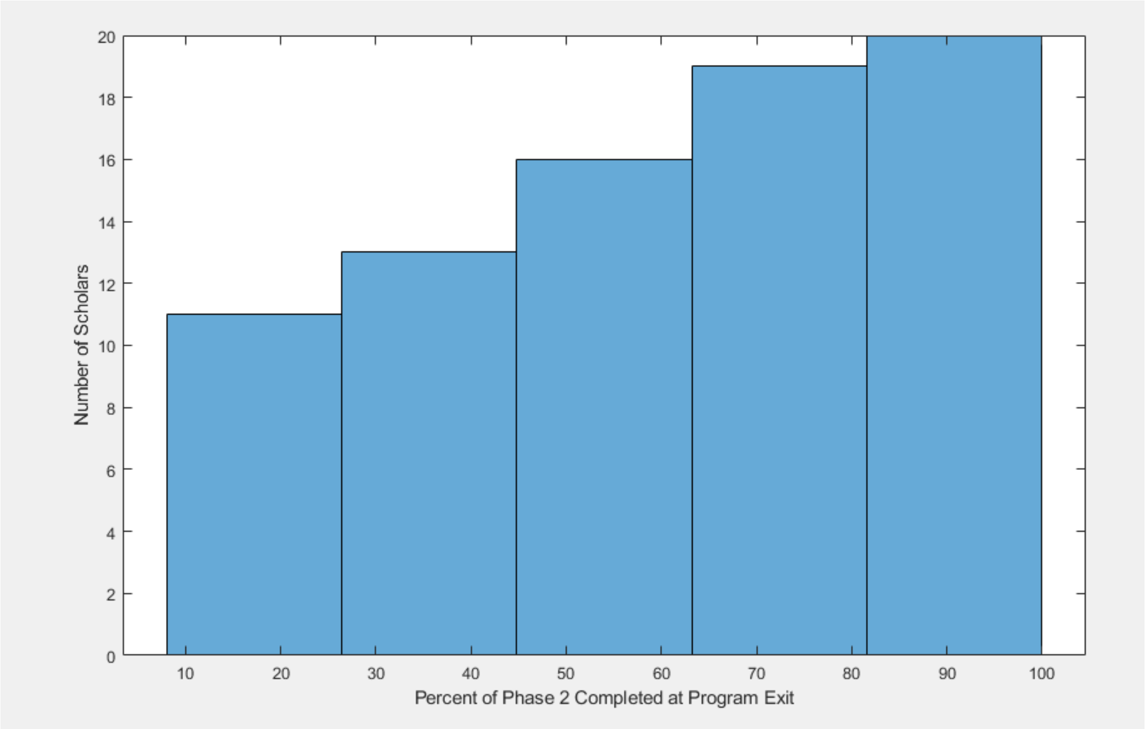

Figure 30. Histogram of Phase 2 attrition timing.

To better understand factors associated with attrition, it is important to examine scholar attrition rate by discipline. These data, shown in Figure 31, includes attrition data by discipline for scholars who left during Phase 2. For most disciplines, the analysis shows a narrow band of Phase 2 attrition, ranging from 1.5% to 4.5%. However, two observations stand out regarding the relationship between discipline and Phase 2 attrition. First, the cluster of seven disciplines with 0% attrition rates is notable. With the exception of civil engineering, each is a low-frequency discipline, with less than 50 scholars who have reached Phase 2 over the lifetime of the SMART Program. The small number of awards in these disciplines do not provide enough data to detect a relationship between discipline and attrition. Civil engineering, however, was a surprising member of this group as it is one of the largest degree fields among SMART scholar awards, but not a single scholar has left the program during Phase 2 for any reason, voluntary or involuntary.

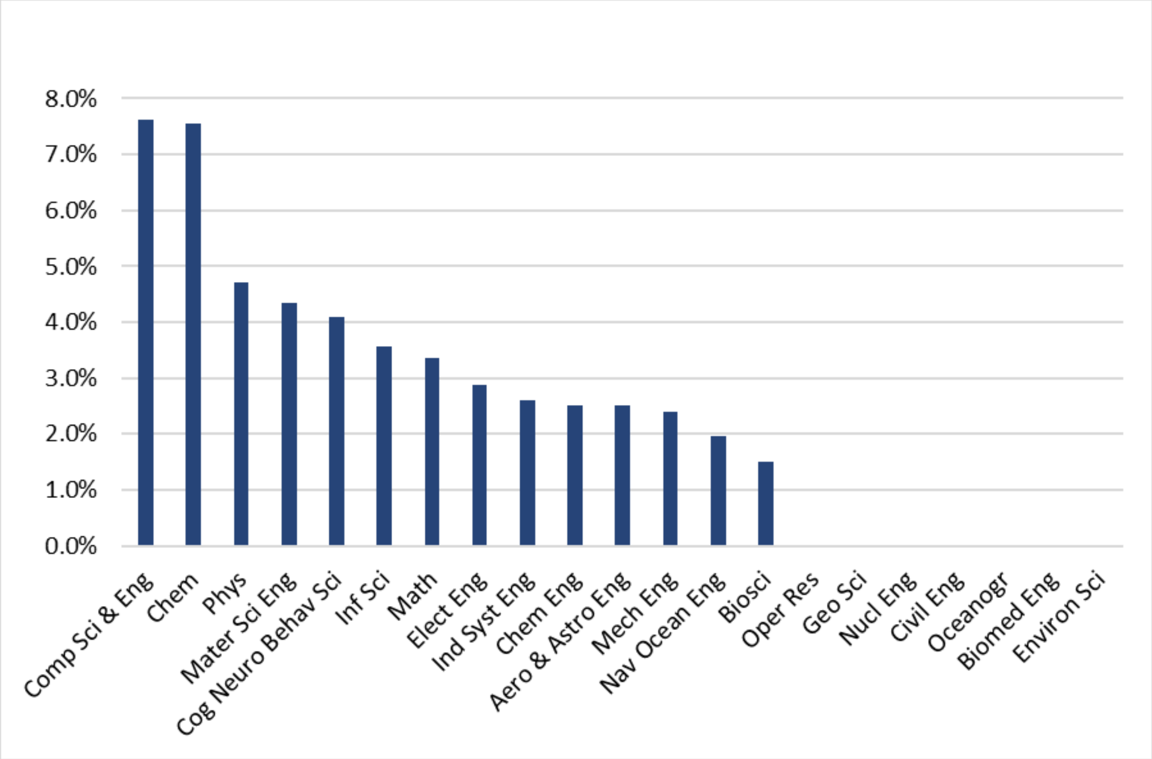

Figure 31. Phase 2 attrition rate by discipline.

The second observation concerns the two disciplines with high attrition rates—computer and computational sciences and computer engineering (a discipline with a high number of scholars) and chemistry (with a middling number of scholars) at 7.5% attrition each. Both of these are higher than the next highest attrition rate discipline and indicate a need to better understand why scholars in these disciplines are leaving the program, whether or not at their own volition. For computer science scholars who voluntarily leave during Phase 2, the rationale for attrition could be rather straightforward as the computer science industry has a very high turnover rate and the potential of a vastly larger salary in the private sector than in government service. For chemists, however, an analogous industry does not exist, though a weaker effect due to the pharmaceutical industry may play a part in this. It is also possible that this high attrition rate could be partially due to the relatively small number of chemists in the program, with only 4 of 53 chemistry scholars leaving the program during Phase 2.

Another aspect of the findings appears when considering what disciplines still have scholars in Phase 2 who may yet choose to leave the program. For most disciplines, 20%–30% of the scholars in that disciplines have yet to complete their Phase 2 commitment, suggesting that the attrition rates will rise some as time goes on. However, the disciplines of civil engineering; cognitive, neural, and behavioral sciences; and operations engineering all had lower numbers of scholars still in Phase 2, at 15%, 12%, and 12%, respectively. This implies the attrition rates for these disciplines are unlikely to grow much compared to their peers, which is especially notable for civil engineering as it is already outstanding from the rest for its lack of attrition. On the other end of this scale were two disciplines with a large number of scholars yet to complete Phase 2: computer and computational sciences and computer engineering and information sciences at 31% and 43%, respectively. Since many of these scholars still have the opportunity to leave the program, it's likely some of them will, which is concerning as these disciplines both already have high attrition rates compared to the SMART Program at large.

A third way to examine the data is to analyze attrition rate by degree type, distinguishing between those scholars pursuing a BS, MS, and a PhD. For this analysis, scholars pursuing multiple degrees were classified as though they were seeking just their highest-level degree.

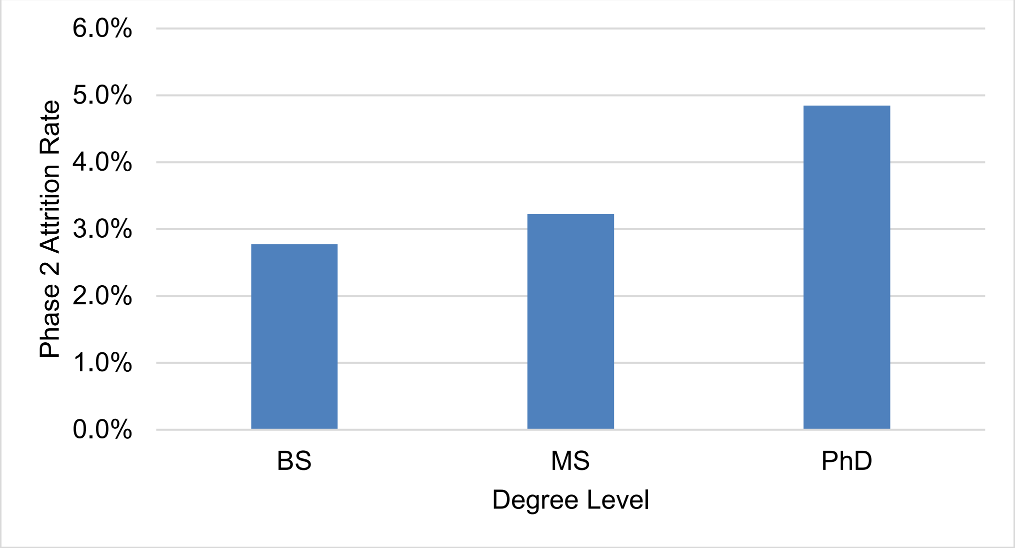

Figure 32. Phase 2 attrition rate by degree level.

Scholars with more advanced degrees are more likely to exit the program prior to completing Phase 2 (see Figure 32). Although the reasons why the scholars left the program were not included in the data, we might infer that the difference between attrition rates for PhD-level scholars and the other degrees is likely due to the longer service commitments for PhD scholars. The data indicate that many PhD-level scholars seek and receive awards for 4 or 5 years, while the BS and MS scholars rarely had service commitments longer than 3 years (see Section 3.C.2 on Service Commitment Length by Degree Level). A clear explanation for the difference between attrition rates for MS and BS scholars does not exist, as the award lengths among those degrees are very similar. Further, when looking at the cohorts who are still completing Phase 2, there are not any meaningful differences between the three degree levels, as all three have about 24% of their scholars still serving their commitment.

The final analysis performed on these data examined attrition rate by Phase 2 commitment length. For simplicity, because not all commitment lengths were of integer or half-integer length, they were rounded to the nearest half year.

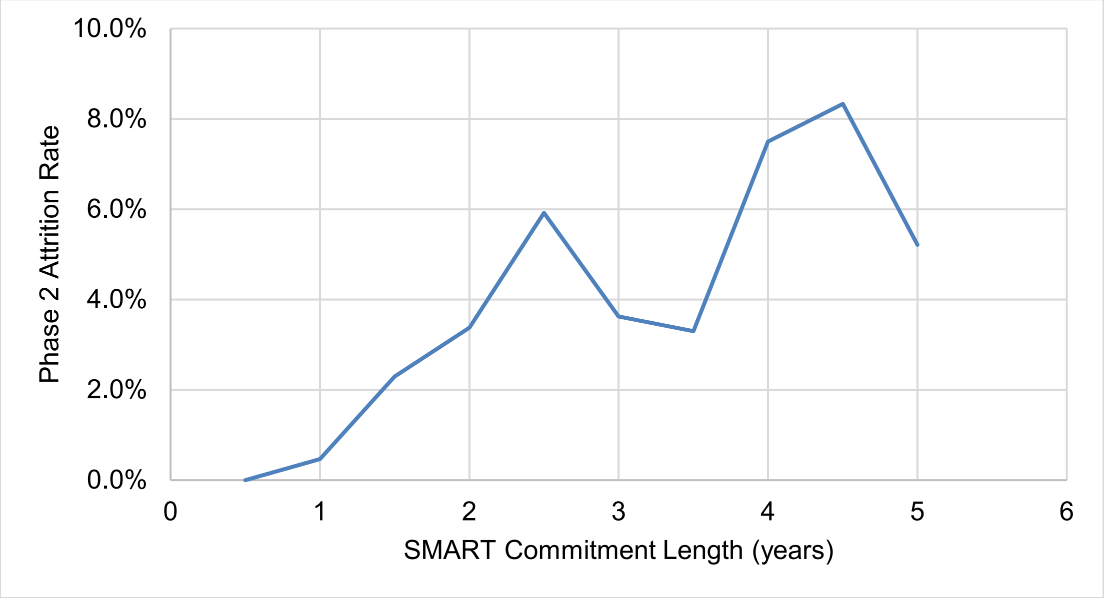

Figure 33. Phase 2 attrition rate by commitment length.

As can be seen in Figure 33, attrition rate increases with longer commitment lengths. With the exception for a large dip for 3- and 3.5-year awards (the reason for which is unclear), the attrition rate increases with commitment length. For scholars who are still completing Phase 2 and still have the opportunity to exit before completing the service commitment, the commitment increases fairly linearly with time, suggesting that the effect of commitment length on attrition rate will become sharper as the outstanding Phase 2 scholars finish the program.

E. Overall Hiring and Commitment Findings

The SMART Program awards scholarships to both RC and RT scholars, however only RC scholars are officially hired after Phase 1 of the program as RT scholars maintain their government employment throughout their time in the SMART Program. Our examination of the hiring data across the life of the SMART Program indicate that more than half of the 2,235 scholars attained bachelor’s degrees through the program, approximately one-fourth used the scholarship to attain a master’s degree, and the remainder pursued doctoral degrees through SMART. These findings are indicative of the SFs’ needs for bachelor’s-level expertise across disciplines. Subsequent analyses of the number of hires with particular discipline degrees and/or by their degree level support the finding that the SFs have had a significant need for bachelors-level scholars, but specifically for those with degrees in mechanical engineering, electrical engineering, computer and computational sciences and computer engineering, and civil engineering. Further, with most disciplines, bachelor's degrees are the most common; however, there are a few disciplines where doctoral degrees are more common (i.e., oceanography; materials science and engineering; cognitive, neural, and behavioral sciences; chemistry; and biosciences).

We examined the hiring data relative to the frequency with which awards were given in each discipline, identifying low-, mid-, and high-frequency disciplines. Certain low-frequency disciplines had a 40%–50% lower rate of hiring from the first 3 years of the SMART Program to the subsequent 3 years (e.g., cognitive, neural, and behavioral sciences and operations research) while the opposite trend was observed for other disciplines (e.g., chemical engineering hiring quadrupled over the same timeframe). Hiring rates for the mid-frequency disciplines varied slightly across cohorts, reflecting the fluctuations in the SFs' workforce needs. Finally, the high-frequency disciplines generally showed strong hiring across cohorts, which can be expected given that scholars with degrees in these disciplines receive the largest number of SMART awards. While scholars with degrees in electrical engineering made up the largest group of hires across the cohorts, scholars with degrees in mechanical engineering and computer and computational sciences and computer engineering showed a significant increase in hiring, indicative of the increased need for this expertise at SFs. Further, scholars in high-frequency disciplines generally enter the DoD workforce during Phase 2 in occupational slots that are named similar to that of the degrees they received. Yet, due to differences in naming conventions, not all scholars enter the DoD workforce in jobs that are similarly titled to their disciplines.

