

Data Brief

Building the Cybersecurity Workforce Pipeline

A Study of the National Centers
of Academic Excellence in
Cybersecurity

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Executive Summary

With an estimated 700,000 open cybersecurity positions, investing in cyber talent and education is critical to U.S. national and economic security.¹ These shortfalls prompted the National Cyber Director to begin creating a National Cyber Workforce and Education strategy in the summer of 2022 to improve cyber talent and education.² Given that education and training at the postsecondary level will feature prominently in any such strategy, understanding how effective current programs are will help policymakers make informed decisions moving forward.

This data brief focuses on one such program, the National Centers of Academic Excellence in Cybersecurity (NCAE-C). The NCAE-C program has operated for more than two decades out of a program office housed within the National Cryptologic University. It is a consortium of 365 institutions with cyber or cyber-related degrees or certification programs that meet high federal standards, sponsor cyber education initiatives, and engage in faculty professional development. For this analysis, we focus on nondegree awards (e.g., certificates), associate's degrees, and bachelor's degrees, as these comprise the main pipelines for cyber talent coming from institutions of higher education.

Our main goal was to determine whether NCAE-C-designated institutions are graduating cyber talent at a higher rate than schools without the designation. The NCAE-C program has grown significantly in scope and scale since its inception, but little data is available on its effectiveness. Using completions data from the Department of Education's Integrated Postsecondary Education Data System (IPEDS) on students who have completed a program in a cybersecurity-related field of study, we find that:

- **Institutions with the NCAE-C designation produced an outsized number of cyber and cyber-related graduates relative to non-NCAE-C institutions.** Across all subjects, NCAE-C institutions granted only 40 percent of all bachelor's degrees and 24 percent of associate's degrees in 2020. But in cyber fields, NCAE-C institutions graduated 50 percent of all bachelor's degrees, 32 percent of all associate's degrees, and 19 percent of all nondegree credentials.
- **NCAE-C institutions have shown rapid growth in completions in cyber-related fields, far outpacing non-NCAE-C institutions.** While the number of cyber-related associate's degrees awarded at non-NCAE-C schools actually

decreased between 2010 and 2020, degrees in these fields at NCAE-C schools doubled in that same time. Furthermore, the number of cyber-related bachelor's degrees granted per year by NCAE-C schools has more than tripled.

- **NCAE-C institutions accounted for a higher percentage of cybersecurity bachelor's degrees than non-NCAE-C institutions in many states.** For example, NCAE-C schools in South Dakota awarded 50 percent of cybersecurity bachelor's degrees in the state from 2010 to 2020, despite only awarding 5 percent of all bachelor's degrees over the same time period.
- **Despite some improvements over the past decade, women are still underrepresented in cyber-related programs.** Similar to broader trends observed in other STEM fields, women are underrepresented in the NCAE-C community. While women's share of earned, cyber-related bachelor's degrees has risen over the last decade, the fact that it remains at less than 20 percent is emblematic of a pervasive gender imbalance across all award types.
- **The NCAE-C program and its designated institutions do more than just graduate cyber talent.** Standout institutions such as Dakota State University, Pittsburgh Technical College, and Capitol Technology University, as well as the schools that run the five CAE national centers, collaborate with and bolster the NCAE-C community and outside partners in many forms. Through these networks, institutions receive access to networks of employers, professional development for faculty, new potential funding streams, and a nationally-recognized designation.

In spite of the promise it shows for growing the cyber workforce, the NCAE-C program is not yet authorized in law or regularly funded by Congress. The lack of congressional authorization, consistent funding, and mandates that often accompany newly appropriated funds make strategic planning difficult for program administrators. Their success in training cybersecurity talent and building out pipelines across the country justifies more regular funding. To this point, Congress should officially authorize the NCAE-C program as an official National Security Agency (NSA) program of record and appropriate yearly funds.

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The National Centers of Academic Excellence in Cyber

The National Centers of Academic Excellence in Cyber (NCAE-C) program was created in 1999 to grow the cybersecurity workforce within the intelligence community.³

Today, the NCAE-C program is managed by the NSA, housed in NSA's National Cryptologic University, and run in partnership with five other federal entities: Cybersecurity and Infrastructure Security Agency, the Federal Bureau of Investigation, the Department of Defense (DOD), the National Science Foundation (NSF), and the National Initiative for Cybersecurity Education (NICE).⁴ The goal of the NCAE-C program is to create and maintain a collaborative community of universities, colleges, and community colleges that meet cyber and computer science curriculum standards, in sync with the National Institute of Standards and Technology (NIST) Cybersecurity Framework, and actively engage in solutions to challenges in cybersecurity education.⁵

For this analysis, we used the list on the Centers of Academic Excellence Community website as of January 2022, which totals 365 institutions across 48 states, Puerto Rico, and the District of Columbia.⁶

There are three types of NCAE-C designations:⁷

- **CAE in Cyber Defense (CAE-CD):** The most common designation, available to regionally accredited schools that offer cybersecurity degrees and/or certificates
- **CAE in Cyber Operations (CAE-CO):** A more technical-oriented designation than CAE-CD, with an emphasis on computer science, computer engineering, and/or electrical engineering
- **CAE in Research (CAE-R):** Only awarded to research universities, DOD schools, and PhD-producing military academies

Institutions seeking the CAE-CD or CAE-CO designation for a particular program of study must go through two steps. First, the institution must submit evidence related to the program for validation, such as curriculum, faculty information, and program maturity. Second, if validated, the institution can apply for a CAE designation. CAE-R institutions have a slightly different process. Schools must also provide evidence of significant cyber defense research, including research by faculty and students, along with funding, publications, and a sufficient number of graduate students enrolled.

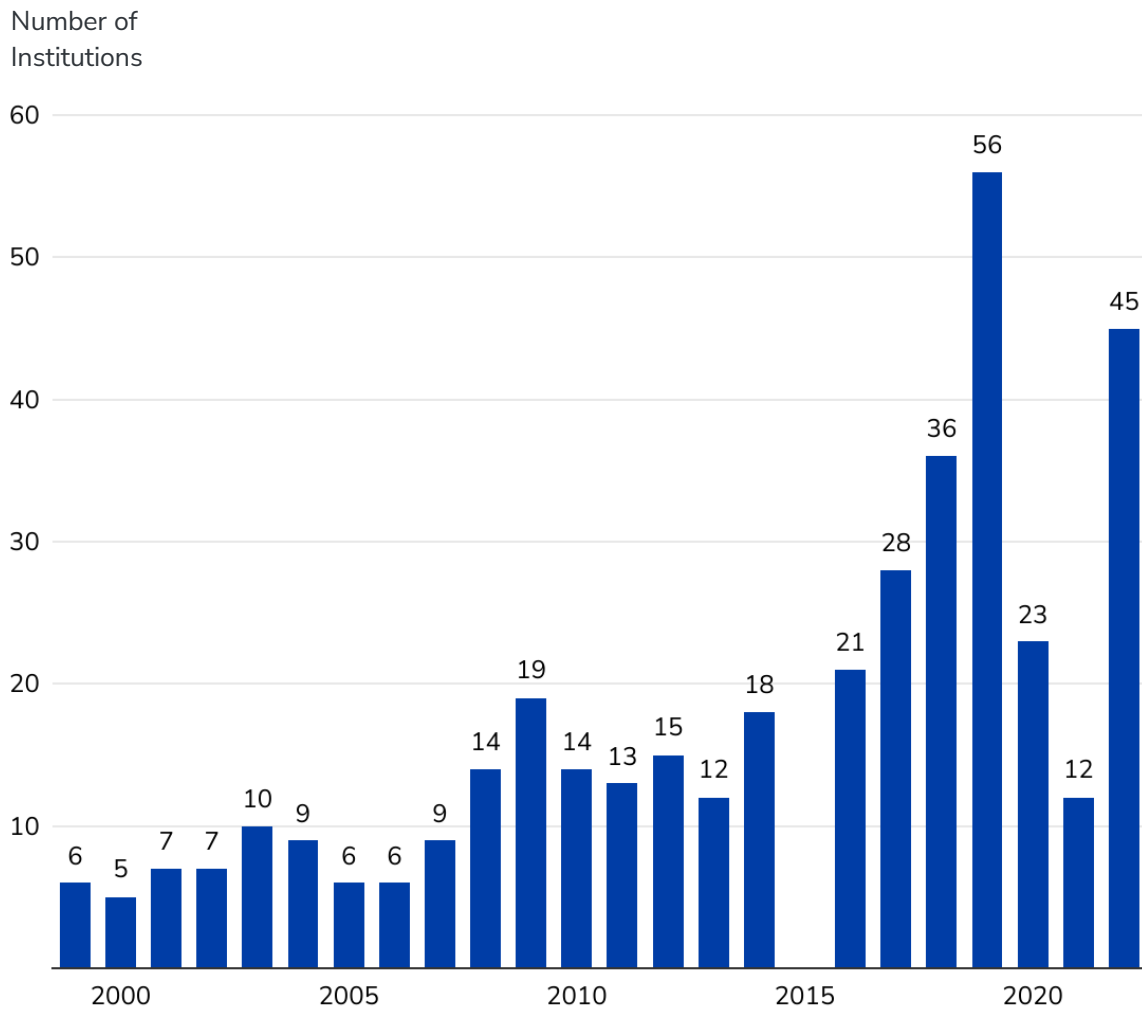
The designation review process is conducted by NSA along with other subject-matter experts from fellow NCAE-C-designated institutions, the various other federal participants in the program, and industry partners. There are several resources available to applicants to assist them in the application process.⁸ Once a program is approved, they are required to fulfill a set of annual obligations including submission of updates on the program, attendance at NCAE-C meetings with other stakeholders, and faculty professional development.

Schools accepted by the program receive a number of benefits. They can compete for periodic funding made available to NCAE-C schools and gain the ability to develop relationships with government agencies. They receive access to professional development opportunities for faculty, along with assistance on curriculum and program design. And perhaps most importantly, they receive a nationally recognized designation — a signal to prospective students that a particular institution’s cyber program is held in high regard by potential employers. For smaller institutions especially, this is a powerful draw.

In our research, we did find anecdotal evidence that some top-ranked institutions believe the burden of the administrative requirements outweighs the benefits, even though they consider the NCAE-C program to be effective and successful.⁹ These schools already have proficient faculty and well-designed programs, and do not need any additional renown brought about through designation. That said, there are several leading institutions within the NCAE-C community that may value the relationships with government employers and funders through the program.

Alongside the increasing importance of cybersecurity, the program has grown significantly in scope and scale.¹⁰ The number of newly-designated schools in the first fifteen years of the program was low, but relatively consistent. However, Figure A shows a sharp increase of designations beginning in 2013 and peaking in 2019, when 56 schools were added in one year. There was a precipitous drop in 2020, potentially due to the COVID-19 pandemic, but designation levels rebounded in 2022.

Figure A: Number of NCAE-C Designated Institutions, by Year



Note: No schools were designated in 2015.

Source: CSET calculations from www.caecommunity.org/cae-map.

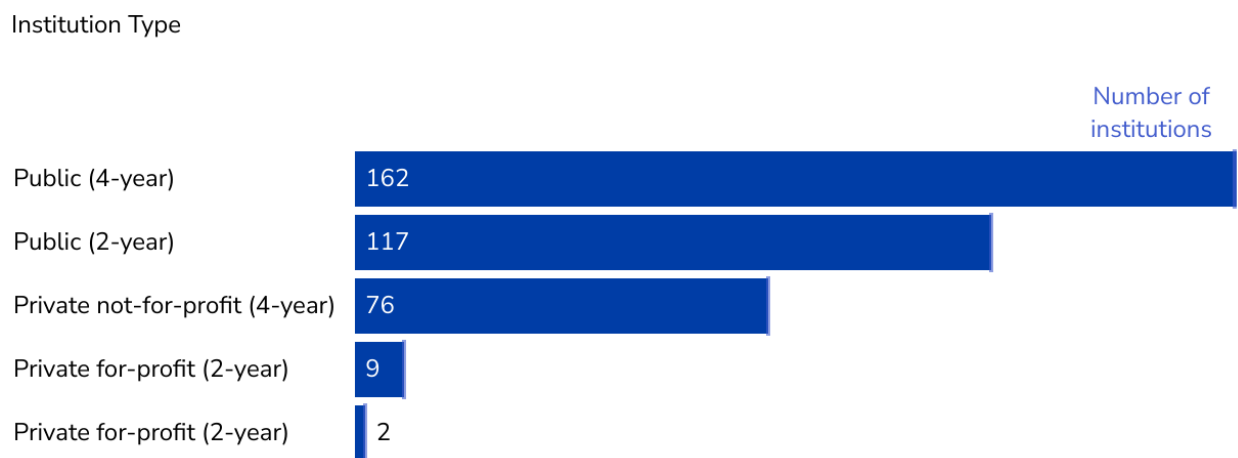
Currently, the NCAE-C program includes five CAE National Centers and five regional hubs to assist in the administration and growth of the national community of institutions and partners, and its additional programs. Each is led by a school or consortium of schools. In addition to generally coordinating the NCAE-C community, each national center helps the NSA program office administer a specific feature of the program. One national center assists schools during the application process, another leads the coordination and management of the community, a third develops education pathways, a fourth assists the program office in the review of applications, and the final national center builds out career preparation resources with and for NCAE-C

schools.¹¹ They also collectively work on standards development as part of the NICE Challenge Project.¹² The schools that serve as the national centers go above and beyond just training cyber professionals at their own institutions by aiding the program as a whole.

In the past, the regional hubs provided professional development for faculty in the region, organized community events, and helped to build ties between other designated institutions. However, per conversations with the NCAE-C program office, a reorganization of the community is currently underway that will eliminate the regional hubs. Their responsibilities will be taken up by the national centers.

Over three-quarters of NCAE-C institutions are either public four-year schools or community colleges. Some of the 365 institutions have multiple campuses. In the Department of Education database, individual campuses of the same institution are listed separately from each other. For this analysis we combined each campus into one institution.¹³ There are 440 campuses in total and 23 schools have multiple campuses. Pennsylvania State University has the most campuses with 23.

Figure B: NCAE-C Institution Sectors



Source: CSET analysis of IPEDS data.

The NCAE-C program is not a program of record and therefore, not funded by Congress on an annual basis. There is currently no authorizing language for the program.¹⁴ Although the NCAE-C program has not had funding to provide grants in every fiscal year, it periodically receives funding from Congress to accelerate growth of the program and encourage research. In FY2015, Congress allocated \$6 million for

research, which was subsequently awarded to CAE-CD-designated institutions. In FY2017, the program received \$25 million from the President's budget, which facilitated establishment of 14 CAE National Resource Centers and three new CAE Regional Resource Centers, in addition to allowing the program office to issue 45 grants for projects at designated institutions.¹⁵

Individual schools within the CAE community do not receive earmarked funding from the federal government as part of the program. The program office conducts a competitive grant process to determine which school or coalition of schools will receive said funds in response to specific congressional aims (i.e., Workforce Development, Diversity, etc.)

According to NCAE-C program administrators we interviewed, several factors prevent long-term development solutions: not being a program of record, the unpredictable nature of funding, and the timeline of the federal allocation process. This makes it difficult for the program office and federal/academic partners to sustain initiatives, accomplish short-term goals (3–5 years), and develop long-term strategy (5–10 years) that accomplishes national cybersecurity education and workforce development goals.

Methodology

Our main goal was to determine whether institutions with the NCAE-C designation are graduating cyber talent at a higher rate than non-NCAE-C schools. We used the Integrated Postsecondary Education Data System (IPEDS), the main repository of postsecondary education data for the National Center for Education Statistics (NCES), to determine how many graduates each institution produced in cybersecurity and related fields of study, and compared these totals to the totals for all schools. We compiled our list of NCAE-C institutions from the program institution map.¹⁶

We developed a definition of cyber-related fields of study that allowed us to use IPEDS. The repository uses a system called the Classification of Instructional Programs (CIP) as a taxonomy for sorting fields of study. We manually combed through thousands of CIP codes to identify those relevant to cybersecurity and created a list of 29 CIP codes that constitute cybersecurity-relevant fields of study. (A full list of CIP codes can be found in Appendix C). In this brief, we refer to the 29 identified CIP codes as cyber fields.

NCAE-C institutions offer different levels of awards based on their designations. This includes nondegree credentials and associate's, bachelor's, master's, and doctoral degrees. IPEDS has multiple subcategories for nondegree credentials. In our measurements, we combined all nondegree credential requiring less than two years of study into one category called nondegree credentials. Because undergraduate programs constitute the largest source of cybersecurity talent, we focused on undergraduate education in this brief, but may revisit graduate credentials in the future.