Of the 1,921 scholars that started and were expected to complete Phase 2 by 2022, 96.0% (1,844 Scholars) of them satisfied their commitment. Even though most scholars satisfy their commitment, it is important to understand factors associated with scholars who leave the program prior to their completion of Phase 2, either of their own volition or because they were dismissed or fired from their SFs. In sum, although the attrition analysis was limited for the 2014–2017 and 2018–2021 cohorts as many were still completing Phase 2 at the time of data collection, it appears that the attrition rate decreases with each cohort cluster. Further (limited) analysis suggests that scholars who exit the program during Phase 2 do so partially into up to 70% through their service commitments. Analyses also suggest an intersection between discipline and Phase 2 attrition whereby two high-frequency disciplines, computer and computational sciences and computer engineering and civil engineering, show divergent attrition rates, 7.5% and 0%, respectively. Although it appears that the low-frequency disciplines have better Phase 2 retention rates, civil engineering is an anomaly to this finding with no attrition during Phase 2 across the life of the program. Finally, attrition rates seem to be associated with the length of service commitments where PhD-level scholars leave the program at higher rates than BS and MS scholars; the latter with shorter commitment lengths than the former. Although these findings provide insights into attrition rates during Phase 2, as noted earlier, the analyses are limited by the completeness of the data. We recommend that the SPO update their record-keeping procedures to identify the exact date and reason for program departure.

5. Retention and Post-Service Commitment

A. Chapter Organization

The current chapter describes the outcomes relevant to long-term retention of scholars in the post-service commitment period and addresses the following guiding question:

- To what extent do scholar factors such as degree level, discipline of study, cohort year, and workforce need of the discipline affect post-Phase 2 retention (i.e., Phase 3)?

The chapter includes data of the 2,518 SMART scholars that were hired and/or started Phase 2 from the inception of the program through the start of 2022. The particular analyses described in this chapter include some on the entire set of scholars that started Phase 2 along with other analyses that may focus on a subset, such as the 1,844 scholars that have completed Phase 2, or distinguishing between RC/RT scholars, scholars hired into different pay-systems, or those that earned various STEM degrees. The retention and post-commitment analyses in this section were based on the “Degree Attainment” and “Retention” datasets.

B. Hiring and Service Commitment Outcomes

This chapter reports on SMART Program outcomes that are relevant to retention within the DoD. For the purposes of this report, retention refers to remaining scholars employed by the DoD over time. For the subsequent retention analyses, we relied on a Phase 2 start date of earlier than 2022 as the primary inclusion criterion for our retention data, resulting in the analysis of data from 2,518 scholars. Of those scholars:

- 1,279 were “retained” (completed Phase 2 service commitment and still employed in the DoD as of February 2022)
- 590 were “progressing” in the program (still completing their service commitment)
- 53 had received a follow-on scholarship and were still with the program
- 510 had separated (left after service commitment was satisfied) from the DoD
- 60 withdrew (left during service commitment) from the program
- 26 were dismissed from the program (note: there were indications in the data that some of the dismissals may have actually been withdrawals)

As a point of clarification to who was excluded from the retention analysis, there were 1,265 scholars that did not start Phase 2 by 2022 who were not part of the retention analysis. Of the 1,265 excluded from this analysis:

- 877 were still in school pursuing their degree (i.e., participating in Phase 1 at the time the data were collected)
- 51 received a follow-on award and had not started Phase 2 yet
- 145 withdrew from the program prior to starting Phase 2
- 131 were dismissed from the program
- 43 labeled as "transition" (the meaning of this label was not clear, but none of these scholars have data that would indicate that they were hired), all within the 2017–2020 cohorts
- 14 took a leave of absence, all of who were not expected to have started Phase 2 yet
- 4 were suspended from the program

An additional lens for assessing SMART is through the retention of scholars that have completed Phase 2. There have been a total of 1,844 scholars across the life of the program that completed Phase 2 before 2022. Of those scholars, 1,334 are still in service as of 2022 indicating an overall retention rate of 72.3% of scholars that could leave at any time without incurring a penalty. This is the standard metric for overall retention rate that the SMART Program uses to describe the program's retention, and provides a clear description of long-term retention of SMART scholars.

Retention as a metric is defined by timeframe, with the retention period indicating the extent of the retention. For example, in the analyses to follow we will describe different retention periods to provide a more nuanced look at retention and factors that might influence retention. The retention outcomes are analyzed through a few different lenses to provide a deeper understanding of what might influence or correlate with retention as well as to provide additional context. In this chapter, the outcome of retention is analyzed by groups of cohorts based on their cohort year, the degree level they attained through SMART, whether they were an RC or RT scholar, the pay scale they entered into service through (i.e., general schedule [GS] level and pay banding), distance between university and SF, discipline, and commitment length. Additionally, we provide a comparison of retention rates between SMART scholars in recent years to an overall average of DoD S&T hires during that same period.

C. SMART Program Retention

One of the important outcomes of SMART to the DoD is the accumulated impact of the continued work of the SMART scholars after they are hired by their SF.[33] This chapter describes the retention outcomes from those who graduated and were hired by the DoD through completion of the service commitment (end of Phase 2) and then continued to work beyond their commitment requirement. Upon completion of Phase 2, SMART scholars can opt to remain employed at their SFs or at another location within the DoD, or choose another non-Federal employment option. The following analyses provides outcome data that show the amount of time SMART scholars are being retained as members of the DoD workforce.

The analyses include breaking down the retention of scholars with respect to the type of SMART scholar (RT or RC), degree level, pay scales (i.e., GS or pay banding), disciplines, commitment length, and distance between university and SF for the SMART scholars by the cohort year. Additionally, we provide contextual information regarding the retention of civilian employees within the DoD's S&E enterprise.

We note that due to data limitations the focus of this chapter is on those scholars who start Phase 2, in that the data element is used as an indication that they were hired by their SF if they were an RC scholar and returned to full-time employment if an RT scholar. As such, although analyzing data regarding scholar withdrawals, dismissals, or separations from the SMART Program during Phase 2 and Phase 3 could be very informative to the SPO, data regarding the timeliness of scholars leaving service are not consistently tracked in current SPO databases. For example, data regarding when in Phase 2 or Phase 3 a scholar leaves the program were not available in the data set we analyzed, as their program exit dates are not consistently recorded. Exit interviews for scholars who leave DoD service during Phase 3 take place with the SF and not with the SPO, therefore the SPO may have little insight into the information collected during such exit interviews. We recommend comprehensive data collection regarding the exit of scholars during Phase 2 as these exit interviews could be conducted by the SPO and may provide insights into retention, or lack thereof. Additionally, the SPO may be able to partner with the SFs to collect data at exit interviews during Phase 3 to gather insights regarding the role of the SMART Program in longer-term retention for the DoD.

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[33] Most scholars are RC scholars, so the beginning of their commitment in Phase 2 coincides with them being hired into the DoD as full-time employees. For RT scholars, however, the beginning of Phase 2 is when they return to the SF's workforce after graduation. Therefore, to be consistent in the analysis of both RT and RC scholars, the start of Phase 2 is used as the "hired" date for calculating long-term retention.

1. Longer-Term Retention Overview

There were 2,518 scholars (both RC and RT) who started Phase 2 before 2022, indicating that they were hired by the DoD. Of those, 1,922 are still retained, progressing, or continuing with a follow-on award, for an overall percentage of 76.3% still with the DoD (Phase 2 or Phase 3). If we were to restrict this to just the 1,789 scholars who satisfied their commitment and entered Phase 3, there are 1,271 scholars who are still working for the DoD for a post-commitment retention rate of 72.1%. Those two retention rates (76.3% and 72.1%) include both people from early cohorts and from more recent cohorts, and can be used as general benchmarks. However, retention is timespan dependent, so to provide a more nuanced analysis of retention we also organized the data by cohorts to differentiate the retention rates of those who came in early cohorts from those in later cohorts. Figure 34 shows the retention data (scholars who graduated, were hired by the DoD, and are still working for the DoD as of 2022) from each cohort year by degree level. To include scholars from relatively recent cohorts (i.e., last 2–3 years) in this analysis, the data include a mix of both Phase 2 and 3 scholars who are still employed as of January 2022. For earlier cohorts from the first 10 or more years of the program, the data represent those who completed Phase 2 and are well into Phase 3, with some who were past their 10-year post Phase 2 period where they were asked to continue providing annual updates on status.

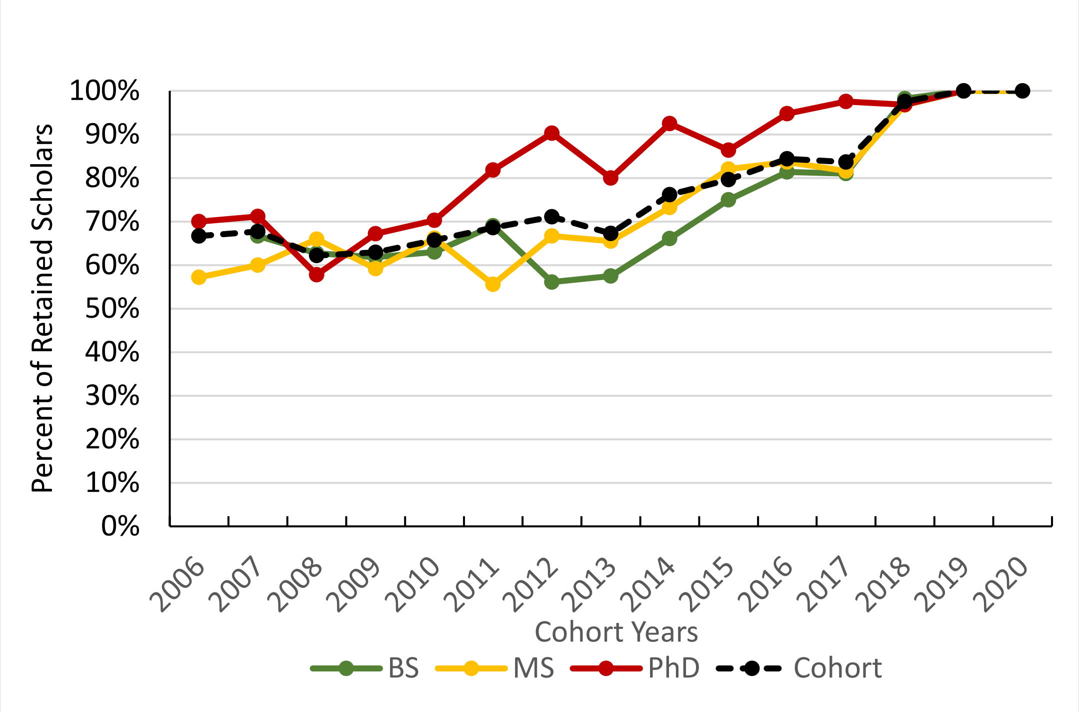

Figure 34. Scholars who were retained by the DoD. The colored lines indicate percentages of scholars by degree level who started the SMART Program in particular cohort years and who were hired by the DoD (i.e., started Phase 2) and were still working for the DoD as of 2022. The black dotted line indicates the percentage of scholars from the full cohort that were still working for the DoD as of the beginning of 2022.

The overall percentage of scholars (i.e., all degree levels) that are still with the DoD from the earliest cohorts (2006–2009) range from 62%–68%, even though those cohorts were well over 10 years ago and have long since finished their service commitment. Similarly, in the next cohort grouping (2010–2013), the overall retention rate of those hired ranged from 66%–71%. Then, as we look at more recent cohort groups (2014–2017), the retention rate is higher, ranging from 76%–84%. For the most recent cohort group (those who entered the program between 2018 to now), the retention rate is very high, ranging from 98%–100%. It makes sense that the retention rate of more recent cohorts is higher than earlier cohorts in that the earlier cohorts have more years since they were hired to have potentially left. One interesting point from these data is that the retention rate has declined from 2018 back to about 2014, but then more or less levels out in the 60%-70% range for earlier cohorts. This suggests that if scholars stay for about 7–8 or more years, they are very likely to remain in service; and this appears to be the case for all degree levels. Another point of note is the relatively higher retention rate for PhD scholars since the 2011 cohorts; this may be influenced by the longer time that PhD students on average may receive SMART to complete their degree that then turns into a longer service commitment.

2. Recruitment and Retention Scholars

The SMART scholarship is primarily used to recruit STEM personnel into the DoD (i.e., RCs), but the SMART Program is also used to support existing DoD employees (i.e., RTs) when they receive the award. Those RT scholars are technically not hired at the time they enter Phase 2, in that they have already been hired prior to receiving the award. However, we can compare the longer-term retention of both RC and RT scholars by using the Phase 2 start date, which is equivalent for all scholars in that that point is where they begin to satisfy their commitment to the DoD. Figure 35 shows data of both RC scholars and RT scholars grouped by cohort years. The bars indicate the number of scholars from a cohort year who were hired and are still working for the DoD (i.e., retained) as of January 2022. The lines indicate the retention percentage of RC and RT scholars from particular cohort years. Over the life of the program, 85% of RT scholars have been retained and 75% of RC scholars retained. For most cohort years, the percentage of those retained is higher for RT scholars versus RC scholars, though both are fairly high. The low data point for RT scholars from the 2006 cohort represent just a few scholars with only four RT scholars as part of that cohort and only one remains. The relatively lower bars for 2019 and 2020 are due to there being only a few scholars from those cohorts who have graduated and started Phase 2 by January 2022; most of the scholars from those most recent cohorts are still in Phase 1 pursuing their degrees.

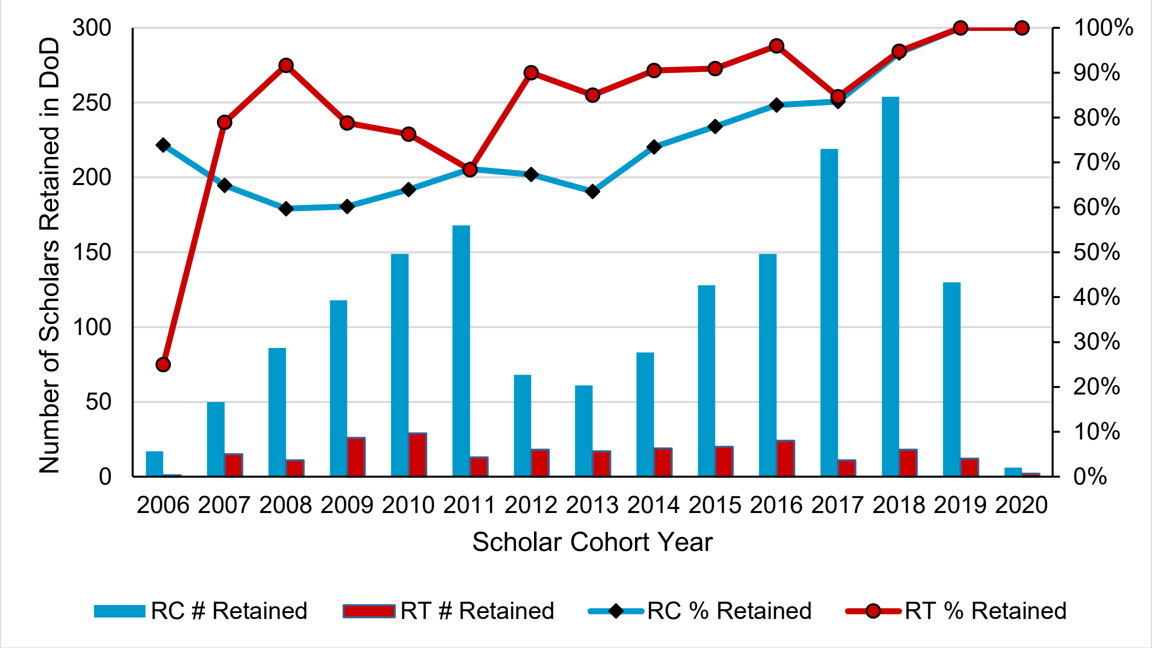

Figure 35. Data for retention (RT) and recruit (RC) scholars by cohort years. The bars indicate the number of scholars from a cohort year who were hired and are still working for the DoD (i.e., retained) as of January 2022. The lines indicate the retention percentage of RC and RT scholars from cohort years.

The finding that the RT scholars (85%) were more likely to be retained than the RC scholars (75%) is consistent with what we found in SMART 1.0. This indicates that SMART is an effective retention tool for those who are already in service as DoD civilian personnel. Also, those scholars that were military veterans (i.e., a total of 97 scholars claimed military veteran status) were retained at a rate of 83% over the life of the program. Taken together, this appears as though the scholars that have already been a part of the DoD are more likely to be retained versus those scholars that are new to the DoD.