This method of determining completions totals for each institution does not measure the number of graduates specifically from NCAE-designated programs. Many schools receive the designation for a single program, degree, or center of excellence. However, due to the number of schools included in our dataset it was infeasible to single out and measure only specifically-designated programs of study across a decade. Furthermore, schools within our list of NCAE-C institutions received designations in different years from 2010 to 2020. For example, according to their website, Western Governors University received its designation in 2020 for its BS in Cybersecurity and Information Assurance and has graduated 2,000 people since that time.¹⁷ Our data shows much higher numbers than that, with 13,000 graduates in cyber fields from 2010 to 2020.

This means that graduation totals within this brief include degrees granted prior to NCAE-C designation.

We acknowledge this distinction; however, we are ultimately interested in the effectiveness of each designated institutions designated at any time in this window in training cybersecurity professionals. While it is not possible to know whether it is the institution or the designation driving graduate outcomes, designation at some point in the time during 2010 to 2020 is nonetheless one characteristic that uniformly distinguishes these institutions. Moreover, to fully capture the role of these institutions in the cyber talent pipeline, we consider a broad range of fields of study relevant to cybersecurity professions.¹⁸

To determine if NCAE-C schools graduate cybersecurity talent at higher rates than non-NCAE-C institutions, we compared NCAE-C schools completion totals in cybersecurity fields of study from 2010 to 2020 to those from other schools nationwide. For this comparison we reviewed trends over time by award type, calculated the share of total cybersecurity awards granted at NCAE-C schools, and calculated the growth rate of cyber-related programs.

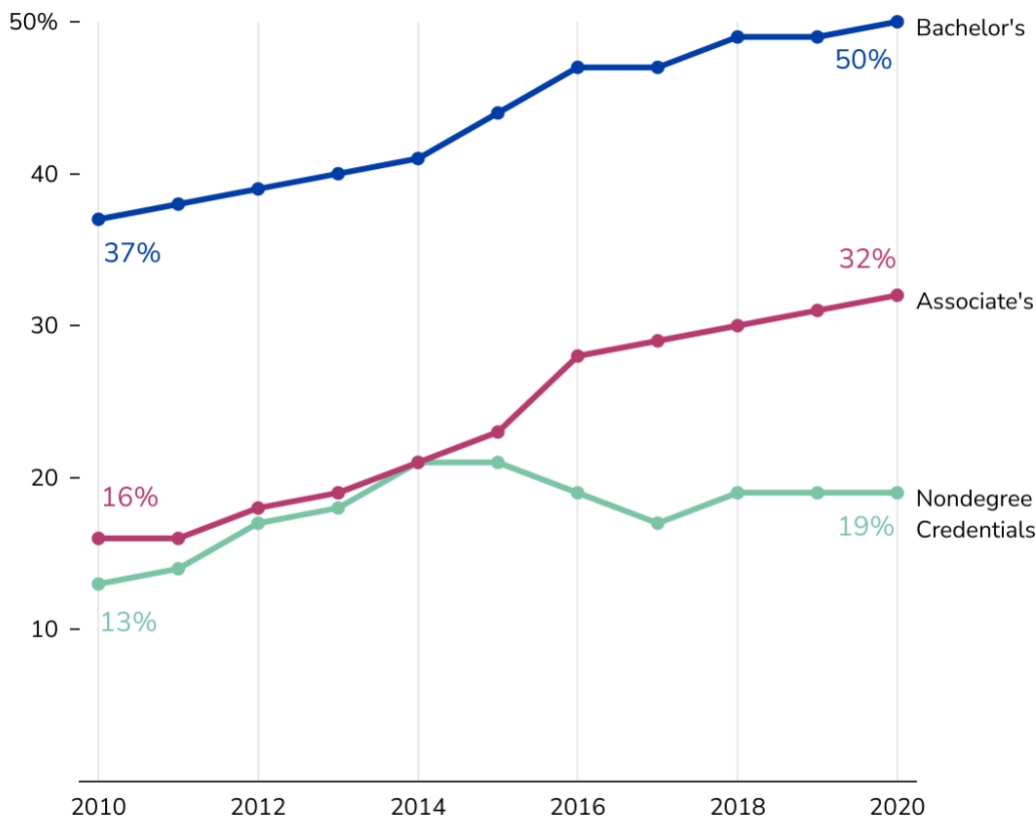
Findings

Our research found that NCAE-C designated institutions graduate high numbers of students in cyber and cyber-adjacent programs, especially in comparison to non-NCAE-C schools. As the program has grown in scope and scale, the number of awards granted by NCAE-C schools has also sharply risen across all award types.

Although they make up only nine percent of all institutions, NCAE-C institutions now award 50 percent of all cyber-related bachelor's degrees within the United States, up from an already considerable 37 percent in 2010. The high share of completions at all award levels, which can be seen in Figure C, indicates that NCAE-C institutions have an outsized impact in training cyber and cyber-related talent.¹⁹

Figure C: The Share of Cybersecurity Awards Granted by NCAE-C Schools as a Percentage of Cybersecurity Awards Granted at All Schools, by Award Type

Percent of Total Cybersecurity Awards Granted by NCAE Schools



Source: CSET analysis of IPEDS data.

Over the past decade, NCAE-C institutions have also shown rapid growth in completions in cyber-related fields. The large increase in completions, particularly in two- and four-year degrees, is shown in Table A below. Table A shows that while the number of cyber-related associate’s degrees awarded at non-NCAE-C schools actually decreased from 2010 to 2020, degrees in these fields at NCAE-C schools doubled in that same time. Furthermore, the number of cyber-related bachelor’s degrees granted per year by NCAE-C schools has more than tripled. Across all award types, the rate of growth of NCAE-C completions far outpaced non-NCAE-C institutions. This is further evidence that not only have these schools trained a large share of cyber talent in the past, but they are also getting better over time.

Table A: NCAE-C-Designated Schools’ Completions Have Grown at Much Higher Rates than All Schools over the Last 10 years, Especially in Cybersecurity-Relevant Fields

Percentage Change in Completions* from 2010 to 2020				
Award Type	NCAE-C Schools		All Other Schools	
	Cyber	All Fields	Cyber	All Fields
Nondegree Credentials	190%	110%	78%	-8%
Associate’s Degrees	100%	46%	-22%	14%
Bachelor’s Degrees	227%	42%	95%	14%

*The term “completions” refers to the number of students that earned a degree or nondegree credential.

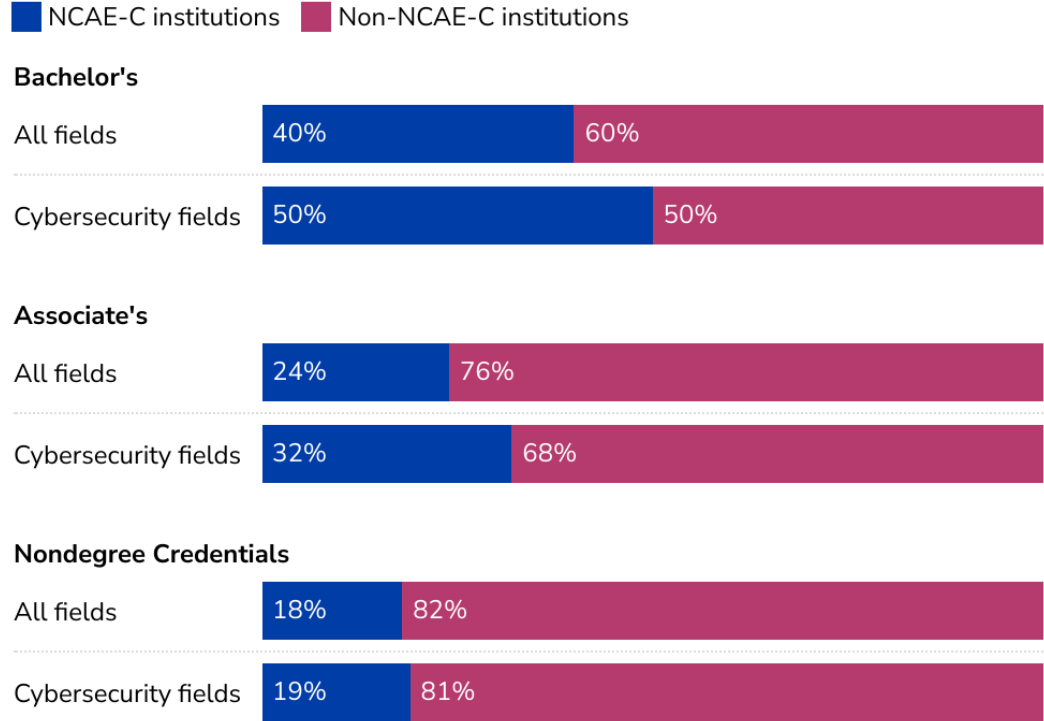
Source: CSET analysis of IPEDS data.

Over the last decade, NCAE-C schools have graduated an increasing share of cybersecurity graduates at all award levels compared to non-NCAE-C institutions. They are also doing so at an increasingly greater rate. These two findings indicate that NCAE-C institutions are training substantially more cyber-related talent relative to non-NCAE-C institutions, in terms of their shares of graduates.

Table B shows that NCAE-C schools graduated fewer students than non-NCAE-C schools in 2020 across all fields: only 40 percent of all bachelor’s degrees and a quarter of associate’s degrees. But the output of NCAE-C schools is more comparable in cybersecurity fields. For bachelor’s degrees, they graduate roughly the same amount

in cyber as non-NCAE-C schools; half of all cyber bachelor’s degrees are awarded by NCAE-C schools and about a third of all cyber associates graduate from NCAE-C schools.

Table B: Comparison of Completions Totals Between NCAE-C Schools and Non-NCAE-C Schools in 2020 Across All Fields and Awards Levels. NCAE-C Schools Make Up Only 9 Percent of All U.S. Institutions



Source: CSET analysis of IPEDS data.

It is also important to note the relative scale of NCAE-C schools compared to non-NCAE-C institutions. If it were the case that NCAE-C schools graduate 40 percent of cyber talent, but also 40 percent of all talent, that would indicate that NCAE-C schools are simply major suppliers of talent in general, not specific to cyber. Table B above shows the comparison between NCAE-C schools and non-NCAE-C schools, across both cyber fields and all fields. The difference becomes starker if you consider degree totals as well; while NCAE-C-designated schools awarded 417,000 fewer bachelor’s and 530,000 fewer associate’s degrees in total, they awarded the same amount of cyber bachelor’s degrees and only 12,000 less cyber associate’s degrees. This shows

that NCAE-C schools are not simply graduating an outsized share of all talent, but that they are doing so in cyber fields specifically.

With the data available, we cannot determine exactly how large of a factor NCAE-C designation is to this trend where NCAE-C schools have become major producers of cyber-related talent in the U.S. workforce. However, there is a relationship between the two. Schools that were accredited over the last decade are now producing an outsized number of cyber graduates.

There are a few explanations for NCAE-C schools' success: it could be a form of selection bias, in which only schools that have propensity for cyber training begin the designation process; it could be that the process of preparing for and receiving designation improves schools' programs in terms of size and quality; or it could be that inclusion in the NCAE-C program post-designation, and thus receiving the resources available to schools in the community, could bolster their effectiveness. Regardless of the specific cause, this analysis reveals the positive impact of NCAE-C designated schools.

Gender Analysis

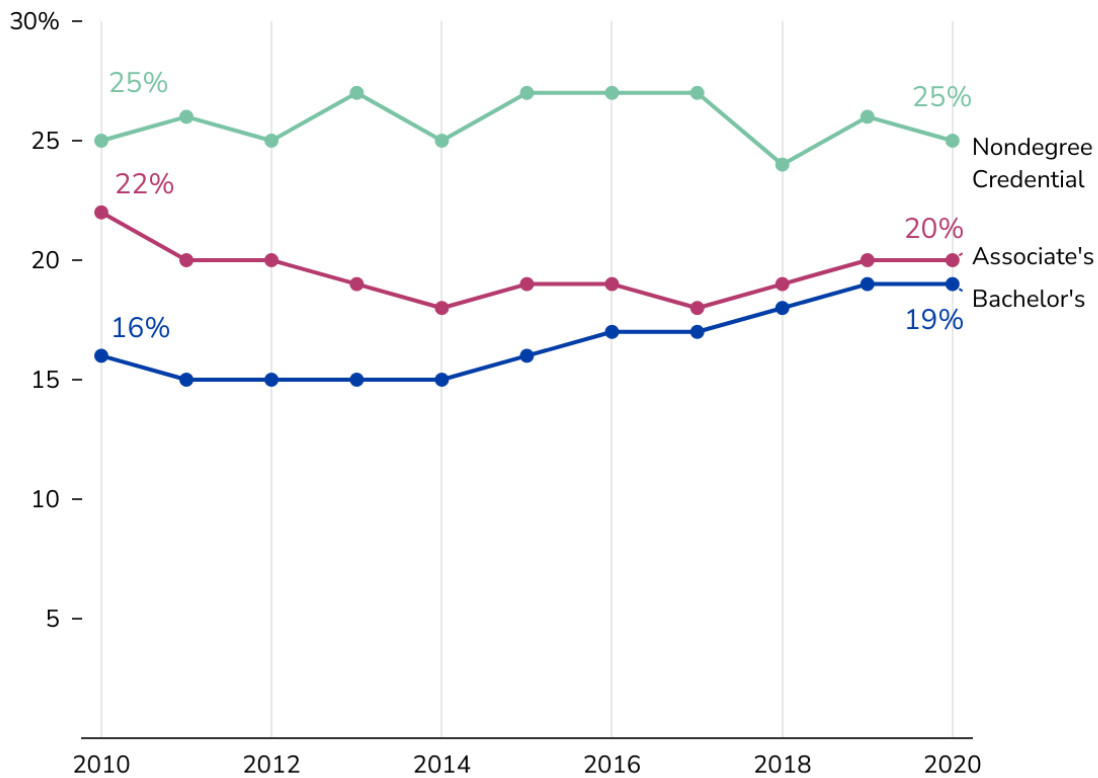
We also wanted to examine whether NCAE-C schools fare better in gender equity for cybersecurity graduates than other schools. This is a pressing issue—women only make up about one-third of the STEM workforce and account for 26 percent of those employed in computer and mathematical occupations.²⁰ This disparity in computer sciences and engineering already exists by the time women reach postsecondary studies. Men are five times more likely than women to even enroll in engineering or computer sciences programs.²¹ While NCAE-C schools are demonstrating success in general, it is also necessary to understand if they have made progress in addressing this particular problem.

At NCAE-C institutions, while women earned more bachelor's, associate's, and nondegree awards across all fields than men in each year from 2010 to 2020, they are significantly underrepresented when only comparing cyber-related degrees over that same time. This is also observed in cyber fields when comparing NCAE-C to non-NCAE-C schools, meaning it is a problem that pervades the entire postsecondary cyber ecosystem.

Figure D shows the gender disparity in cyber at NCAE-C schools across each award type. On average over the past decade, 17 percent of NCAE-C cyber bachelor’s graduates are women, 20 percent of NCAE-C cyber associate’s graduates are women, and 26 percent of NCAE-C cyber nondegree graduates are women. Women’s share of associate’s degrees over the time period has remained somewhat flat, with a slight drop from 22 percent of degrees in 2010 to 20 percent in 2020, indicating very little progress has been made in this area.

Figure D. Percentage Shares of NCAE-C Cyber Bachelor’s, Associate’s, and Nondegree Women Graduates from 2010 to 2020

Women's Share of Completions



Source: CSET analysis of IPEDS data.

Bachelor’s degree growth in cyber fields for women has trended positively over the last decade. This is a positive sign, but the persistently low share remains emblematic of pervasive gender imbalance in cyber fields across both NCAE and non-NCAE institutions. Our findings further validate overall gender trends in STEM, even in an

otherwise effective training program like NCAE, and reaffirm the need to address these deficiencies across the pipeline.

Top States

In addition to a high-level comparison of schools within the NCAE-C program to non-NCAE-C schools, we wanted to determine whether certain states or institutions stand out. We begin with a state-level analysis.

We first ranked states by the total number of cyber-related awards granted by NCAE-C schools. For bachelor's degrees, the top three were Maryland, Virginia, and Florida. For associate's degrees, the top three were Virginia, Florida, and Texas. This shows that these states, in part through their NCAE-C institutions, are doing commendable work in building out their cyber talent pipeline at the postsecondary level. It is also somewhat unsurprising, as these states have relatively high populations, many universities to contribute to their number of graduates, and well-documented efforts to build out their cyber workforce.²²

We also explored whether there were other states — ones that may be smaller or less well-known for their cybersecurity training efforts — doing laudable work through NCAE-C institutions. Using different ways of ranking states, we found that there are a small number of states in which NCAE-C institutions graduate a large majority of cyber talent even though they do not graduate a large number of the states' total graduates.²³

Most notably, in South Dakota, NCAE-C schools grant over half of all cyber-related bachelor's degrees, while only awarding four percent of the total number of bachelor's degrees. NCAE-C schools also graduate a comparatively large amount of cyber talent in Vermont, Nevada, West Virginia, and New Jersey. These states are clear examples of states in which NCAE-C schools have an outsized impact on the cyber talent pipeline.