3. Retention by GS-Status

One of the findings reported in SMART 1.0 was that some scholars were being hired at GS-levels below what would be expected based on a person’s degree level (i.e., underemployment), and that this might cause some scholars to leave DoD employment (Balakrishnan et al. 2018). For individuals hired into the GS pay scale system, a person who just earned a BS would be expected to start at least at a GS-7, a person who recently earned an MS at GS-9, and a recent PhD at a GS-11. IDA compared retention rates of those hired through the GS schedule, differentiating GS hires into three groups: those hired below expected GS level (i.e. BS hired at GS-6 or lower, MS hired at GS-8 or lower, or a PhD hired at GS-10 or lower), those hired at their expected GS level, and those hired above the expected GS level (i.e., BS hired at GS-8 or higher, MS hired at GS-10 or higher, or a PhD hired at GS-13 or higher), along with those not hired through the GS system (e.g., hired through a pay banding system). Across all years, there were 744 scholars hired through the GS system and 1,773 scholars who were not hired through the GS system.

The findings shown in Figure 36 indicate that the retention rates for those hired above their expected GS level (purple line) were more likely to be retained than those hired at their expected GS level (green line), 71% versus 59%. The data for those hired below their expected GS level (red line) were highly variable and represent only 10 scholars across the 2006–2017 cohort years and none in the 2018–2021 cohort years.

There has also been some variation in the likelihood of scholars being hired into the GS system versus another pay system like the Science and Technology Reinvention Laboratory (STRL) Lab Demo scales that are available to many of the SMART SFs.[34] As shown in Figure 36, for those hired outside of the GS system (blue line) the retention rate (81% across all cohort groups) was mostly higher than those hired through the GS system (red, purple, and green lines) with a retention rate of 65% across all cohort groups. For those hired at a rate above what was expected in the GS system (purple line), the overall retention rate was 71% (retained 247 scholars out of 347 hired). For those hired at the expected GS rate (green line), the overall retention rate was 59% (retained 230 scholars out of 387 hired). There were very few hired at rate below what was expected in GS system (red line), and that retention rate was 70% (retained 7 scholars out of 10 hired); the erratic trend for this line may be based on the low number of cases.

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[34] The GS system is the standard classification and pay system for Federal employees. It consists of 15 grades (1–15) with 10 steps within each grade (https://www.opm.gov/policy-data-oversight/pay-leave/pay-systems/general-schedule/). With the 10 steps in each grade, the pay scales for some grades overlap with adjacent grades. The STRL Lab Demo system is an alternative classification and pay system within the DoD designed for more flexibility to manage its S&T personnel at designated laboratories and facilities.

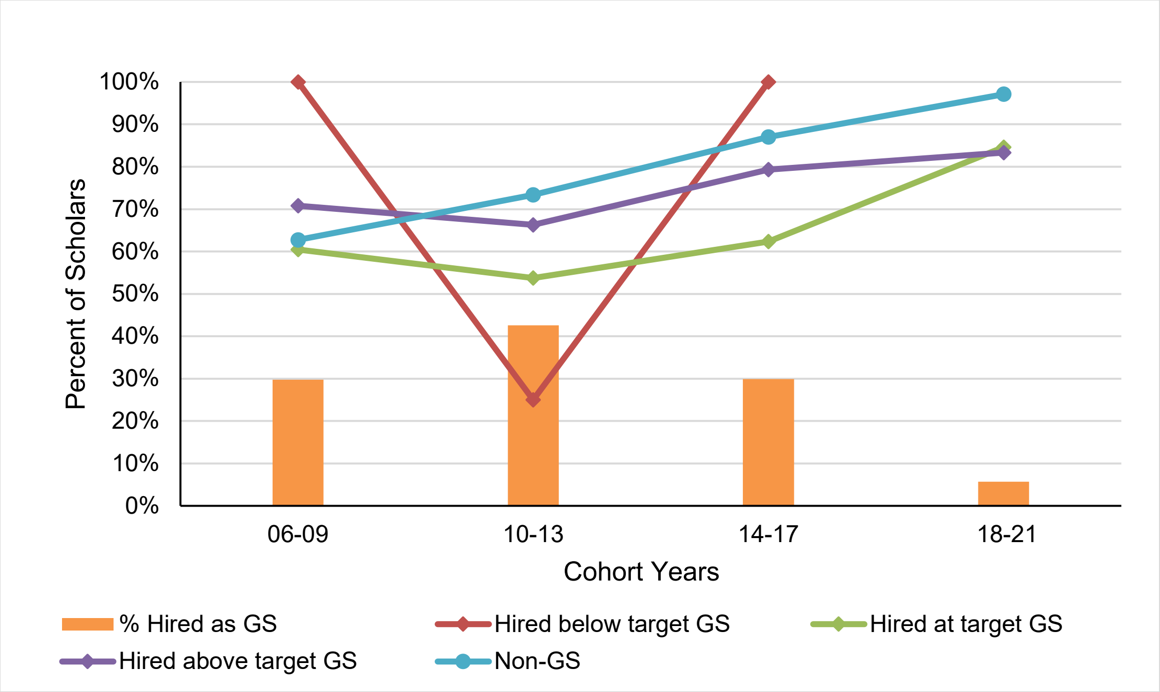

Figure 36. The percentage of scholars who were retained across 4-year grouped cohort bins and hired as GS civilians, indicated by the orange bars. The different GS-status levels are indicated by the lines and represent the percent of SMART scholars in a given GS status who are still employed in 2022.

The orange bars in Figure 36 represent the percent of scholars who were hired into the GS system, with the percentage ranging from approximately 30% in the 2006–2009 cohorts to 43% in the 2010–2013 cohort, and then back down to 30% in the 2014–2017 cohort, before dropping precipitously to 6% for the 2018–2021 cohorts. This suggests an increasing trend that SF that are participating in SMART are more likely to be able to take advantage of non-GS pay scale flexibilities.

SMART 1.0 did not have quantitative analysis on retention and pay scale factors, so this is a new analysis of a factor that may influence retention. However, SMART 1.0 did allude to such an influence based on anecdotal evidence. In SMART 1.0, a reason stated for some scholars leaving was because they said they were hired at a lower than expected GS level than if they had the same degree but had not received the scholarship; though in our analysis we could only identify this occurring 10 times between 2006–2017. Based on those findings, the SMART Program Office made clear statements to the SFs that the practice of hiring scholars at lower than expected levels would not be tolerated. Based on the 2018–2021 cohort, it appears as no SF hired any scholar at a GS level below what would be expected. This analysis also suggests that the pay rate or pay scale at which a scholar is hired may have some influence in retention, though there may be additional influences on retention as well.

4. S&E Civilian Retention

For context on relative retention rates, we can use DoD STEM professionals as a benchmark of what would be expected with regards to retention for those who were hired into similar positions to the SMART scholars. Based on the data available from DMDC, reliable hire and retention data could only be assessed back to those who were hired in 2016–2021. The DMDC data include people hired with BS, MS, or PhD degrees who were hired into positions that were similar to positions that SMART scholars were hired into (see Chapter 4 on hiring to see the range of occupations occupied by SMART scholars). As shown in Figure 37, across the years, SMART scholars were consistently a little more or equally likely to still be retained (i.e., employed by the DoD in early 2022).

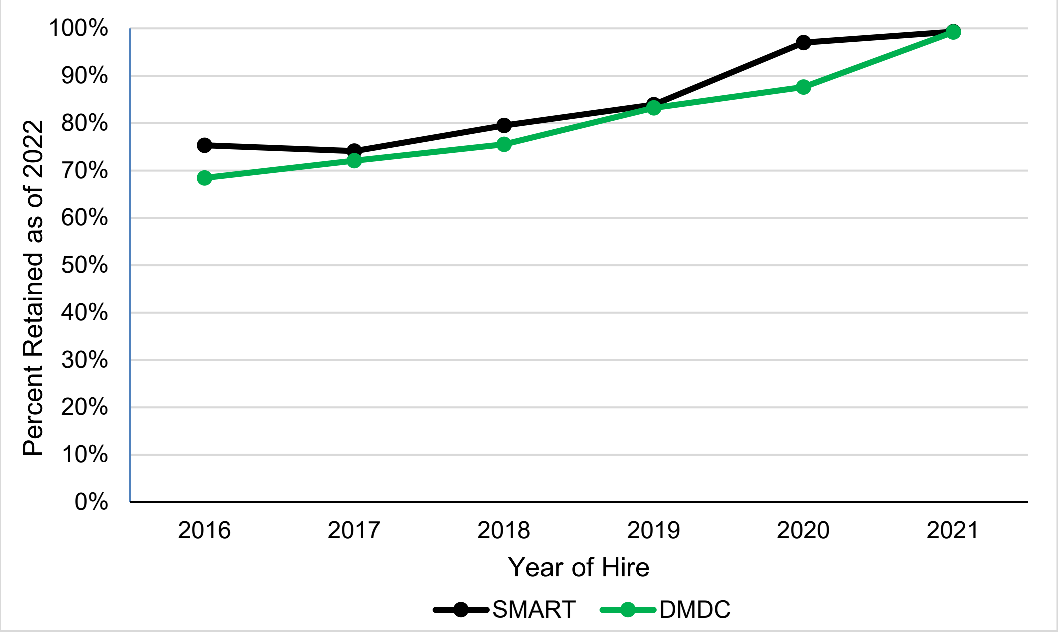

Figure 37. The percentage of SMART scholars and DoD STEM workforce hired into similar STEM occupations. The data points indicate the percentage of people hired in a given year who were still employed by the DoD at the beginning of 2022. The black line indicates the retention rates for the SMART scholars and the green line for the DoD STEM comparison group.

This finding that SMART scholars may be more likely to stay in DoD employment versus standard DoD STEM hires is a departure from the findings of SMART 1.0. In SMART 1.0, overall, the DMDC comparison group was more likely to be retained than the SMART scholars. There are some considerable differences in the analyses between SMART 1.0 and SMART 2.0. First, SMART 2.0 includes a new set of scholars and DoD STEM professionals hired since 2016, while SMART 1.0 analyzed data from prior to 2016. In SMART 1.0, IDA was able to conduct a propensity matching process that associated individual SMART scholars with very similar DoD STEM professionals hired by the same organization at the same time in similar positions. In SMART 2.0, we were not able to propensity match SMART scholars with DoD professionals because of data access limitations. Since the SMART 1.0 evaluation, the SPO has also implemented changes, such as a requirement that SMART scholars must be hired at least at the GS level expected for someone at a particular degree level. Our analyses show that the SFs have adhered to this rule such that there were no instances of scholars being hired below their expected GS level in the 2018–2021 cohort. There may also be a shift in some additional factors addressed in the SMART selection process, like geographical distance between university and SF locations.

5. Retention and Distance

The SMART Program recruits applicants from all over the country and the DoD SFs are also located across the country. Some scholars may move across the country for their new position while others may not have to leave their standard commuting area to take their position at their SF. Figure 38 shows scholar data of the distance between their university and their SF. In cohort years 2006–2009, the median distance for scholars who left during Phase 3 (not retained to 2022) was 649 miles while those that were retained had a median distance of 424 miles; for the 2010–2013 cohorts, those that left had a median distance of 339 miles while those retained had a median of 284 miles; for the 2014–2017 cohorts, those that left had a median distance of 361miles while those retained had a median of 236 miles; for the 2018–2021 cohorts those that left had a median distance of 248 miles while those retained had a median of 258 miles.

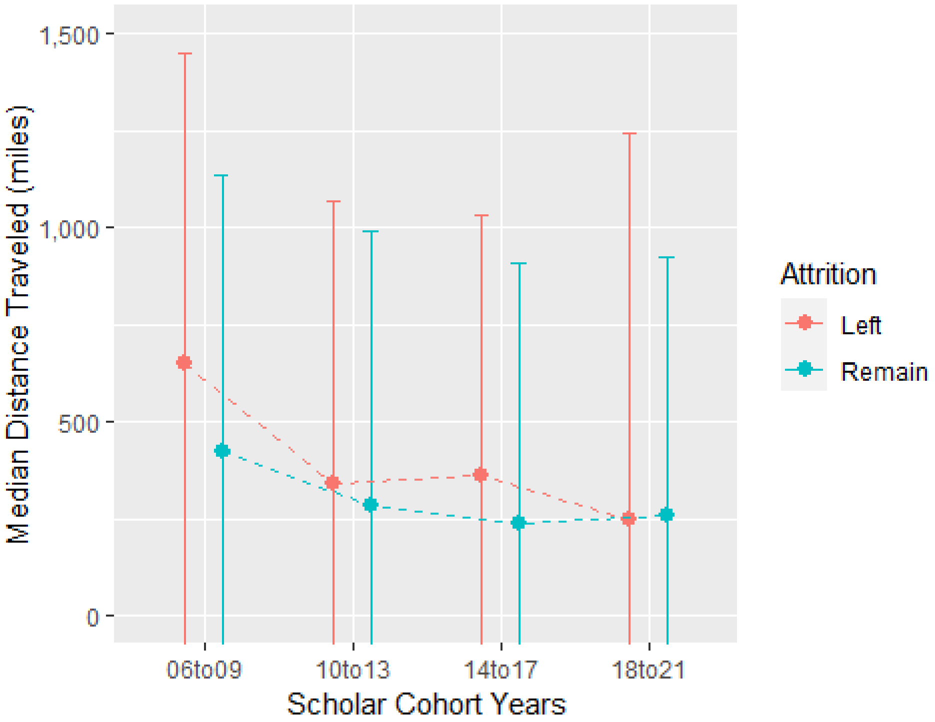

Figure 38. The distance from a scholar's university to their SF. Each dot represents the median distance traveled for that group, while bars show the range of +1 and -1 standard deviation. For each group, one standard deviation below the median falls into the negative and so for the purposes of this figure the bottom is cut off. The red lines indicate those scholars from the cohort year groups that were not retained until 2022 and the blue lines indicate those who were still employed (retained) as of January 2022. Note that the most recent cohort has had less time to attrit (leave).

There are two trends noted in the distance data. First, across cohort years, the distance between university and SF decreased for both scholars that were and were not retained, as shown by the downward slope of the blue and red dotted lines, indicating that scholars selected were more likely to be closer to the SF in more recent years. Additionally, the difference between the median distances for the scholars that have remained versus left has decreased over cohort years as well. These trends suggest that as distance between SF and a scholar's university location increases, this distance potentially influences one's decision to stay or leave the DoD workforce. However, as the distance traveled approximates 250 miles, the influence of distance seems to lessen. This can be seen in Figure 38 where the median distance traveled for those who left or stay in the DoD are essentially the same. There has been a U.S. trend towards not migrating as far from home for a job (Molloy, Smith, and Wozniak 2017), and this may be just be a further indication of this phenomenon.

These findings are consistent with the SMART 1.0 survey results that showed that one of the main reasons scholars left the DoD/SFs was that they "wanted to be closer to family or friends." For the current analysis, we only had access to the locations of scholars' universities (not friends and family) and the SFs, which were used to derive a distance measure. While the distance between university and SF and friends/family and SF might not be the same, the end result remained consistent: the distance between the SF and the place where scholars had an established relationship (family/friends or university) was related with the likelihood that they would be retained by the DoD beyond the service commitment.

6. Retention by Discipline

The retention rate across disciplines differs, with scholars in some disciplines being more likely to stay or leave versus other disciplines. For data presentation, we divided the disciplines into three groups: low-frequency are disciplines with relatively few scholars across the entirety of the program (i.e., less than 50 in cohorts 2006–2021), mid-frequency disciplines (i.e., those with between 50–100 scholars), and high-frequency disciplines (i.e., over 100 scholars). Figure 39, Figure 40, and Figure 41 depict the percentage of scholars who were retained by the DoD by low, medium, and high scholar disciplines. The groupings of low/medium/high frequency discipline in these graphs are the same as was used in Chapter 4 on hiring.