Top Institutions

When comparing institutions, we grouped each institution by its sector as defined by the Department of Education.²⁴ This allowed us to make comparisons between schools that primarily grant the same types of awards.²⁵

Ranking institutions by their total output of cyber graduates does highlight schools that graduate large amounts of cyber talent, but it also inordinately favors larger institutions, many of which are well-known in this sphere.²⁶

Instead, we ranked institutions by their share of cybersecurity graduates against their total graduates. This illuminates schools that focus their efforts on cybersecurity-related programs, bringing to the fore smaller or lesser-known schools.²⁷

Tables C and D show the rankings of schools with a strong focus on cybersecurity and highlight institutions and states that otherwise do not appear when ranking by total output. This includes Dakota State University in South Dakota, Capitol Technology University in Maryland, and Pittsburgh Technical College in Pennsylvania, which are standout institutions we explore in more depth in the next section.

Table C. Top NCAE-C Public and Private Four-Year Institutions, Ranked by Share of Cyber Bachelor’s Graduates within Each Institution from 2010 to 2020

Institution	State	Cyber Graduates	All Graduates	Share of Cyber Graduates
Capitol Technology University	MD	365	766	48%
Dakota State University	SD	1,247	2,838	44%
New England Institute of Technology	RI	823	2,784	30%
University of Maryland Global Campus	MD	15,596	54,407	29%
Champlain College	VT	1,744	6,740	26%
NCAE-C Total		337,579	7,476,816	4.5%

Source: CSET analysis of IPEDS data.

Table D. Top NCAE-C Public and Private Two-Year institutions, Ranked by Share of Cyber Associate’s Graduates within Each Institution from 2010 to 2020

Institution	State	Cyber Graduates	All Graduates	Share of Cyber Graduates
Pittsburgh Technical College	PA	2,216	6,408	35%
Gwinnett Technical College	GA	1,460	6,956	21%
College of Eastern Idaho	ID	199	1,222	16%
Augusta Technical College	GA	584	3,769	15%
Waukesha County Technical College	WI	904	7,375	12%
NCAE-C Total		337,579	7,476,816	4.5%

Source: CSET analysis of IPEDS data.

Innovation at the School Level

Using the top institution rankings from the above section, we identified schools that appeared to be doing outstanding work in cyber education. The various methods we used for ranking states and institutions were motivated by a desire to discover schools that were investing in cybersecurity education that may be less-often discussed in national-level discourse.

The three highlighted schools below had the highest share of graduates earning a cyber-related award. This could point to a particular focus on educating and training cyber talent. This is only one way to rank NCAE-C effectiveness, but it allows us to control for the size of the institution, thus shining a light on two somewhat smaller institutions.

For each school, we reviewed program structure, degree and course offerings, and the broader context of their efforts within their region and education sector. Below are three notable examples from this review to showcase how they have achieved success.

Dakota State University (South Dakota)

Over the last 10 years, nearly half of students graduating from Dakota State University (DSU) earned their degree in a cyber-related field. The university has had an NCAE-C designation for 18 years and holds each of the three designations: cyber defense, cyber operations, and research.²⁸ DSU is an active participant in the DOD Cyber Scholarship Program and the CyberCorps Scholarship for Service; along with University of Colorado Colorado Springs (the Northwest Regional Hub), it leads the Cybersecurity Faculty Development grant to support, upskill, and recruit cyber faculty.

DSU was one of the first four schools to earn the CAE-CO designation in 2012, specifically for what was then its Computer and Network Security major. The other two designations it holds, CAE-CD and CAE-R, are university-wide designations, not for specific degrees, programs, or certifications.²⁹ DSU currently offers many other cyber-specific degrees within The Beacom College of Computer and Cyber Sciences, such as bachelor's degrees in Cyber Operations and Network and Security Administration, doctorates in Cyber Defense and Cyber Operations, and an associate's degree in Network and Security Administration.³⁰

DSU has robust partnerships with the NSA, DHS, and NSF. Some students even get to work on NSA cyber projects in a secure lab on the DSU campus, side-by-side with NSA staff and expert DSU faculty. It also hosts security competitions and conferences; offers camps for middle- and high-school students, as well as teachers; has a secure lab for students and faculty; and provides hands-on opportunities for students to work on NSA projects.³¹

The success and breadth of DSU's efforts in cyber are at least partially attributable to statewide efforts. The latest example of this is from early 2022, when DSU and the South Dakota Board of Regents invested \$90 million of state, local, and philanthropic funds to expand the DSU Applied Research Lab, expand capacity of their cyber programs, and enable dual enrollment for high school students. Lawmakers and school administrators hope this investment will also attract private industry, including defense contractors, to the area, creating jobs for graduates.³²

The efforts of DSU are an example of a school that has built up a robust program of cyber degrees and support programs over a long period of time. South Dakota is not one of the locations traditionally called a "tech hub," yet efforts by the college, bolstered by the NCAE-C program and supported by local, state, and non-governmental funds, have led to a strong cyber talent pipeline in the region.

Pittsburgh Technical College (Pennsylvania)

When looking at public and private two-year institutions, Pittsburgh Technical College (PTC) has the strongest emphasis on cyber education when calculated by share of degrees awarded: Over one-third of the associate's degrees granted over the last decade have been in cyber-related fields, despite them only receiving the NCAE-C designation two years ago. Within the School of Information Systems and Technology, its Information Technology associate's degree has two NCAE-C-designated concentrations: Network Administration, and Information Security and Computer Forensics.³³ These degrees are designed to take as little as 21 months, including a three-month internship.

The designation followed the 2019 opening of a new cybersecurity-focused center within the school, funded by philanthropic donations. The school also hosts hackathons and competitions using resources provided by Symantec Coyote Diamond, IBM's Master the Mainframe contest, Syracuse SEED Labs, and the Digital Forensic Research Workshop (DFRWS), and it partners with tech companies to provide students with software and internships.³⁴

Unlike DSU and Capitol Technology University, the other institutions highlighted in this brief, PTC has only been NCAE-C-designated for a short while. While it lacks size and long-standing pedigree, their strong graduation rate and successful partnerships with local and national industry prove their dedication to training competent cyber professionals. PTC's experience also illustrates how some schools that seek out NCAE-C designation already have a history of cyber-focused efforts that are then augmented and improved through the application and designation process.

Capitol Technology University (Maryland)

Capitol Technology University is an example of a small, private, nonprofit institution that focuses on STEM training, especially cybersecurity. Located in Laurel, MD, it is a short distance from Washington, D.C., and maintains close connections with government agencies and contractors. The school was first designated as a NCAE-C school in 2003, and currently offers one associate's degree, four bachelor's degrees (including one online), five master's degrees, six doctoral degrees and five certificates in cyber-specific fields.³⁵

At the end of 2022, Capitol Tech—along with Mohawk Valley Community College and Towson University—used an NSA grant to form the NCAE-C Northeast Regional Hub Leadership Consortium. This consortium assists NCAE-C institutions in their faculty development and curriculum design, and helps non-NCAE-C schools seeking the designation navigate the process. They also assist with collaboration between all schools (including at the K–12 level) within the region, federal and nonprofit partners, and employers.³⁶

Capitol Technology University has fostered a strong relationship with the NSA, which is located nearby, and even offers a master's-level course for newly hired NSA employees.³⁷ Their excellence in cyber was also recognized when the school was awarded the SC Media Award for Best Cybersecurity Higher Education Program in early 2020.³⁸

Capitol Technology University and its programs are an example of a successful pipeline for cyber talent into the private and public sectors. Leveraging their location and the connection to government partners forged by the NCAE-C program, they have developed a long list of cyber-related programs that provide in-demand skills to employers in the area. They also use their expertise to help build the training ecosystem for both K–12 and postsecondary institutions.

Conclusion

The demand for cybersecurity talent continues to grow and outpace the supply of talent. The National Centers for Academic Excellence in Cyber were created to help fill this gap, and our analysis shows that they have contributed significantly to the achievement of this goal. Over the last 10 years, NCAE-C institutions increased the number of students graduating with cyber-related awards at a rate much higher than other schools, and year-over-year they account for an increasing share of graduates at all award levels in cybersecurity fields. In 2020, NCAE-C schools graduated 50 percent of all cyber bachelor's degrees, 32 percent of all cyber associate's degrees, and 19 percent of all nondegree cyber credentials, despite making up only nine percent of all U.S. institutions.

The NCAE-C program and its designated institutions do more than just graduate cyber talent. Standout institutions, including those leading the national centers, collaborate heavily with the NCAE-C community and outside partners. These efforts strengthen each school within the community by providing resources they would not have access to otherwise.

The NCAE-C program and its designated institutions have achieved this success despite unpredictable funding from Congress. Institutions within the program are graduating cyber talent at a very high rate, helping to bridge the talent gap that sparked the program's creation.

In order to allow long-term strategic planning and expansion, we recommend that Congress officially authorize the NCAE-C program as a program of record and provide yearly appropriations.

Different methods for ranking NCAE-C institutions and states show us that large, well-known institutions are producing many graduates across all award types, but that there are also lesser-known institutions that award a significantly high percentage of cyber-related awards. There are also a number of states with an outsized impact in cyber-related bachelor's degree attainment compared to their overall number of granted bachelor's, especially South Dakota, Vermont, Nevada, West Virginia, and New Jersey. While we cannot say this is only because of the designation, this speaks to the efficacy and impact of the institution's program and membership in the NCAE-C community.

Though over the past decade women have earned more bachelor's degrees than men in general, this trend is not observed in cyber-relevant fields offered by schools within the NCAE-C community. Instead, women are significantly underrepresented and account for less than 20 percent of total bachelor's and associate's degrees awarded within the NCAE-C. This trend is not unique to the NCAE-C or to cyber specifically, but indicative of a broader trend within STEM.

There are areas where future research is warranted. First, this data brief is limited to bachelor's degrees, associate's degrees, and nondegree credentials. It does not include an examination of master's degrees and doctorate degrees. Similarly, the "research" designation is granted to research universities, DOD schools, and PhD-producing military academies. An exploration of the research output of these institutions could shed light on whether NCAE-R schools, the most advanced level of designation, are part of the list of top producers of cyber-related research. IPEDS also contains data on completion rates, which could be analyzed to determine whether NCAE-C institutions graduate enrolled students at a higher rate than other schools. Lastly, this data brief only examines gender and does not include other demographic data. Further examination of these characteristics is necessary.

Continued support for the National Centers of Academic Excellence in Cyber, and other educational programs that train cyber talent, will help the United States build and maintain a competitive cyber workforce.

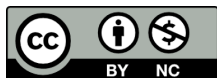
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Appendix A: Full List of NCAE-C Institutions

Alamance Community College	Forsyth Technical Community College	North Dakota State University	United States Naval Academy
American Public University System	Fort Hays State University	North Idaho College	University at Albany, State University of New York
Anne Arundel Community College	Franklin University	Northampton Community College	University at Buffalo, State University of New York
Arapahoe Community College	Fullerton College	Northeast Community College	University Northwest
Arizona State University	George Mason University	Northeastern University	University of Advancing Technology
Athens State University	Georgetown University	Northern Kentucky University	University of Arkansas
Auburn University	Georgia Institute of Technology	Northern Michigan University	University of Arkansas at Little Rock
Augusta Technical College	Georgia Southern University, Armstrong Campus	Northern Virginia Community College	University of California, Davis
Augusta University	Georgia State University	Norwich University	University of California, Irvine
Baker College	Germanna Community College	Nova Southeastern University	University of Central Florida
Bay Path University	Glendale Community College	Oakland University	University of Cincinnati
Bellevue University	Grand Canyon University	Ohlone College	University of Colorado Colorado Springs
Binghamton University	Grand Rapids Community College	Oklahoma Christian University	University of Connecticut
Bismarck State College	Great Falls College Montana State University	Oklahoma City Community College	University of Dallas
Bloomsburg University of Pennsylvania	Green River College	Oklahoma State University	University of Dayton
Blue Ridge Community and Technical College	Guilford Technical Community College	Old Dominion University	University of Delaware
Bluegrass Community & Technical College	Gwinnett Technical College	Our Lady of the Lake University	University of Denver
Boise State University	Hagerstown Community College	Owensboro Community & Technical College	University of Detroit Mercy
Bossier Parish Community College	Hampton University	Pace University	University of Florida
Boston University	Harford Community College	Pennsylvania Highlands Community College	University of Georgia
Bowie State University	Henry Ford College	Pennsylvania State University	University of Hawaii at Manoa
Brigham Young University	Highline College	Pikes Peak Community College	University of Hawaii Maui College
Brookdale Community College	Hill College	Pitt Community College	University of Hawaii - West Oahu
Butler Community College	Honolulu Community College	Pittsburgh Technical College	University of Houston
Cathoun Community College	Hood College	Polytechnic University of Puerto Rico	University of Idaho
California State Polytechnic University, Pomona	Houston Community College	Portland Community College	University of Illinois Springfield
California State University San Marcos	Howard Community College	Portland State University	University of Illinois Urbana-Champaign
California State University, Sacramento	Idaho State University	Prince George's Community College	University of Kansas
California State University, San Bernardino	Illinois Institute of Technology	Pueblo Community College	University of Louisville, Kentucky
Capella University	Illinois State University	Purdue University	University of Maine at Augusta
Capitol Technology University	Indian River State College	Radford University	University of Maryland Global Campus
Carnegie Mellon University	Indiana University	Red Rocks Community College	University of Maryland, Baltimore County
Cecil College	Indiana University of Pennsylvania	Regent University	University of Maryland, College Park
Cedarville University	Iowa State University	Regis University	University of Massachusetts Dartmouth
Central New Mexico Community College	Ivy Tech Community College	Roane State Community College	University of Massachusetts Lowell
Central Piedmont Community College	Jackson State Community College	Robert Morris University	University of Memphis
Century College	Jacksonville State University	Rochester Institute of Technology	University of Missouri - Columbia
Champlain College	James Madison University	Rock Valley College	University of Missouri - St. Louis
Chemeketa Community College	John A. Logan College	Rockland Community College	University of Nebraska Omaha
Chippewa Valley Technical College	Johnson County Community College	Roosevelt University	University of Nevada, Las Vegas
	Kansas State University	Rose State College	University of Nevada, Reno
	Kean University	Rowan College at Burlington County	
	Kennesaw State University	Rutgers, The State University of New Jersey	
	Kent State University	Sacred Heart University	
	Lake Superior College		

<p>City College of San Francisco City University of Seattle Clark State Community College Clemson University Coastline Community College College of DuPage College of Eastern Idaho College of Southern Maryland College of Southern Nevada Collin College Colorado Mesa University Colorado School of Mines Colorado State University Pueblo Colorado Technical University Columbia Basin College Columbus State Community College Columbus State University Community College of Rhode Island Cosumnes River College County College of Morris Cypress College Dakota State University Danville Community College Dartmouth College Davenport University Daytona State College Delta College DePaul University Drexel University East Carolina University East Stroudsburg University Eastern Michigan University Eastern Washington University ECPI University Edmonds Community College El Paso Community College Embry-Riddle Aeronautical University - Daytona Beach Embry-Riddle Aeronautical University - Prescott ENMU-Ruidoso Branch Community College Estrella Mountain Community College Excelsior College Fairleigh Dickinson University Fayetteville Technical Community College Ferris State University Florida A&M University Florida Atlantic University Florida Institute of Technology Florida International University</p>	<p>Lansing Community College Laredo College LeMoyne-Owen College Leeward Community College Lehigh Carbon Community College Lewis University Liberty University Lincoln Land Community College Long Beach City College Lord Fairfax Community College Louisiana Tech University Loyola University Chicago Macomb Community College Madison College Marquette University Marymount University McLennan Community College Mercy College Metropolitan Community College Metropolitan Community College, Kansas City Metropolitan State University Miami Dade College Middle Georgia State University Minot State University Mississippi State University Missoula College Missouri University of Science and Technology Mohawk Valley Community College Montgomery College Montreat College Moraine Valley Community College Morgan State University Mount Aloysius College Mountain Empire Community College Mt. Hood Community College Murray State University National University New England Institute of Technology New Jersey City University New Jersey Institute of Technology New Mexico Tech New River Community College New York Institute of Technology New York University Norfolk State University North Carolina A&T State University</p>	<p>Saint Leo University Saint Vincent College Sam Houston State University Sampson Community College San Antonio College Sierra College Sinclair Community College Snead State Community College South Carolina State University South Texas College Southeast Missouri State University Southern Maine Community College Southern Methodist University Southern Utah University Southwest Virginia Community College Spokane Falls Community College St. Cloud State University St. Louis Community College St. Petersburg College St. Philip's College Stevens Institute of Technology Syracuse University Tennessee Tech University Terra State Community College Texas A&M University Texas A&M University-Corpus Christi Texas A&M University-San Antonio Texas State Technical College in Harlingen The Citadel The College of Westchester Community College of Baltimore County The George Washington University The Johns Hopkins University The Ohio State University The University of Alabama The University of Alabama at Birmingham The University of Alabama in Huntsville The University of Arizona, Tucson The University of Tennessee at Chattanooga The University of Texas at Austin The University of Texas at San Antonio Thomas Nelson Community</p>	<p>University of New Hampshire University of New Haven University of New Mexico University of New Orleans University of North Carolina, Charlotte University of North Carolina, Wilmington University of North Florida University of North Georgia University of North Texas University of Pittsburgh University of Rhode Island University of San Diego University of South Alabama University of South Carolina University of South Florida University of Texas at Dallas University of Texas at El Paso University of the Cumberland University of Tulsa University of Virginia University of Washington University of West Florida University of Wisconsin-Stout University of Wisconsin-Whitewater Utica College Valencia College Valley Forge Military College Vincennes University Virginia Commonwealth University Virginia Polytechnic Institute & State University Virginia Western Community College Volunteer State Community College Wake Technical Community College Walden University Walsh College Washtenaw Community College Waukesha County Technical College Webster University West Chester University of Pennsylvania West Virginia University Westchester Community College Western Governors University Western Washington University Whatcom Community College Wichita State University</p>
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Florida Memorial University Florida State College at Jacksonville Florida State University	North Carolina State University	College Tidewater Community College Tiffin University Towson University Trident Technical College Tuskegee University United States Air Force Academy	Wilmington University Worcester Polytechnic Institute Wright State University Xavier University
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Source: CSET calculations from <https://www.caecommunity.org/cae-map>.