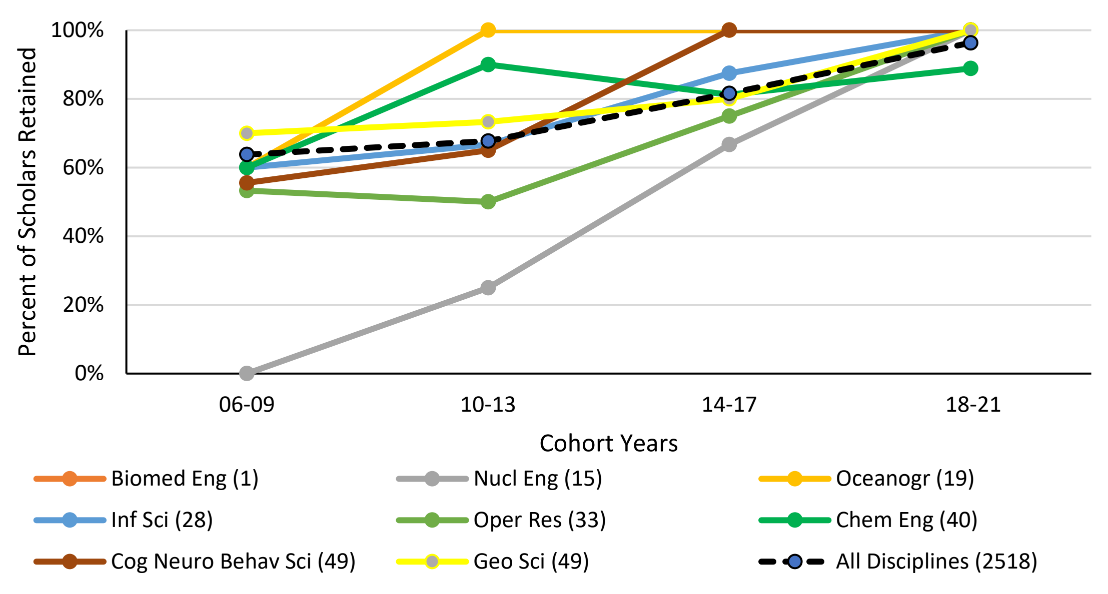

Figure 39. Retention percentages for scholars who were hired (entered Phase 2) and are still working for the DoD as of January 2022, by discipline. This graph only includes low-frequency disciplines (less than 50 total scholars) grouped by 4-year cohort bins. The number in parenthesis after discipline name is the total number of scholars in that discipline that were hired over the course of the program. The dotted black line indicates that retention rate for all SMART scholars for reference.

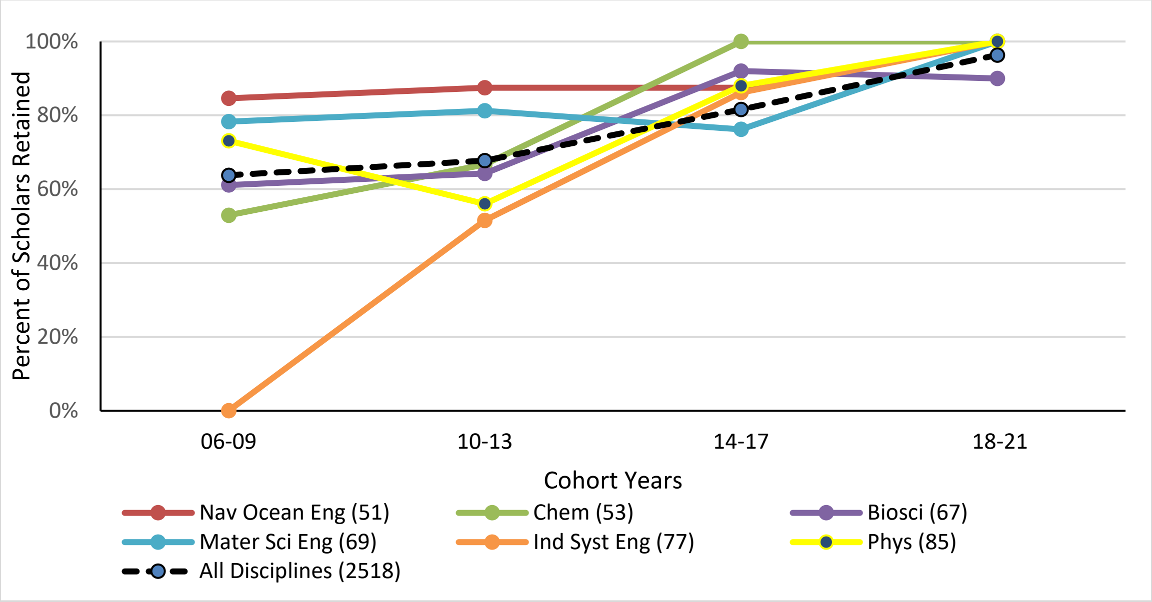

Figure 40. Retention percentages for scholars who were hired (entered Phase 2) and are still working for the DoD as of January 2022, by discipline. This graph only includes mid-frequency disciplines (between 50 and 100 total scholars) grouped by 4-year cohort bins. The number in parenthesis after discipline name is the total number of scholars in that discipline that were hired over the course of the program. The dotted black line indicates that retention rate for all SMART scholars for reference.

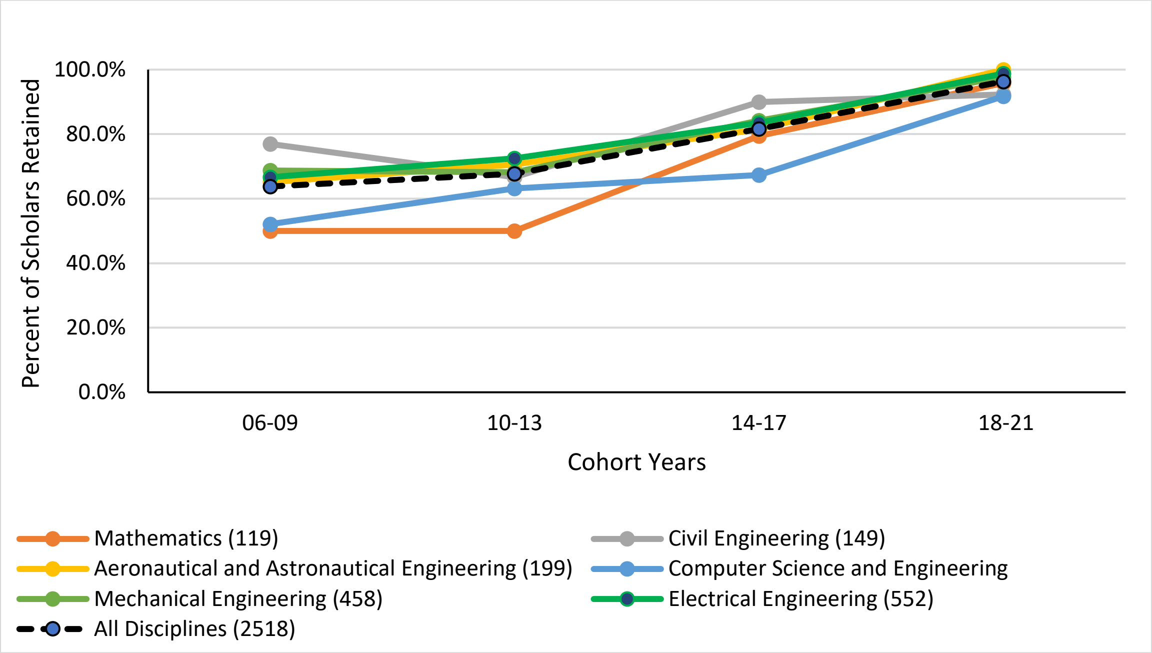

Figure 41. Retention percentages for scholars who were hired (entered Phase 2) and are still working for the DoD as of January 2022, by discipline. This graph only includes high-frequency disciplines (over 100 total scholars) grouped by 4-year cohort bins. The number in parenthesis after discipline name is the total number of scholars in that discipline that were hired over the course of the program. The dotted black line indicates that retention rate for all SMART scholars for reference.

These analyses provide insights into the likelihood of scholars being retained beyond Phase 3 by discipline. From a workforce planning perspective, relating retention to scholar disciplines can allow SFs to better predict which disciplines they might need to fill looking forward. In other words, these data allow the SFs to have some numerical basis for their workforce planning needs 3–4 years into the future. For example, for the low-frequency disciplines, SFs hiring operations researchers might face a personnel gap in this area while those hiring oceanographers will not have the same gap. Likewise, for the high-frequency disciplines, SFs hiring mechanical engineers might not face a personnel gap while those hiring computer scientists and computer engineers might need to select more scholars in this discipline to fill open positions. Although the analyses show that there is a higher turnover (lower retention percentage) of scholars with computer science and computer engineering backgrounds than with oceanography backgrounds, we note that there is also a limited need (i.e., number of hires) for oceanographers within the DoD relative to computer scientists/computer engineers.

Market factors for particular disciplines may also have an influence across disciplines, in that some disciplines may have relatively more/less opportunities outside of the DoD. In a Review of National Defense Science and Engineering Graduate Fellowship, where fellows were not required to work for the DoD after graduating, there was considerable differences across disciplines as to the likelihood that they did take positions with the DoD (Belanich et al. 2019). For NDSEG, those that attained a PhD in naval architecture and ocean engineering, about 50% worked for the DoD while fewer than 10% of those earned a chemistry PhD.

7. Retention by Commitment Length

Scholars have varying lengths of commitments to remain in the DoD after they graduate. Commitment length is based on the number of years the scholars receive the scholarship, and is what determines the length of time between the start of Phase 2 to the end of Phase 2. For the 2,518 scholars who started Phase 2, 3 did not have a Phase 2 end date in the data we received so they were excluded from this analysis, leaving 2,515 scholars where commitment lengths in years were derived. Commitment lengths varied from 0.5 years to 8 years (i.e., people with multiple awards). Figure 42shows the retention rates by cohort groups for scholars with different commitment lengths. In general, those with a longer commitment length were more likely to be retained. While in recent cohorts this may be due to scholars still being in their commitment phase, but it is also true for the early cohorts (i.e., 2006–2009 and 2010–2013) where they must be well beyond their commitment phase.

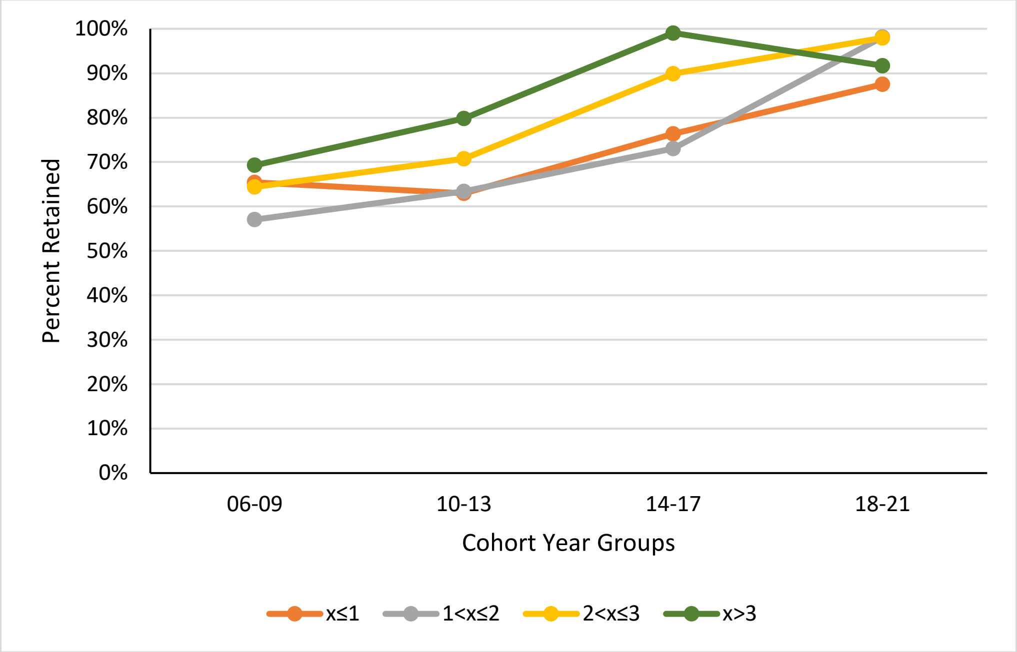

Figure 42. The retention rate for scholars of different commitment lengths. The data are broken up by length of commitment, where x is the commitment length. The orange line indicates commitment lengths of 1 year or less, the gray line for greater than 1 year but equal or less than 2 years, the yellow line for greater than 2 but less than or equal to 3, the green line for greater than 3 years.

SMART 1.0 (Balakrishnan et al. 2018) found no difference in commitment length and long-term retention. The differences between SMART 1.0 and 2.0 may be due to the longer term of retention that we were able to measure in 2022 versus in 2016 (SMART 1.0 data covered only cohorts up to 2016), in that it may have taken several extra years for the commitment length factor to show an effect. There have been findings in the literature that suggest that as age and tenure at an organization increase, they are more likely to be committed to an organization (Brimeyer, Perrucci, and Wadsworth 2010; Ng and Feldman 2009).

D. Overall Retention Findings

Overall, there is a relatively high level of retention in the SMART Program, with 76.3% of the scholars who have been hired over the life of the program (first hires in 2007) still with the DoD. As to be expected, the retention rates for scholars hired from the 2006–2009 cohorts was lower than the rates of more recent cohorts, but scholars from those early cohorts (i.e., joined DoD 10+ years ago) are likely to still be with DoD (62%–68% retention).

As with the SMART 1.0 evaluation, RT scholars are more likely to be retained over the long term than the RC scholars, at the rate of 85% to 75%, respectively. This indicates that as a retention mechanism for current personnel, SMART is effective in keeping those scholars over the long term.

Anecdotal evidence from SMART 1.0 indicated that there were some scholars who were hired at a GS level below what would be expected, and that led to them leaving their SF. This analysis did not identify many such scholars; only 10 and all prior to the 2018 cohort. However, analysis of retention by pay scale indicates that if a scholar was hired at a GS level above what would be standard they were more likely to be retained versus if they were hired at the standard GS level based on their degree level. Also, the retention rate was higher for those hired through an STRL using a pay banding system versus the GS system.

In SMART 1.0, the overall retention rate was higher for a comparable DoD workforce (i.e., hired into similar positions at the same facilities at the same time) versus SMART scholars. Due to data access limitations, a similar matching of SMART scholars to the DoD workforce was not possible. However, using a less precise comparison group (i.e., hired in similar position at the same time) the SMART scholars were slightly more likely to be retained over the past few years than the DoD STEM workforce in general.

Additional variables among SMART scholars were related to differences in likelihood of retention. One such variable was the distance between a SMART scholar's university and their SF such that the further a scholar moved from their university to SF the less likely they were to be retained over the long term. The retention rates also varied by disciplines, with some disciplines having relatively high retention rates (e.g., civil engineering, naval architecture, and oceanography) and some having lower retention rates (e.g., computer science, mathematics, industrial engineering, and nuclear engineering). Also, those with longer commitments were more likely to be retained.

6. Summary of Findings

The SMART Program generates multiple outcomes of interest, such as the awards given to scholars, degrees earned by scholars, and scholars hired by DoD agencies, with many of those scholars being retained within the DoD over the long-term. A summary of the findings of this outcome evaluation are presented below, and organized to align with the processes described in the SMART 2.0 Process Evaluation (Belanich et al. 2021).

A. Application-to-Award Outcomes

The SMART Program has conducted considerable outreach in recent years that has generated many applicants. Of the 28,877 individuals who started applications for Program Years 2019–2021 (applications for cohorts 2020–2022), only 7,259 applicants completed their applications and were deemed eligible for the SMART scholarship program. This in turn led to 1,577 award offers for an award rate of 21.7%. Overall, this award rate indicates that the SMART Program could be considered a selective program (i.e., can select the best candidates from an ample supply) in that only about one-fifth of the eligible applicants are selected.

There are a few factors that provide a more nuanced understanding of the application to awards outcomes for SMART:

- Individuals applying for RT scholarships are nearly 3.5 times more likely to receive an award than are those seeking RC scholarships. This suggests that prior to applying, RT scholars may be identified as valuable to their agencies and could benefit the agency with additional academic credentials or as a potential resource for STEM employee professional development.
- The award rate differences across STEM disciplines suggest that outreach efforts could be adjusted to meet the supply of applicants for the disciplines where there may not be enough applications. For example, in demand disciplines that have a relatively low supply of applicants (e.g., electrical engineering, operations research, and naval architecture and ocean engineering) are associated with high award rates and could benefit from increased emphasis in SMART's outreach efforts to bring in more applicants.
- Awardees were less diverse than the distribution of SMART applicants, both in gender and in racial/ethnic backgrounds; as was also found in SMART 1.0 (Balakrishnan et al. 2018). However, the scholarship awardees were

substantially more diverse in gender, race, and ethnicity than the overall DoD STEM workforce, suggesting that SMART is helping to increase diversity in the DoD workforce. Also, the long-term trend shows that the SMART Program is increasingly demographically diverse over years.

- There is an intersection between gender and disciplines, in that the four disciplines with the most awardees (e.g., computer and computational sciences and computer engineering) were all fields where female applicants were a minority (30% or less); while females were the majority for nine disciplines all having relatively few awards (e.g., cognitive, neural, and behavioral sciences). This suggests that SMART could increase gender diversity if SFs who employ these more gender-equitable disciplines were encouraged to use the program for bringing in talent.
- Scorecard scores may have a limited utility as a filter for selection of scholars for the disciplines where there are many applicants and a relatively low award rate (e.g., mechanical engineering). Further, scorecard scores do not seem to benefit the selection process for applications in disciplines where there are relatively few awards or a high award rate (e.g., operations research, industrial and systems engineering, and biosciences). With the 2022 applicant class (i.e., 2023 cohort), all completed applications will advance to the point where the SFs can review the entire pool of applications (no filtering at the semifinalist level) and their associated scorecards, so an analysis of those results will help inform the value of scorecard scores in the selection process.

B. Overall Degree Pursuit Findings

A primary objective of the SMART Program is to support scholars to complete a STEM degree that will benefit the DoD. Since its inception to 2021, the SMART Program has supported scholars to attain a total of 2,870 degrees.

- Of the 2,870 degrees attained from 2007 to 2021, 1,412 were bachelor’s degrees, 752 were master’s, and 706 were doctoral.
- The number of graduates in a given year fluctuated over time due to budget constraints and increases, and that budget variability had the largest effect on those attaining bachelor’s degrees, with the program providing a steadier number of master’s and PhD degrees.
- The majority of degrees earned between 2006 and 2021 were done so by RC scholars (2,559), with 10.8% of degrees being earned by RT scholars (311). Over years, the budget decreases affect the program’s ability to generate new graduates, with the decrease being more pronounced with RC scholars attaining degrees than for RT scholars.

- Over the life of the program, three disciplines dominate SMART-supported degree production: electrical engineering (22.3%), mechanical engineering (18.0%), and computer and computational sciences and engineering (16.9%). Bachelor's degrees were the most common degree level for each of those disciplines. No other discipline accounted for more than 10% of degrees.
- There were several disciplines where SMART support for either a master's or a doctoral degree was more common than a bachelor's: oceanography, nuclear engineering, material science and engineering, cognitive, neural, and behavioral science, chemistry, and bioscience.
- The percentage of female scholars earning degrees has increased over the years, from about 27% in early years to over 32% in recent years, which might be due to the SPO's efforts to increase the diversity of the program.
- Likewise, the percent of scholars earning degrees who identify as minority races/ethnicities has increased over time, with Asian American and Hispanic scholars having shown the largest overall increase.
- Over 90% of scholars complete their degree while still in the SMART Program. This is a relatively attrition rate, but there is no clear comparison benchmark for perspective. Across disciplines there is wide variation of attrition rates, with some disciplines like industrial and systems engineering and computer science having attrition rates of over 10%, while for others (e.g., chemical engineering and naval architecture) the incompletion rate is below 3%. Also, MS scholars are the most likely to complete their degrees followed by BS students, with PhD scholars being the most likely to be dismissed or withdraw during Phase 1 (not complete their degree).

C. Overall Hiring and Commitment Findings

The SMART Program awards scholarships to both RC and RT scholars; however, only RC scholars are officially hired after Phase 1 of the program as RT scholars maintain their government employment throughout their time in the SMART Program. Since the start of the SMART Program through 2022, there have been 2,235 RC scholars that have entered Phase 2 (i.e., hired into government service) and 285 RT scholars that started Phase 2.

- Of the new hires (RC scholars), 1,202 earned a bachelor's degree (53.8%), 539 earned a master's degree (24.1%), and 494 earned a doctoral degree (22.1%).
- The annual number of awards offered fluctuates with the SMART budget, and that fluctuation affects the number of graduates and hires 2-3 years after those

budget changes are implemented. This indicates that budget fluctuations can disrupt the primary outcome of SMART: the hiring of new STEM graduates.

- SF workforce needs dictate the number of scholars hired with degrees in particular disciplines. There are, however, disciplines from which scholars are regularly hired at high, mid, or low frequency. Still, there is some variation over time in terms of frequency of hiring, where some disciplines become more sought after while others less so due to increased or decreased need.
- Despite these variations in hiring of scholars from specific disciplines, not all scholars enter the DoD workforce in jobs that are similarly titled to their disciplines due to differences in naming conventions of occupations.
- Of the 1,921 scholars (both RC and RT scholars) that started and were expected to complete Phase 2 by 2022, 96.0% (1,844 Scholars) of them satisfied their commitment.
- For the few scholars that do not complete their service commitment (i.e., leave during Phase 2), there is variation in the likelihood of attrition across disciplines. For example, computer science and chemistry scholars are most likely to attrite with over 7% of those scholars not completing Phase 2. On the other hand, there were seven disciplines with 0% attrition rates, each (with the exception of civil engineering) classified as a low-frequency discipline in terms of number of awards.
- Phase 2 attrition rates seem to be associated with the length of service commitments, such that scholars who have longer commitment lengths are less likely to complete them. Aligned with this, PhD-level scholars with many receiving awards greater of 3 years or more have higher attrition rate than BS and MS scholars who mostly had commitment lengths of 2 years and rarely 3 years or more.

D. Overall Retention Findings

Overall, there is a relatively high level of retention in the SMART Program. Across the life of the program, 76.3% of all scholars who have started Phase 2 (i.e., 1,922 of 2,518) were still working for the DoD as of 2022. When we restrict this to just the scholars who satisfied their commitment, 72.3% (1,334 of 1,844 scholars) were still working for DoD as of 2022. As to be expected, the retention rates for scholars hired from the 2006–2009 cohorts were lower than the rates of more recent cohorts, but scholars from the early cohorts (i.e., joined the DoD 10+ years ago) are still likely to be with the DoD (62%–68% retention). Long-term retention appeared to be influenced by a few factors:

- Retention rates varied by disciplines, with some disciplines having relatively high long-term retention rates (e.g., civil engineering, naval architecture, and oceanography) and some having lower retention rates (e.g., computer science, mathematics, industrial engineering, and nuclear engineering).
- RT scholars are more likely to be retained over the long-term than the RC scholars, at the rate of 85% to 75%, respectively. This indicates that as a retention mechanism for current personnel, SMART is effective in keeping those scholars over the long-term.
- Analysis of retention by pay scale indicates that if a scholar was hired at a GS level above what would be expected based on degree level they were more likely to be retained versus if they were hired at the standard GS level. Also, the retention rate was higher for those hired through an STRL using a pay banding system versus the GS system.
- There seems to be a relationship between the distance where a scholar pursued their degree and their SF such that the further a scholar moved from their university to SF, the less likely they were to be retained over the long term.
- With limited data on DoD STEM professionals as a comparison, it appears that SMART scholars were a little more or equally likely to be retained (i.e., employed by the DoD in early 2022).

E. Conclusion

The analysis of outcome data over the life of the SMART Program indicates that that overwhelming majority of scholars (90%) are new to the DoD, indicating that the program is attracting new talent. These scholars are hired by the DoD upon completion of their degree. Retention scholars (approximately 10% of the scholars) continue to remain employed by the DoD at relatively high rates, indicating that the use of SMART as a retention tool with RT scholars appears to be effective. For RC scholars, they appear to be retained at a level about the same as standard DoD employees.

There were a few factors that influenced the outcome measures assessed in this report. There were discipline influences in all phases of the program, with large differences in the number of scholars across disciplines. Also, budget reductions have caused some disruption to program outcomes over time since scholars are usually funded for multiple years but the program budget is appropriated annually; this led to amplified drops in new scholarships when program funding dipped, and subsequently decreased the output of new employees through SMART 2–3 years later.

In general, the primary outcome of the SMART Program is its lasting impact on the DoD STEM workforce, with the many scholars whom have attained degrees needed by the

DoD and have subsequently contributed to the Department as part of the STEM workforce. These contributions are ongoing, with many scholars still employed at sponsoring facilities 10+ years after they were awarded their SMART scholarship.