Appendix B: List of NCAE-C Institutions Per State

Texas	23	Idaho	5
Virginia	23	Oklahoma	5
Florida	20	Oregon	5
Maryland	19	Hawaii	5
California	17	Indiana	4
New York	16	New Mexico	4
Pennsylvania	16	Nebraska	4
Illinois	15	Connecticut	3
Michigan	14	Louisiana	3
North Carolina	14	North Dakota	3
Ohio	13	Nevada	3
Colorado	12	Rhode Island	3
Georgia	11	Utah	3
Alabama	10	West Virginia	3
Washington	10	Arkansas	2
New Jersey	9	District of Columbia	2
Missouri	7	Delaware	2
Tennessee	7	Maine	2
Arizona	6	Montana	2
Wisconsin	6	New Hampshire	2
Kansas	6	Vermont	2
Kentucky	6	Iowa	1
Massachusetts	6	Mississippi	1
Minnesota	6	South Dakota	1
South Carolina	5		

Source: CSET calculations from <https://www.caecommunity.org/cae-map>

Appendix C: Full List of CIP Codes Used

Table C1: List of All Cyber and Cyber-Related CIP Codes in 2010 Taxonomy.³⁹

11	COMPUTER AND INFORMATION SCIENCES AND SUPPORT SERVICES	11.1005	Information Technology Project Management
11.01	Computer and Information Sciences, General	11.1006	Computer Support Specialist
11.02	Computer Programming	11.1099	Computer/Information Technology Services Administration and Management, Other
11.03	Data Processing	11.99	Computer and Information Sciences and Support Services, Other
11.04	Information Science/Studies	11.9999	Computer and Information Sciences and Support Services, Other
11.05	Computer Systems Analysis	14.09	Computer Engineering
11.06	Data Entry/Microcomputer Applications	14.0901	Computer Engineering, General
11.07	Computer Science	14.0902	Computer Hardware Engineering
11.08	Computer Software and Media Applications	14.0903	Computer Software Engineering
11.09	Computer Systems Networking and Telecommunications	14.0999	Computer Engineering, Other
11.10	Computer/Information Technology Administration and Management	15.12	Computer Engineering Technologies/Technicians
11.1001	Network and System Administration/Administrator	29.0207	Cyber/Electronic Operations and Warfare
11.1002	System, Networking, and LAN/WAN Management/Manager	43.0116	Cyber/Computer Forensics and Counterterrorism
11.1003	Computer and Information Systems Security/Information Assurance	52.21	Telecommunications Management
11.1004	Web/Multimedia Management and Webmaster		

Appendix D: Top Institutions Ranked by Cyber Graduates

Table D1. Top NCAE-C Public and Private Four-Year Institutions, Ranked by Cyber Bachelor's Graduates from 2010 to 2020

Institution	State	Cyber Bachelor's Awarded
University of Maryland Global Campus	MD	15,596
Pennsylvania State University	PA	13,432
Western Governors University	UT	12,969
Purdue University	IN	9,096
University of Washington	WA	8,454

Source: CSET analysis of IPEDS data.

Table D2. Top NCAE-C Public and Private Two-Year Institutions, Ranked by Cyber Associate's Graduates from 2010-2020

Institution	State	Cyber Associate's Awarded
Northern Virginia Community College	VA	6,560
Ivy Tech Community College	IN	4,296
Pittsburgh Technical College	PA	2,216
Valencia College	FL	2,216
Montgomery College	AL	1,827

Source: CSET analysis of IPEDS data.

Appendix E: Top State Rankings

To discover such states where NCAE-C schools graduate relatively high amounts of cyber talent compared to their total output of graduates, we tallied the share of cyber graduates within the state that came from NCAE-C schools, and the share of all graduates that came from NCAE-C schools, then used the difference between the two shares to rank states. This method allows us to see states in which NCAE-C schools have outsized impact in cyber compared to their impact on the state education system writ large.

Table F1. Top States by Percentage of NCAE-C Cybersecurity Bachelor’s Graduates from NCAE-C Total Bachelor’s Graduates within Each State from 2010 to 2020

State	NCAE-C Cyber	Non-NCAE-C Cyber	State Total Cyber	State’s NCAE-C Share, Cyber	NCAE-C All	Non-NCAE-C All	State Total All	State’s NCAE-C Share, Total	NCAE-C Cyber Share — NCAE-C Total Share
South Dakota	1,247	1,232	2,479	50%	2,838	60,202	43,040	4%	45%
Vermont	2,156	1,231	3,387	63%	12,653	56,366	69,019	18%	45%
Nevada	3,773	2,044	5,817	64%	45,713	108,632	154,345	29%	35%
West Virginia	5,859	1,358	7,217	81%	102,657	65,008	167,665	61%	19%
New Jersey	11,013	1,358	7,217	61%	192,301	265,182	457,483	423%	19%

Source: CSET analysis of IPEDS data.

For associate’s degrees, ranking in this way is not as informative. States in which NCAE-C institutions are awarding most associate’s degrees in cyber fields also have most of their non-cyber associates produced by NCAE-C schools. For example, in Rhode Island, 85 percent of cyber associate’s degrees are awarded by NCAE-C institutions, but NCAE-C institutions also award 73 percent of all associate’s degrees.

Endnotes

¹ “Announcement of White House National Cyber Workforce and Education Summit,” The White House, Statements and Briefings, July 21, 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/07/18/announcement-of-white-house-national-cyber-workforce-and-education-summit/>.

² “FACT SHEET: National Cyber Workforce and Education Summit,” The White House, Statements and Briefings, July 21, 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/07/21/fact-sheet-national-cyber-workforce-and-education-summit/>.

³ It was originally launched as the National Centers of Academic Excellence in Information Assurance (IA) Education program.

⁴ The Cybersecurity and Infrastructure Security Agency (CISA) within the Department of Homeland Security (DHS), the National Science Foundation (NSF), the National Initiative for Cybersecurity Education (NICE) within the National Institute of Standards and Technology (NIST), which is itself within the Department of Commerce, the Department of Defense (DOD) and the Federal Bureau of Investigation (FBI) within the Department of Justice. For a breakdown of the roles and responsibilities of each agency, see “Program Book,” National Centers of Academic Excellence in Cybersecurity, 2022 https://www.caecommunity.org/sites/default/files/2022-06/CAE_Book_6.0_Web.pdf. QUERY:

⁵ “About the Programs,” CAE in Cybersecurity Community, <https://www.caecommunity.org/about-us/national-cae-cybersecurity-program/applicant-checklist>.