Appendix A.
Logic Models from Process Evaluation

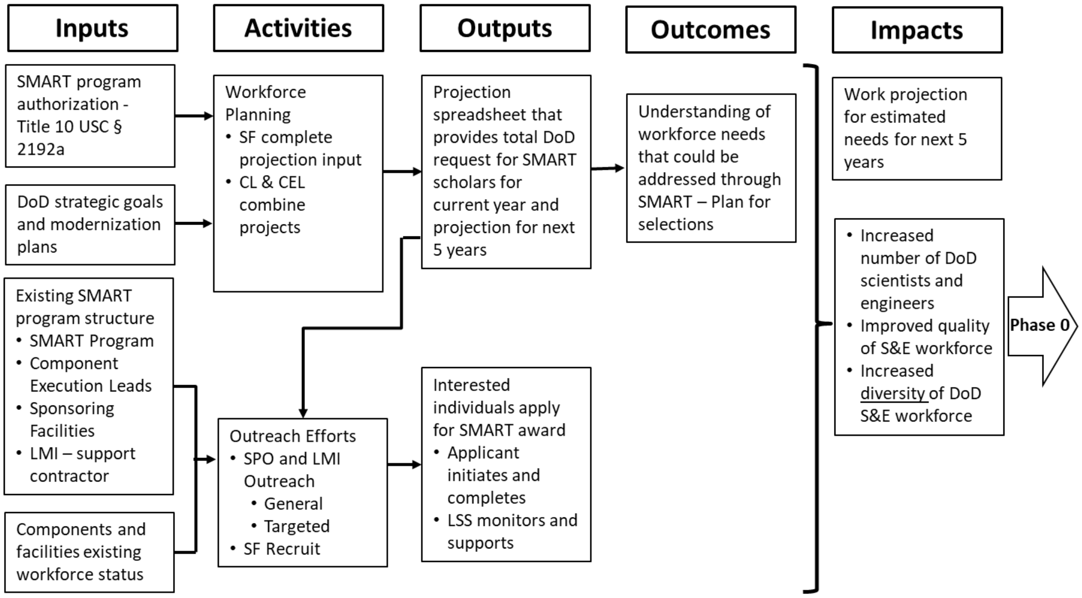

Figure A-1. Logic Model of the Workforce Planning and Preparing Processes

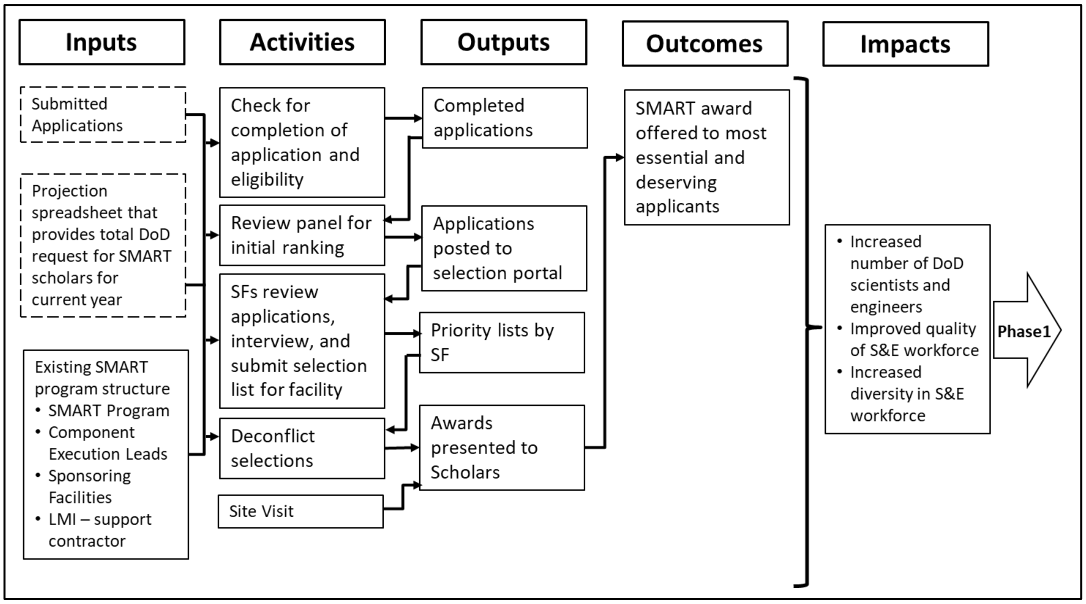

Figure A-2. Logic Model: Phase 0 – Application to Awards

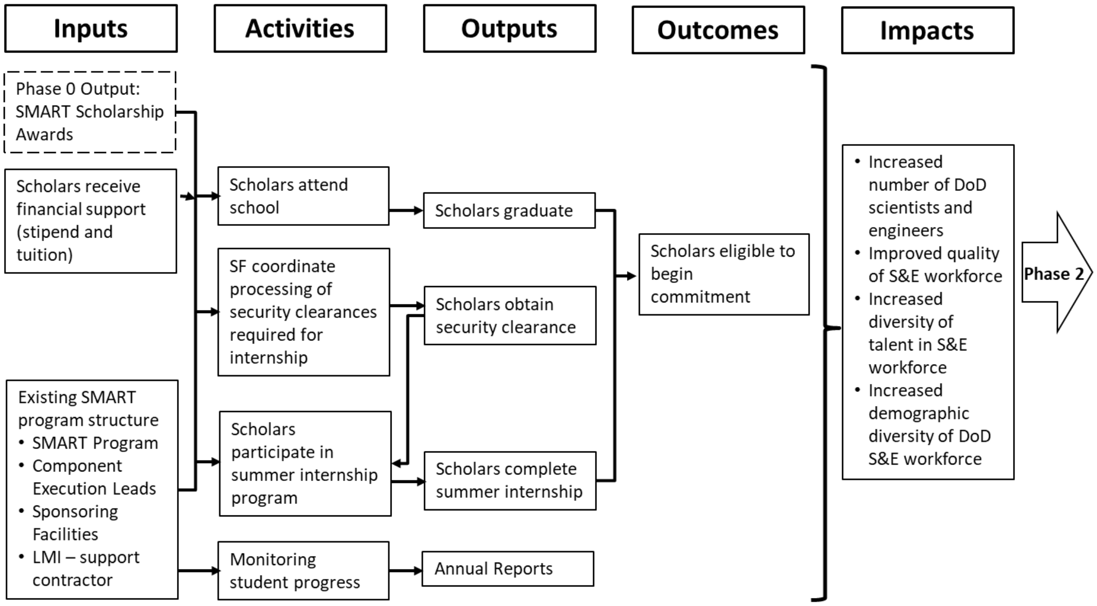

Figure A-3. Logic Model: Degree Pursuit

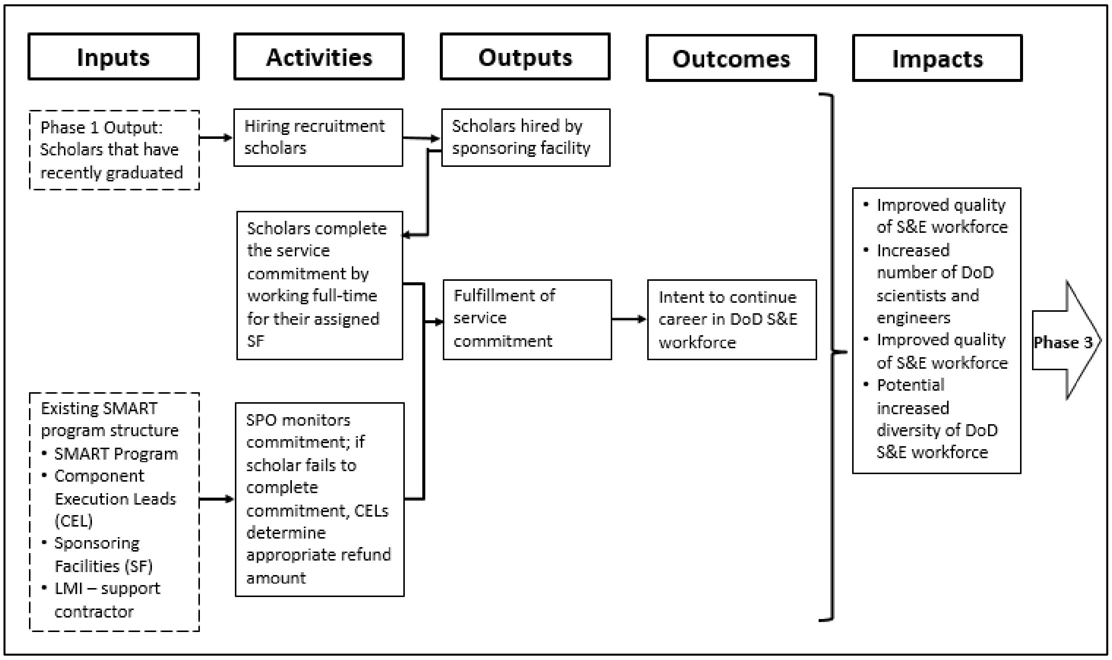

Figure A-4. Logic Model: Phase 2 – Service Commitment

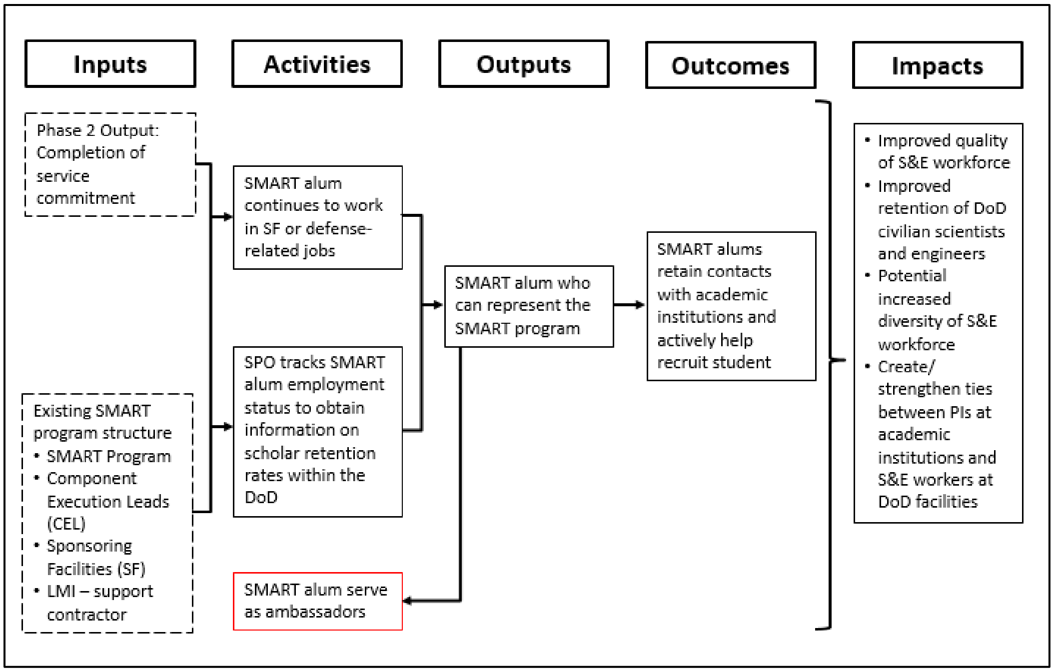

Figure A-5. Logic Model: Phase 3 – Retention Beyond Service Commitment. Those with dashed borders are activities/outcomes from previous phases. The red border denotes a relatively new activity or output for the SMART Program.

Appendix B.
Letters of Recommendation

Introduction to LORs

Letters of recommendation (LORs), also known as reference reports, are a technique used in personnel selection in both industry and academia (admission decisions). A 2001 study (Bliss) reported that 80% of surveyed organizations used LORs for hiring as did virtually all surveyed academic institutions. Their inclusion in the personnel selection process has historically served two purposes: checking the information that a candidate includes in other parts of their application, as well as predicting future job performance (Beason and Belt 1976).

LORs can take different forms, with some giving prompts for a writer to discuss the applicant in regards to certain topics while others are completely unstructured. LORs are typically used in conjunction with other tools such as interviews, personal statements, or cognitive ability tests for assessment and selection of candidates for acceptance into academic programs, scholarship awards, and employment. Despite their common presence, the research regarding the utility of LORs in the assessment and selection process is inconsistent. Many existing LOR studies focused on their use in the selection of clinical interns or medical residents. In this realm, decision makers report weighing LORs highly in their selection process (Ross 1984). Similarly, a study looking at the use of LORs in academia (Norcross, Kohout, and Wicherski 2005) found that department representatives in psychology graduate programs ranked LORs as the most important factor in admissions decisions. However, LORs may have less weight placed upon them in industry settings as opposed to academia (Nicklin 2009). This same research also disagreed with previous studies, instead indicating that LORs may not be considered highly in the decision-making process, even for academics. After surveying 575 Society for Industrial and Organizational Psychology (SIOP) and Academy of Management members, as well as human resources and personnel-related professions, 75% of the participants reported putting less than 25% of their decision weight on LORs.

LOR Content, Biases, and Implications

LORs provide an opportunity for a writer to expound on the ability, character, personality traits, previous performance, or potential of the applicant in question. A study by Dalal et al. (2022) examined the content and tone of more than 30,000 LORs (for around 10,000 applicants) submitted for graduate academic programs. Each LOR received scores based on separate dictionaries that were created for psychological constructs relevant to graduate school performance (personality, motivation, critical thinking, ability), and for other aspects deemed important for interpreting the tone of LORs (standout words, positive tone, negative tone, tentativeness, and certainty).

While the most commonly featured terms related to motivation (8%), critical thinking (5%), and positive emotional tone (9%), results indicated content differences across LORs and across applicant groups. LORs for female applicants featured fewer terms related to critical thinking and tentative tone than LORs for male applicants. Madera (2018) looked at the inclusion of "doubt raisers," described as phrases or statements that question an applicant's aptness for a job, in LOR content for men and women applying for assistant professor positions. Analysis showed that more doubt raisers were contained in LORs for women, and this held true regardless of whether the letter writer was male or female. Additionally, LORs for African American applicants showed fewer terms related to standout words and tentative tone, while featuring high proportions of terms related to motivation (Dalal et al. 2022). Finally, LORs were examined for differences in level of degree or program of study. Results indicated that LORs for STEM applicants featured higher proportions of terms related to ability, standout words, critical thinking, and tentative tone, while non-STEM applicants featured more terms related to personality, positive emotional tone, motivation, and certainty tone. In a comparison of master's and doctoral program LORs, doctoral LORs had higher proportions of critical thinking, negative emotional tone, and tentative tone, while master's LORs had higher proportions of the other areas.

These analyses suggest that LORs are prone to bias. Letter writers focused on different facets of applicants and used different language to describe them. Letter writers for STEM program applicants seemed to focus on more concrete aspects of candidates, while non-STEM LORs focused on potential and behavior patterns. The less positive content in doctoral LORs may point to higher evaluative standards held by letters writers for PhD applicants. These differences, taken together with the differences found with gender and racial groups, necessitate a need for closer examination of the LOR process, with the intent of reducing or eliminating the issue of LOR bias.

On the other hand, letter inflation (or leniency bias) is a perennial problem recognized by both academia and industry. Inflation occurs when letter writers provide recommendations that sound exaggerated and unrealistic, producing a type of ceiling-effect in ratings and ultimately reducing the ability for decision-makers to discriminate among applicants (Aamodt and Williams 2005). Inflation is evident in studies in which a disproportionate number of candidates are rated in the "top 1–5%" of their distribution (Aamodt and Williams 2005). The known presence of widespread inflation poses a continuing challenge, as anything less than a glowing, over-the-top recommendation may be viewed as a red flag by decision-makers.

The use of any selection measure comes with legal and ethical consideration of the ways in which it is implemented. An assessment tool can be considered biased either in the way it measures a construct or in the way it predicts outcomes. Standardized tests like the GRE have been scrutinized in the past (Helms 2006) for measurement bias, in which different test-takers with the same level of the assessed construct (e.g., cognitive ability) receive different scores on the same test, or for prediction bias, in which test scores predict outcomes differently for different test-taking groups. LORs have been offered as a means of moving away from the risk associated with standardized tools and of allowing a more holistic approach to applicant evaluation (Buckley et al. 2018). However, due to their largely unstructured nature, questions persist regarding the validity, reliability, and adverse impact of LORs when used as tools for selection. Further, the unstandardized nature of LORs invites the bias both when the letter is being written and when the letter is being interpreted.

LOR Interpretation, Reliability, and Validity

As part of a package of application materials, a decision-maker reading LORs will likely be relying on intuitive evaluations. Intuitive evaluations present an obvious problem for reliability when multiple decision-makers are involved (Hastie and Dawes 2001). Intuitive decisions are also a “black box” in that decisions cannot be easily traced and even the decision-maker may not have insight into the “how” of the decision. Last, ambiguous contexts and unstructured materials open the door to systematic differences simply by way of humans relying on schemas, heuristics, and stereotypes for the purposes of information processing (Dalal et al. 2022). Separately, the relationship between the letter writer and the decision-maker may influence how LORs are interpreted. More weight may be placed upon a letter when the writer is someone that the evaluator knows or is from a prestigious organization (Sheehan, McDevitt, and Ross 1998).

A study by Saudek (2018) granted some insight into how different phrases in LORs are understood by decision-makers in the context of a pediatric residency program. A list of commonly used phrases was rated on a 5-point Likert scale, from 1 (very negative) to 5 (very positive). Items with Likert scores of 4 and 5 were grouped together as important/positive, while items receiving a Likert scale rating of 1 or 2 were grouped together as not important/negative. Principal components analysis generated three independent groups of phrases with moderate to strong correlation with each other. Phrases such as “I give my highest recommendation,” “exceeded expectations,” and “will be an asset to any program” were rated most highly, while phrases such as “showed improvement,” “overcame personal setbacks,” and “performed at expected level” received the most negative ratings.

Despite the aforementioned issues with the use of LORs as a selection tool, a meta-analysis of LORs in college admission (Kuncel 2014) found modest validity for their use in predicting performance in undergraduate, graduate, and professional school programs. The LORs in these cases included either built in numerical ratings or were coded for favorability (i.e., they were assigned a numerical rating for favorability). Results revealed low but consistent correlations with academic outcomes, with the highest being GPA in college (0.28). Adding LORs to regression models for academic outcomes did not substantially improve predictive power, yet LORs did demonstrate incremental validity in the prediction of degree attainment in graduate school ($R_2 = 0.031$ without vs. $R_2 = 0.055$ with). This result is particularly important as degree attainment is a notoriously difficult criterion to predict. LORs proved better than, or equal to, all other traditional predictors with the exception of subject-specific knowledge tests. Meta-analysis authors suggest that LORs may be revealing of non-cognitive factors such as motivation and persistence, which are imperative for attaining a graduate degree and may not be easily captured by other predictors.

Standardized LORs (SLORs)

One of the solutions proposed to mitigate concerns with the LORs is to implement a more structured approach. Standardizing recommendation letters can be done by asking for ratings of applicants on specific, important competencies (Liu et al. 2009). A less structured approach to standardizing can be done by asking for behavioral examples to support the narrative included in the LOR (Alweis et al. 2017). Standardized LORs (SLORs) have been implemented in a variety of contexts, but empirical studies on SLOR validity and impact are largely restricted to healthcare settings for candidates applying for medical residencies. Most authors note in their studies that SLORs rely on a solid understanding of the candidate attributes needed for the role, preferably informed by a job analysis.

One of the few empirical analyses of SLOR validity outside of this medical setting used applicants for a Canadian Forces Basic Officer Training Program (McCarthy and Goffin 2001). Several different formats of SLOR were used, including a multi-item scale of personality-based items rated on a 7-point Likert, a relative percentile method in which raters used an intentionally wide scale ranging from 0 (below average) to 100 (above average) with the percentiles providing meaningful reference points, and a forced-ranking procedure that prevented the letter writer from providing uniformly high scores. Each format was tested against sets of performance criterion that included supervisor and peer ratings of officer candidate performance, with scales including technical knowledge and skill; integrity; physical fitness; communication; cooperation; leadership; responsibility; and persistence. Results showed that the relative percentile method predicted military performance at a level favorable to many conventional selection methods ($R_2 = 0.18$), while the other scale formats did not significantly predict performance. Authors noted the presence of leniency bias creeping into the percentile scores (averages were around 80); however, ratings at the very top of the scale only occurred 4.3% of the time.

A more recent study (Feldman 2021) completed during the 2020–2021 application cycle of a neurology residency program looked at the outcomes of implementing SLORs into the selection process. The SLOR format included seven competency domains, including patient care, medical knowledge, procedural/technical skill, research, initiative, professionalism and communication, and coachability. SLOR writers were required to assign one of six possible scores for each domain: top 1%, 2%–5%, 6%–10%, 11%–25%, 26%–50%, and bottom 50%.

Results of incorporating SLORs demonstrated the recurrent problem of grade inflation—letter writers scored almost all applicants in the top 1%–10% across all domains. Researchers did note that inflation seemed to be less problematic when the letters were written by more experienced individuals (department chairs, program directors). Results also indicated poor inter-rater reliability for applicants who had several SLORs written by different raters. Authors ultimately conclude that the SLORs contributed little meaningful information, however, still posited that SLORs have significant potential. Recommendations included using more experienced SLOR writers, as well as using explicitly defined anchor points on whatever scale is implemented (a score of 1 means 'performs admirably in this domain, unlikely to see someone of this caliber again in the next 10 years').

A final example comes from Education Testing Services (ETS), which developed its form of a SLOR for use in graduate school admissions to assess non-cognitive attributes (Walters 2006). This tool was simply called Standardized Letters of Recommendation (SLR) at first, before being refined into a web-based tool later called the Personal Potential Index (PPI). ETS gathered information on attributes and items based on academic literature as well as surveys with graduate deans and faculty, asking about attributes important for success in graduate school (Briel et al. 2000). The scales for the PPI included knowledge and creativity; communication; teamwork; resilience; planning and organization; and ethics and integrity. Four items were developed for each of the six attributes within the PPI, and ratings ranged from 1 (below average) to 5 (truly exceptional), with raters asked to compare the applicant relative to peers within the department. See Table B-1 for the initial SLR scales and items.

Table B-1. ETS Standardized Letter of Recommendation scales

Knowledge Scale Items
1. Has foundational knowledge in some branch of behavioral science (e.g., educational theory, psychology, economics).
2. Has knowledge of behavioral science research methods.
3. Has knowledge of educational or psychological assessment.
4. Has knowledge of program evaluation.

Analytical Skills Items
5. Has quantitative research methods and data analysis skills.
6. Has qualitative research methods and data analysis skills.
7. Has demonstrated skill in measurement and assessment techniques.
8. Is skilled in statistical methods.
Communication Skills Items
9. Demonstrates clear and critical thinking.
10. Speaks in a clear, organized, and logical manner.
11. Writes with precision and style.
12. Listens well and responds appropriately.
Motivation Scale Items
13. Maintains high standards of performance.
14. Can overcome challenges and setbacks.
15. Seek out opportunities to learn.
16. Has a high level of energy.
Self-organization Scale Items
17. Organizes work and time effectively.
18. Set realistic goals.
19. Makes good decisions.
20. Can work independently of others.
Professionalism & Maturity Scale Items
21. Maintains high ethical standards.
22. Demonstrates honesty and sincerity.
23. Is dependable.
24. Regulates own emotions appropriately.
Teamwork Scale Items
25. Shares ideas easily.
26. Supports the efforts of others.
27. Works well in group settings.
28. Behaves in an open and friendly manner.

Results from this study suffered from the ceiling effect seen in other studies; most evaluators endorsed the upper score categories for each item (McCaffrey 2018). To improve the validity and utility of such tools, the authors suggested introducing forced-choice items, requiring evaluators to provide qualitative information to supplement the quantitative ratings, using behavioral anchoring techniques that exemplify the behaviors related to each item, and asking applicants to fill out self-evaluations on the same scales. Explicit instructions for how to approach and complete the SLOR could also be given ahead of time or be built into a web-based format for SLOR collection.

A later study examining the relationship between PPI scores and admission rates, graduate school GPA, and degree progress (Klieger 2022) found that for PhD STEM applicants, scores on planning and organization and communication skills predicted both graduate GPA and a reduced risk of academic probation, and that these provided incremental validity over undergraduate GPA and GRE scores as predictors. In addition, this study found that the differences in the mean scores of underrepresented groups and White, Asian, and male individuals were smaller on the PPI than differences between those groups on the GRE and undergraduate GPA. These results are pointed to as evidence that a selection tool that considers non-cognitive factors can help increase diversity. However, once again, this study suffered from the presence of grade inflation in PPI ratings. Although the PPI was debuted in 2009, it did not achieve wide adoption and ETS discontinued the tool as of July 2016 (Kent 2016).

Recommendations

Although ceiling effects and the incorporation of conscious and subconscious biases continue to be a lingering issue, LORs can be a critical piece of information in the evaluation of applications. IDA recommends a number of actions that developers of LORs can take to try to improve the reliability and validity of such tools. First, to shift towards SLORs, developers must perform a job analysis to ensure that the constructs/dimensions of scales are appropriate for evaluation of candidates for specific positions to improve the validity of such tools. The results of the job analysis could be combined with other survey development approaches to improve accuracy of the ratings such as revising the number of items on the SLOR, adjusting the scale range, and other such modifications. Programs requesting SLORs can restrict evaluators to only those with sufficient experience and familiarity with the applicant and can also set a minimum number of evaluators per applicant to improve the validity of the evaluations.

Further, in order to improve reliability and validity, the inclusion of explicit instructions for SLOR writers or providing training on the SLOR process with a focus on how to provide responses that improve the accuracy of the ratings could decrease the ceiling effect (or grade inflation) encountered by current evaluation processes. Brief training on unconscious bias and mitigation strategies can help to bring attention to how bias can infiltrate an evaluation and provide guidance on how to avoid it when completing SLORs for applicants. Likewise, incorporating formal prompts that encourage objectivity can also reduce bias in SLORs.

Rationing the number of upper scores that can be given on any SLOR and/or using a forced ranking format in which evaluators are asked to rank order the attributes of interest from most descriptive to least descriptive of the applicant may also drive down rates of artificial grade inflation/ceiling effects (Christiansen et al. 2005). Developers can also incorporate behavioral anchors or exemplars for Likert scales to ensure that evaluators have a clear understanding of the scoring scales. A clear evaluation rubric helps to drive objectivity in the evaluation and provides transparency regarding the evaluation process to both the applicant and evaluator. Further, objective questions such as, “did you consider your rating in light of the criterion listed?” can direct evaluators to reassess their responses to improve accuracy and reduce bias. Similarly, evaluators could be asked to provide qualitative information in support of their quantitative ratings which might lead to additional reflection on the scores provided and improve accuracy of the evaluation (e.g., “Give two specific examples of how the applicant demonstrated this ability”).

Moving to a web-based SLOR process can help reduce the burden on LOR writers and evaluators. In this approach, the evaluator would receive a personal identification number (PIN) such as a SMART ID plus an evaluator number that is linked to an application. An automated system would deploy electronic messages to the evaluator with a personalized PIN and a link to the SLOR. This would allow for the program to easily track which SLORs have been received and which are outstanding, in which case, the system will automatically send another prompt to the evaluator to complete the SLOR. The completed SLORs can be electronically linked to the application such that the program requesting the SLOR is able to access all applicant materials in one location. The added benefit to such as system is that the SLORs can remain anonymous. This anonymity could reduce rates of grade inflation as evaluators may feel more confident in submitting an honest, wholistic assessment of the applicant via a web-based LOR system that the applicant cannot access.

Finally, programs can request that the applicant provide a self-evaluation using the same scales as their SLOR writers in order to compare agreement levels between the evaluations. While self-evaluations may fall prey to faking or exaggeration when used alone, there is some precedent for their use when combined with scores from outside evaluators (Elhadi et al. 2020) In this study, medical students completed clinical scenarios involving procedural skills such as tube insertion, vein catheterization, and lumbar punctures, and later completed questionnaires self-assessing their performance skills. Examiners evaluated the students on these same performance skills, and no significant differences were found between the self-assessment and the evaluator ratings. If applicants are aware that they are being given ratings on the same scales they may be dissuaded from faking self-assessment scores, and when used complementarily, differences between the assessment scores can be noted for further exploration in the selection process. Requesting self-assessments also gives program officials the ability to assess how well the applicant can objectively evaluate their own performance and skills (or competency). The ability to evaluate one’s competency is critical to being able to identify issues, make corrections, and develop unused skills and abilities.

Appendix C.
DMDC

The Defense Manpower Data Center (DMDC) is an organization within the U.S. DoD that serves as the authoritative source for personnel, manpower, and related data for both the DoD active duty and civilian workforce. The DMDC's data encompasses various aspects such as demographics, personnel assignments, training, education, and compensation. This comprehensive dataset is used for a wide range of purposes, including personnel management, force planning, budgeting, policy development, and statistical analysis.

As part of an agreement with DMDC, IDA receives regular holdings of personnel data, providing a vital look into the DoD civilian workforce. An understanding of the broader DoD S&E workforce allowed points of comparison with the SMART scholar cohorts, with respect to factors such as race, ethnicity, gender, and retention/attrition. All data containing personally identifying information (PII) were processed and analyzed within the confines of a dedicated, secure PII facility.

At the time of analysis, IDA's holdings of DMDC data did not include names or social security numbers. This means that specific SMART scholars could not be identified among the DMDC data holdings. Without the ability to identify specific scholars, this further meant that the propensity score matching technique used in the SMART 1.0 analysis could not be utilized to artificially construct a comparison group that would be matched with SMART scholars on an individual-to-individual basis, based on dimensions such as occupational title, pay band, and employment location. As an additional limitation, DMDC records held by IDA were only consistently provided going back to 2016, and so workforce analyses could not include earlier years.

For the purposes of this report, a multi-step process was used to ensure an appropriate comparison group among the DoD civilian workforce. Taken as a whole, this group includes nearly 800,000 individuals.[35] IDA filtered the subset to individuals who held a bachelor's degree or above. Restricting the data in this way reduced the number to around 400,000. Next, IDA selected a set of 105 occupation codes that were determined to be directly applicable to the 21 STEM disciplines accepted as part of SMART. Applying this limitation brought the subset to around 120,000 individuals with a bachelor's degree or

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[35] DMDC data from September 2020.

higher, working in SMART-relevant occupations. The table below represents the top 10 occupations included in this sample, by frequency. To note, the DMDC data holdings did not include an explicit hire date, and so entry into the DoD workforce was instead inferred from the first appearance of an individual in the datasets. Similarly, attrition was inferred from the absence of the individual in subsequent year's data.

Table C-1. Top 10 Most Frequent Occupations in DoD S&E Educated Workforce

Occupation	*n*
General Engineering	19,206
Electronics Engineering	15,358
Mechanical Engineering	13,056
Computer Science	8,084
Civil Engineering	7,278
Intelligence	5,312
Aerospace Engineering	4,574
Operations Research	4,410
General Natural Resources Management/Biosciences	4,279
Electrical Engineering	4,179

Appendix D.
School Type, Degree, and Discipline

Table D-1. Applications from and Awards Given to Scholars at HBCUs by Degree and Discipline

Discipline	BS Apps	BS Awards	MS Apps	MS Awards	PhD Apps	PhD Awards	Total Apps	Total Awards
Aero & Astro Eng	3	1	-	-	-	-	3	1
Biomed Eng	7	-	-	-	-	-	7	0
Biosci	15	-	4	-	5	-	24	0
Chem Eng	4	-	1	-	-	-	5	0
Chem	7	-	-	-	4	-	11	0
Civil Eng	11	2	1	-	3	-	15	2
Cog Neuro Behav Sci	2	1	1	-	-	-	3	1
Comp Sci & Eng	38	10	10	4	3	-	51	14
Elect Eng	11	1	1	-	2	1	14	2
Environ Sci	2	1	3	1	3	-	8	2
Geo Sci	1	1	-	-	1	-	2	1
Ind Syst Eng	1	-	-	-	-	-	1	0
Inf Sci	-	-	-	-	-	-	0	0
Mater Sci Eng	-	-	1	1	6	2	7	3
Math	6	3	3	1	1	-	10	4
Mech Eng	18	-	5	-	3	1	26	1
Nav Ocean Eng	-	-	-	-	-	-	0	0
Nucl Eng	-	-	-	-	-	-	0	0
Oceanogr	1	-	-	-	-	-	1	0
Oper Res	-	-	-	-	-	-	0	0
Phys	3	-	3	-	1	-	7	0
Total	130	20	33	7	32	4	195	31
Award Rate by Degree Level	15.4%		21.2%		12.50%		15.9%	

Note: The data represent applications submitted in 2019, 2020, and 2021 for all awards offered in 2020, 2021, and 2022 (some awardees declined the SMART award offer). The SMART Program received applications from students at 46 different HBCUs and awarded scholars at 15 different HBUCs during this time. University data from 157 applications were missing, therefore these applications are counted in the non-HBCU/MSI applications.

Table D-2. Applications from and Awards Given to Scholars at MSIs by Degree and Discipline

Discipline	AS Apps	BS Apps	BS Awards	MS Apps	MS Awards	PhD Apps	PhD Awards	Total Apps	Total Awards
Aero & Astro Eng	-	49	8	19	2	32	2	100	12
Biomed Eng	-	19	1	11	-	13	1	43	2
Biosci	-	45	-	11	1	21	2	77	3
Chem Eng	-	32	2	7	-	7	3	46	5
Chem	-	11	-	4	-	25	7	40	7
Civil Eng	2	29	2	7	2	2	1	40	5
Cog Neuro Behav Sci	-	6	-	2	-	17	4	25	4
Comp Sci & Eng	-	194	41	43	15	14	7	251	63
Elect Eng	-	59	21	26	9	4	2	89	32
Environ Sci	1	8	-	3	-	5	1	17	1
Geo Sci	-	6	-	6	2	10	3	22	5
Ind Syst Eng	-	4	1	-	-	-	-	4	1
Inf Sci	2	13	2	4	1	5	1	24	4
Mater Sci Eng	-	2	-	5	-	17	4	24	4
Math	-	43	5	7	1	11	6	61	12
Mech Eng	3	145	22	32	4	13	4	193	30
Nav Ocean Eng	-	-	-	2	2	-	-	2	2
Nucl Eng	-	1	1	1	-	-	-	2	1
Oceanogr	-	-	-	2	-	1	1	3	1
Oper Res	-	-	-	-	-	1	1	1	1
Phys	-	27	-	7	3	18	5	52	8
Total	8	701	106	199	42	216	55	1124	203
Award Rate by Degree Level	0.00%	15.1%		21.1%		25.5%		18.2%	

Note: The data represent applications submitted in 2019, 2020, and 2021 for all awards offered in 2020, 2021, and 2022 (some awardees declined the SMART award offer). The SMART Program received applications from students at 221 different MSIs (and campuses) and awarded scholars at 73 different MSIs during this time. University data from 157 applications were missing, therefore these applications are counted in the non-HBCU/MSI applications.

Table D-3. Applications From and Awards Given to Scholars at non-HBCU/MSI Universities by Degree and Discipline

Discipline	AS Apps	BS Apps	BS Awards	MS Apps	MS Awards	PhD Apps	PhD Awards	Total Apps	Total Awards
Aero & Astro Eng	1	342	53	120	35	166	42	629	130
Biomed Eng	1	161	4	62	1	79	4	303	9
Biosci	-	202	4	54	2	86	12	342	18
Chem Eng	-	139	5	32	2	48	5	219	12
Chem	-	117	6	26	4	84	14	227	24
Civil Eng	2	169	26	54	18	35	17	260	61
Cog Neuro Behav Sci	1	57	2	17	2	59	11	134	15
Comp Sci & Eng	10	856	201	246	86	79	47	1191	334
Elect Eng	2	251	114	120	59	44	29	417	202
Environ Sci	-	48	3	24	4	3	2	75	9
Geo Sci	-	46	4	27	9	34	10	107	23
Ind Syst Eng	-	44	13	38	15	19	13	101	41
Inf Sci	-	68	13	37	16	11	2	116	31
Mater Sci Eng	-	50	9	23	10	109	14	182	33
Math	-	122	26	40	7	60	25	222	58
Mech Eng	-	656	131	206	54	158	37	1020	222
Nav Ocean Eng	-	31	16	17	8	3	1	51	25
Nucl Eng	-	19	1	6	-	14	7	39	8
Oceanogr	-	6	1	8	2	21	8	35	11
Oper Res	-	4	2	5	5	6	5	15	12
Phys	-	116	11	24	4	67	30	207	45
Total	17	3504	645	1186	347	1233	351	5940	1343
Award Rate by Degree Level	0.00%	18.4%		29.3%		28.5%		22.6%	

Note: The data represent applications submitted in 2019, 2020, and 2021 for all awards offered in 2020, 2021, and 2022 (some awardees declined the SMART award offer). The SMART Program received applications from students at 723 different non-HBCU/MSI universities (and campuses) and awarded scholars at 73 different universities during this time. University data from 157 applications were missing, therefore these applications are counted in these applications.

Table D-4. Applications from Scholars at HBCUs, MSIs, and non-HBCU/MSI Universities by Degree and Discipline

Discipline	HBCU BS Apps	MSI BS Apps	Non-HBCU/MSI BS Apps	HBCU MS Apps	MSI MS Apps	Non-HBCU/MSI MS Apps	HBCU PhD Apps	MSI PhD Apps	Non-HBCU/MSI PhD Apps
Aero & Astro Eng	3	49	342	-	19	120	-	32	166
Biomed Eng	7	19	161	-	11	62	-	13	79
Biosci	15	45	202	4	11	54	5	21	86
Chem Eng	4	32	139	1	7	32	-	7	48
Chem	7	11	117	-	4	26	4	25	84
Civil Eng	11	29	169	1	7	54	3	2	35
Cog Neuro Behav Sci	2	6	57	1	2	17	-	17	59
Comp Sci & Eng	38	194	856	10	43	246	3	14	79
Elect Eng	11	59	251	1	26	120	2	4	44
Environ Sci	2	8	48	3	3	24	3	5	3
Geo Sci	1	6	46	-	6	27	1	10	34
Ind Syst Eng	1	4	44	-	-	38	-	-	19
Inf Sci	-	13	68	-	4	37	-	5	11
Mater Sci Eng	-	2	50	1	5	23	6	17	109
Math	6	43	122	3	7	40	1	11	60
Mech Eng	18	145	656	5	32	206	3	13	158
Nav Ocean Eng	-	-	31	-	2	17	-	-	3
Nucl Eng	-	1	19	-	1	6	-	-	14
Oceanogr	1	-	6	-	2	8	-	1	21
Oper Res	-	-	4	-	-	5	-	1	6
Phys	3	27	116	3	7	24	1	18	67
Total	130	701	3504	33	199	1186	32	216	1233
Percent of Apps by Degree Level	3.00%	16.2%	80.8%	2.33%	14.0%	83.6%	2.16%	14.6%	83.3%

Table D-5. Awards Given to Scholars at HBCUs, MSIs, and non-HBCU/MSI Universities by Degree and Discipline

Discipline	**HBCU BS Awards**	**MSI BS Awards**	**Non-HBCU/MSI BS Awards**	**HBCU MS Awards**	**MSI MS Awards**	**Non-HBCU/MSI MS Awards**	**HBCU PhD Awards**	**MSI PhD Awards**	**Non-HBCU/MSI PhD Awards**
Aero & Astro Eng	1	8	53	-	2	35	-	2	42
Biomed Eng	-	1	4	-	-	1	-	1	4
Biosci	-	-	4	-	1	2	-	2	12
Chem Eng	-	2	5	-	-	2	-	3	5
Chem	-	-	6	-	-	4	-	7	14
Civil Eng	2	2	26	-	2	18	-	1	17
Cog Neuro Behav Sci	1	-	2	-	-	2	-	4	11
Comp Sci & Eng	10	41	201	4	15	86	-	7	47
Elect Eng	1	21	114	-	9	59	1	2	29
Environ Sci	1	-	3	1	-	4	-	1	2
Geo Sci	1	-	4	-	2	9	-	3	10
Ind Syst Eng	-	1	13	-	-	15	-	-	13
Inf Sci	-	2	13	-	1	16	-	1	2
Mater Sci Eng	-	-	9	1	-	10	2	4	14
Math	3	5	26	1	1	7	-	6	25
Mech Eng	-	22	131	-	4	54	1	4	37
Nav Ocean Eng	-	-	16	-	2	8	-	-	1
Nucl Eng	-	1	1	-	-	-	-	-	7
Oceanogr	-	-	1	-	-	2	-	1	8
Oper Res	-	-	2	-	-	5	-	1	5
Phys	-	-	11	-	3	4	-	5	30
Total	20	106	645	7	42	347	4	55	351
Percent of Awards by Degree Level	2.59%	13.8%	83.7%	1.77%	10.6%	87.6%	0.98%	13.4%	85.6%

Appendix E.
National Data on HBCUs and MSIs

Table E-1. Masters and Doctoral-level Black or African American S&E[36] Students at HBCUs and Other Institutions in 2018 by Field and Gender

	All institutions			HBCUs			Percent Enrollment at HBCUs		
Field and degree	All S&E graduate students	Female (% of graduate body)	Male (% of graduate body)	All S&E graduate students	Female (% of HBCU graduate body)	Male (% of HBCU graduate body)	% of All S&E graduate students	% of All Female Students	% of All Male Students
All S&E graduate students	28,854	16,239 (56.3%)	12,615 (43.7%)	3,311	2,016 (60.9%)	1,295 (39.1%)	11.5%	12.4%	10.3%
Science	24,844	15,052	9,792	2,917	1,886	1,031	11.7%	12.5%	10.5%
Engineering	4,010	1,187	2,823	394	130	264	9.8%	11.0%	9.4%
All S&E master's students	20,171	11,285 (55.9%)	8,886 (44.1%)	2,312	1,415 (61.2%)	897 (38.8%)	11.5%	12.5%	10.1%
Science	17,560	10,606	6,954	2,046	1,332	714	11.7%	12.6%	10.3%
Engineering	2,611	679	1,932	266	83	183	10.2%	12.2%	9.5%
All S&E doctoral students	8,683	4,954 (57.1)	3,729 (42.9%)	999	601 (60.2%)	398 (39.8%)	11.5%	12.1%	10.7%
Science	7,284	4,446	2,838	871	554	317	12.0%	12.5%	11.2%
Engineering	1,399	508	891	128	47	81	9.1%	9.3%	9.1%

Note: Universities included in these data reported their status via the Integrated Postsecondary Education Data System Fall 2018 Enrollment Survey. The data do not distinguish between Minority-serving Institutions (MSIs) and other universities. The data are derived from the National Center for Science and Engineering Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering, 2018 (National Center for Science and Engineering Statistics 2021).

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[36] Note that these data includes the following disciplines identified as S&E in the NCSES data: biological and biomedical sciences; computer and information sciences; geosciences, atmospheric sciences, and ocean sciences; mathematics and statistics; physical sciences; psychology; aerospace, aeronautical, and astronautical engineering; bioengineering and biomedical engineering; biological and biosystems engineering; chemical engineering; civil engineering; electrical, electronics, and communications.

Table E-2. S&E Bachelor's Degrees Earned in 2018 by Minority-identifying Students and Type of Institution

	BS S&E Degrees Granted to Black or African American Students			**BS S&E Degrees Granted to Hispanic or Latino Students**			**BS S&E Degrees Granted to American Indian or Alaska Native Students**		
	All Other Schools	HBCUs	Percent Earned at HBCU	All Other Schools	HHEs	Percent Earned at HHE	All Other Schools	TCUs	Percent Earned at TCUs
S&E	37,320	8,347	22.4%	68,443	49,131	71.8%	2537	170	6.5%
Science	32,532	7,593	23.3%	54,929	43,187	78.6%	2179	165	7.3%
Biological sciences	9,365	2,166	23.1%	17,633	8,765	49.7%	452	5	1.1%
Computer sciences	6,558	737	11.2%	8,370	3,582	42.8%	250	19	7.6%
Earth, atmospheric, and ocean sciences	207	9	4.3%	721	326	45.2%	46	3	6.5%
Mathematics and statistics	1,089	249	22.9%	2,556	1,204	47.1%	61	0	0.0%
Physical sciences	1,377	373	27.1%	2,723	1,171	43.0%	85	0	0.0%
Psychology	13,936	1,952	14.0%	22,926	13,553	59.1%	547	15	2.7%
Engineering	4,788	754	15.7%	13,514	5,944	44.0%	358	5	1.4%

Note: Consistent with the Department of Education, if an applicant or scholar reported identifying as Hispanic or Latino, they were counted in this ethnic/racial category and not included in the other racial categories. These data include only U.S. citizens and permanent residents. The Department of Education defines high-Hispanic-enrollment institutions as nonprofit public and private institutions of higher education whose full-time equivalent enrollment of undergraduate students is at least 25% Hispanic, which qualifies them for MSI status. Universities included in these data reported their status via the Integrated Postsecondary Education Data System Fall 2018 Enrollment Survey. These data are derived from the Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, unrevised provisional release data (National Center for Science and Engineering Statistics 2021).

Appendix F.
Glossary

Term	Definition
academic term	An academic term is a division of the academic year. Depending on how the academic institution structures its classes, an academic term may consist of a quarter or a semester. [SMART Scholar Handbook 2020]
academic year	An academic year in the SMART Program consists of the fall through spring academic terms and is generally 9 months in length. An academic year does not include the summer term or condensed winter term. [SMART Scholar Handbook 2020]
award	An award in the SMART Program is an offer of scholarship for the completion and conferral of a specific degree in accordance with the SMART Service Agreement (SSA) in exchange for a period of obligated service. Also referred to as the SMART award. [SMART Scholar Handbook 2020]
award funding	Award funding refers to the amount of funds expended under the scholar's SMART award including all stipend, tuition, approved related educational expenses, travel expenses, health insurance funds, miscellaneous supplies allowance, and all other funds expended by the Federal Government under the scholar's award. Award funding begins 1 August of the first award year. [SMART Scholar Handbook 2020]
award year	An award year refers to a SMART Program funding year which generally begins 1 August and ends 31 July. [SMART Scholar Handbook 2020]
cohort	A cohort refers to the group of scholars who received a SMART award in a particular year. [SMART Scholar Handbook 2020]
cohort year	A cohort year refers to the year the scholar begins their SMART award. [SMART Scholar Handbook 2020]
debt repayment	The procedure for recovering funds determined due the Federal Government under a SMART award based on scholar withdrawal or dismissal from the SMART Program prior to completion of the service commitment. [SMART Scholar Handbook 2020]
degree completion	Degree completion refers to the date on which an individual completes all requirements to complete a degree, including thesis/dissertation writing, edits, defense, etc. This date generally occurs prior to degree conferral and is not set forth on official transcripts. The degree completion date may be the same as the degree conferral date. [SMART Scholar Handbook 2020]
degree conferral	Degree conferral refers to the date on which a degree is bestowed upon an individual. This date is set forth on the official transcript reflecting the degree earned. The degree conferral date may be the same as the degree completion date. [SMART Scholar Handbook 2020]

Term	Definition
dismissal	Dismissal is the process to remove a scholar from the SMART Program based on failure to comply with SMART Program policy, procedure, and/or SSA. [SMART Scholar Handbook 2020]
DoD component	Organizational entities in the DoD. There are four DoD component designations in the SMART Program: the Department of the Army, Department of the Navy, Department of the Air Force, and other DoD Agencies. [SMART Scholar Handbook 2020]
eligible person	An individual who meets the requirements of Section 4093a of Title 10, U.S.C. [DoDI 1025.09]
financial assistance	Financial aid provided under a scholarship or fellowship awarded to a person. [DoDI 1025.09]
full-time employment	Employment that includes regularly scheduled work hours and days required by the administrative work-week for a particular group or class. [SMART Scholar Handbook 2020]
incomplete coursework	Incomplete coursework is receiving a grade of incomplete for a registered course and does not constitute adequate progress toward degree completion as reflected in the Educational Work Plan (EWP). [SMART Scholar Handbook 2020]
internship support payment	Internship support payment(s) (ISP) are intended to support travel, lodging, meals, transportation, and incidental expenses for eligible scholars attending an internship. [SMART Scholar Handbook 2020]
mentor	A mentor is an experienced individual who assists and guides another person's professional development. SMART Program mentors may coordinate internship logistics and assist scholars in educational and professional growth. A mentor may be a facility supervisor or the SMART facility point of contact. [SMART Scholar Handbook 2020]
obligated service	The period of service for an SSPP [SMART Scholarship Program Participant] in exchange for financial assistance. The period of service required may not be less than the total period of pursuit of a degree that is covered by financial assistance. This period is specified in the SSPP service agreement. [DoDI 1025.09]
other DoD Agencies	Individual DoD Agencies that do not belong to the Army, Navy, or Air Force. [SMART Scholar Handbook 2020]
phase 0 – award	Phase 0, award, begins at the time an awardee accepts a SMART award by signing the SSA and ends 31 July of the award year. A phase 0 awardee does not receive award funding. Any time spent attending a site visit, completing orientation, or completing an onboarding session does not count towards completion of the service commitment. Prior to funding an award, the phase 0 awardee must comply with acceptance deadlines, complete orientation, and provide all funding prerequisite documentation. [SMART Scholar Handbook 2020]
phase 1 – degree pursuit	Phase 1, degree pursuit, begins 1 August of the award year in accordance with the SSA and ends upon verified completion of all phase 1 requirements. During phase 1, scholars complete approved degree requirements and internships. As scholars near completion of phase 1, they work with the SF [sponsoring facility], SMART Program, Scholar Coordinator, and Component Liaison to prepare for the start of the service commitment. [SMART Scholar Handbook 2020]

Term	Definition
phase 2 – service commitment	Phase 2 begins the service commitment as defined by the work start date. The work start date is defined as the first day of full-time employment with the SF after verified degree completion. Once phase 1 is verified completed, the SMART Program provides written confirmation of official entry into phase 2, including service commitment start and end dates. During phase 2, scholars complete the service commitment by working full-time for their SF. [SMART Scholar Handbook 2020]
phase 3 – post-service commitment	Phase 3, post-service commitment, is an employment status monitoring period that begins upon completion of the service commitment. During phase 3, the SMART Program tracks scholar employment status to obtain information on scholar retention rates within the DoD. [SMART Scholar Handbook 2020]
program phases	Scholars complete four SMART Program phases: phase 0 - award, phase 1 - degree pursuit, phase 2 - service commitment, and phase 3 - post-service commitment. [SMART Scholar Handbook 2020]
recruitment scholar	A recruitment scholar is a scholar who is not employed in a permanent civilian position by the SF at the time of and throughout the award. Scholars who are employed by the SF in temporary or internship positions at the time of award are recruitment scholars. [SMART Scholar Handbook 2020]
retention	The result of a DoD civilian science and engineering (S&E) employee being retained as either a government or contractor defense employee. [IDA SMART 1.0 Outcome Evaluation Report]
retention scholar	A retention scholar is a scholar who is employed in a permanent civilian position by the SF at the time of and throughout the award. This does not include term or temporary employees or interns, e.g. Pathways. [SMART Scholar Handbook 2020]
S&E	Science and Engineering (S&E), usually used to describe a workforce (i.e., scientists and engineers) or the work that they do.
S&T	Within DoD, Science and Technology (S&T) includes the earliest forms of Research, Development, Test and Evaluation (RDT&E) and is composed of three federal budget categories: Basic Research (6.1), Applied Research (6.2), and Advanced Technology Development (6.3).
satisfactory academic progress	Maintenance of a 3.0 GPA on a 4.0 scale within the criteria defined in the SSA and maintaining adequate progress toward degree completion. [SMART Scholar Handbook 2020, SMART Scholarship Program Participant service agreement, DoDI 1025.09]
scholar	A scholar is an individual who has received and accepted a SMART award. An individual remains a scholar throughout all three program phases. [SMART Scholar Handbook 2020]
scholarship or fellowship	A financial award for full-time study leading to a STEM degree. [DoDI 1025.09] [SMART Scholar Handbook 2020]
scholarship-for-service	Scholarships-for-service refers to programs that provide scholarship funding in exchange for an agreement to complete a period of employment after degree completion or conferral. [SMART Scholar Handbook 2020]
science, technology, engineering, and	Aeronautical and Astronautical Engineering; Biomedical Engineering; Biosciences; Chemical Engineering; Chemistry; Civil Engineering;

Term	Definition
mathematics (STEM) disciplines	Cognitive, Neural, and Behavioral Sciences; Computer and Computational Sciences and Computer Engineering; Electrical Engineering; Environmental Sciences; Geosciences; Industrial and Systems Engineering; Information Sciences; Materials Science and Engineering; Mathematics; Mechanical Engineering; Naval Architecture and Ocean Engineering; Nuclear Engineering; Oceanography; Operations Research; Physics [SMART Public Website]
security clearance	A security clearance is an authorization issued by the Federal Government permitting an individual access to sensitive and classified information. [SMART Scholar Handbook 2020]
service commitment	The period of service for a scholar determined by the DoD as being appropriate to obtain adequate service in exchange for financial assistance. [SMART Scholar Handbook 2020]
SMART component	Representatives of Military Services or Agencies who provide management and oversight to the SMART Program. [IDA SMART 1.0 Outcome Evaluation Report]
SMART Program Office (SPO)	Element of the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) tasked with implementing and administering the SMART Program. [IDA SMART 1.0 Outcome Evaluation Report]
SMART Program Support	Contractors supporting the SMART Program Office who conduct program administration work. [IDA SMART 1.0 Outcome Evaluation Report]
SMART Public Website	The SMART Public Website provides updated information regarding other program events. The SMART Public Website is located at: http://smartscholarship.org. [SMART Scholar Handbook 2020]
SMART Scholar Portal	The SMART Scholar Portal contains scholar submittal documents, posts policies and procedures, and is where scholars update their contact information during all phases. The SMART Scholar Portal is located at: http://smartscholarship.org/scholar. [SMART Scholar Handbook 2020]
SMART Scholarship Program	The SMART Scholarship Program is the Department of Defense Science, Mathematics, and Research for Transformation Scholarship-for-Service Program. [SMART Scholar Handbook 2020]
SMART Scholarship Program lead service	A DoD Component, designated by the ASD(R&E) in accordance with Paragraph 2.2.f., that provides day-to-day administrative support for the SMART Scholarship Program. [DoDI 1025.09]
SMART Service Agreement	The SMART Service Agreement is a signed written agreement whereby the DoD funds the academic pursuit of a scholar in exchange for a period of obligated service to the DoD. The SMART Service Agreement is signed by the scholar and the awarding DoD Component. [SMART Scholar Handbook 2020] A written agreement between the SSPP and the awarding DoD Component that includes the terms and conditions of the financial assistance award, including those pertaining to obligated service. [DoDI 1025.09]
sponsoring facility (SF)	A sponsoring facility is a particular laboratory or agency within the DoD Component that participates in the SMART Program. [SMART Scholar Handbook 2020]

Term	Definition
United States citizen	A United States citizen is an individual who was born or naturalized within the United States and is subject to the jurisdiction of the United States. [SMART Scholar Handbook 2020]
work start date	The work start date is defined as the first day of full-time employment with SF after verified degree completion. [SMART Scholar Handbook 2020]

Abbreviations

BS	bachelor of science
DMDC	Defense Manpower Data Center
DNWTR	did not wish to respond
DoD	Department of Defense
DoDI	DoD Instruction
ETS	Education Testing Services
FFRDC	Federally Funded Research and Development Center
GPA	grade point average
GS	general schedule
HBCU	Historically Black Colleges and University
IDA	Institute for Defense Analyses
IPEDS	Integrated Postsecondary Education Data System
IQR	interquartile range
LOR	letter of recommendation
MS	master of science
MSI	Minority Serving Institution
NCES	National Center for Education Statistics
NDSEG	National Defense Science and Engineering Graduate
NH	Non-Hispanic
OIRA	Office of Information and Regulatory Affairs
OMB	Office of Management and Budget
PhD	doctorate
PII	personally identifying information
PIN	personal identification number
PPBE	DoD Planning, Programming, Budget, and Execution
PPI	Personal Potential Index
PRA	Paperwork Reduction Act
RC	recruitment
RT	retention
S&E	science and engineering
S&T	science and technology
SF	sponsoring facility
SIOP	Society for Industrial and Organizational Psychology
SLOR	standardized letter of recommendation
SLR	Standardized Letters of Recommendation
SMART Program	Science, Mathematics, and Research for Transformation Program
SPO	SMART Program Office
STEM	science, technology, engineering, and mathematics
USD(R&E)	Under Secretary of Defense for Research and Engineering

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program was established in 2006 as a scholarship for service program to enhance the Department of Defense's (DoD) workforce in science, technology, engineering, and mathematics skills and disciplines that are needed by DoD. This outcome evaluation is a follow-up to one conducted in 2015–2018, and is paired with a process evaluation (Evaluation of SMART Program 2.0: Process Evaluation, 2021). The SMART Program is designed to address a broad set of workforce needs, and these outcomes and benefits are distributed across facilities of the three Service Components and Fourth Estate agencies.

15. SUBJECT TERMS

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