⁶ The list used for our analysis was pulled from this website as of June 2022: <https://www.caecommunity.org/cae-map>. The exact number of schools varied by source. For example, there are over 417 designated institutions according to the 2022 NCAE-C Initiatives Guide, but the 2022 Edition of the NCAE-C program book states there are over 380 designated institutions. We reached out to the NCAE-C Program Office for clarification but received no response on the exact number of schools.

⁷ “Program Book,” National Centers of Academic Excellence in Cybersecurity, 2022 https://www.caecommunity.org/sites/default/files/2022-06/CAE_Book_6.0_Web.pdf.

⁸ These were sponsored by the 2015 NSF-awarded Catalyzing Computing and Cybersecurity in Community Colleges (C5) grant that went to Whatcom Community College.

⁹ This information was provided by administrators from NCAE-C institutions during interviews for a separate, forthcoming study on federal cyber scholarships for service.

¹⁰ For a full history of the program, see “Program Book,” National Centers of Academic Excellence in Cybersecurity, 2022 https://www.caecommunity.org/sites/default/files/2022-06/CAE_Book_6.0_Web.pdf.

¹¹ The institutions that serve as the national center in each of these areas can be found here: “CAE National Centers,” NCAE-C, 2023, <https://www.caecommunity.org/about-us/cae-national-centers>.

¹² The NICE Challenge Project creates programs simulating real-world situations to train cybersecurity talent. For more information, see “NICE Challenge Project,” NICE Challenge Project, 2023 <https://nice-challenge.com/>.

¹³ We address the measurement challenges associated with this in the methodology section below.

¹⁴ Laura Bate and RADM (Ret.) Mark Montgomery, *Workforce Development Agenda for the National Cyber Director*, CSC 2.0, June 2022, https://cybersolarium.org/wp-content/uploads/2022/05/CSC2.0_Report_WorkforceDevelopmentAgenda_FullText.pdf

¹⁵ “Program Book,” National Centers of Academic Excellence in Cybersecurity, 2022 https://www.caecommunity.org/sites/default/files/2022-06/CAE_Book_6.0_Web.pdf

¹⁶ Although it is part of the list of schools that we used to build our set of institutions, we were unable to include the Polytechnic University of Puerto Rico in our set. Review of that school showed that only the San Juan campus is NCAE-C-designated, but IPEDS only has data for the Orlando and Miami campuses. The list of schools can be found here: “CAE Institution Map,” NCAE-C, 2023, <https://www.caecommunity.org/cae-map>

¹⁷ “Western Governors University Announces Designation as a National Center of Academic Excellence in Cyber Defense,” Western Governors University, September 27, 2021, <https://www.wgu.edu/newsroom/press-release/2021/09/wgu-designated-as-center-of-academic-excellence-in-national-cyber-defense.html>.

¹⁸ We recognize that the path from field of study to career is not linear. However, especially for STEM majors, there is a strong correlation between the two. For more information, see Amy Burke, “U.S. S&E Workforce: Relationship between Education and Occupation,” National Science Foundation, September 26, 2019, <https://nces.nsf.gov/pubs/nsb20198/u-s-s-e-workforce-relationship-between-education-and-occupation#educational-background-of-workers-in-s-e-occupations>.

¹⁹ For clarity, we combined all IPEDS categories for certificates below the graduate level, which includes: certificates of less than 1 year; certificate of less than 12 weeks; certificate of at least 12 weeks, but less than 1 year; certificates of 1 but less than 2 years; and certificates of 2 but less than 4 years.

²⁰ “The State of U.S. Science and Engineering 2022,” National Science Foundation, January 2022, <https://nces.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force>.

²¹ Tessa E.S. Charlesworth and Mahzarin R. Banaji, *Gender in Science, Technology, Engineering, and Mathematics: Issues, Causes, Solutions*, *The Journal of Neuroscience*, September 11, 2019, <https://doi.org/10.1523/JNEUROSCI.0475-18.2019>.

²² Courtney Mabeus, “Va. Tech to lead cybersecurity workforce initiative,” *Virginia Business*, April 22, 2022, <https://www.virginiabusiness.com/article/va-tech-to-lead-cybersecurity-workforce-initiative/>; “MD Department of Labor To Fund Critical Cybersecurity Upskilling Opportunities for State Employees,” *Maryland Department of Labor*, October 7, 2022, <https://www.dllr.state.md.us/whatsnews/labortofundcriticalcybersecurityupskilling.shtml>; and “Governor Ron DeSantis Announces \$20 Million to Create Cybersecurity and Information Technology Workforce Education Opportunities,” *Florida Department of Education*, March 2, 2022, <https://www.fldoe.org/newsroom/latest-news/icymi-governor-ron-desantis-announces-20-million-to-create-cybersecurity-and-information-technology-workforce-education-opportunities.stml>

²³ Appendix D provides a description of this ranking method and the top five schools by this ranking.

²⁴ The Department of Education categorizes schools in a few ways. One method is by sector, which delineates by level (e.g., two-year or four-year), and control (i.e. public, private, for profit).

²⁵ When performing analysis, we made several decisions regarding the grouping of institutions by sector for clarity. We chose to move schools that, according to IPEDS data, are four-year institutions, but that are “degree-granting, not primarily baccalaureate or above,” into the same group containing the sector of public and private two-year institutions. These schools share more features with a typical community college than a research university, and often include schools that label themselves community colleges. When comparing total associate’s degrees completions across different institutions, it is more accurate to compare those schools against two-year institutions than four-year institutions. When aggregating totals across states, this distinction is not necessary, as we were totaling awards by type, not comparing awards across institutions.

²⁶ See Appendix D for ranked institutions by total cyber graduate output.

²⁷ We considered normalizing institution and state completions by enrollment but chose not to. Normalizing IPEDS completions data would require using enrollment data from IPEDS. There is a two-to six-year lag between enrollment and completion data, so normalizing in that way penalizes schools that have programs which have grown rapidly in that time. Furthermore, IPEDS data does not have enrollment by field of study, which would penalize schools with large enrollment but that may have a good cyber program as well.

²⁸ “Program Book,” *National Centers of Academic Excellence in Cybersecurity*, 2022 https://www.caecommunity.org/sites/default/files/2022-06/CAE_Book_6.0_Web.pdf.

²⁹ “DSU’s Cyber Operations Named a Center of Academic Excellence,” DSU, May 23, 2012, <https://dsu.edu/news/articles/dakota-state-named-a-center-of-academic-excellence-in-cyber-operations-by-t.html>

³⁰ It also has other cyber-adjacent degree programs that fall within CIP 11+, such as a BS in Artificial Intelligence, a PhD in Computer Science, and a AS in Software Development, among others. For a full list, see “The Beacom College of Computer & Cyber Sciences,” DSU, 2023, <https://dsu.edu/academics/colleges/beacom-college-of-computer-and-cyber-sciences.html>.

³¹ “The Beacom College of Computer & Cyber Sciences,” DSU, 2023, <https://dsu.edu/academics/colleges/beacom-college-of-computer-and-cyber-sciences.html>.

³² “Dakota State Announces \$90M Initiative,” DSU, January 26, 2022, <https://dsu.edu/news/2022/01/dakota-state-90-million-initiative.html>.

³³ “Associate in Science Information Technology,” DSU, 2023, <https://ptcollege.edu/program/information-technology/>.

³⁴ Phil Grabowski, “Cyber Forensics: An Academic Partnership with Pittsburgh Technical College,” Cyber Defense Magazine, <https://www.cyberdefensemagazine.com/cyber-forensics-an-academic-partnership-with-pittsburgh-technical-college/>.

³⁵ For a full list, see “Cyber and Information Security,” Capitol Technology University, 2023, <https://www.captechu.edu/fields-of-study/cyber-and-information-security>. According to their website, “Capitol Tech has CAE-CDE institutional designation for all cyber-related programs of study until the end of 2021. After the end of 2021, all cybersecurity programs of study must apply for designation individually.” It is unclear which programs have reapplied successfully, but the NCAE-C program map states that their designation lasts until 2028, indicating one or more have done so. For more information, see: “Bachelor of Science (BS) in Cybersecurity,” Capitol Technology University, 2023, <https://www.captechu.edu/degrees-and-programs/bachelors-degrees/cybersecurity-bs>.

³⁶ “Capitol Tech Chosen by NSA to Lead the Region’s Cybersecurity Programs,” Capitol Technology University, December 2, 2020, <https://www.captechu.edu/news-events/capitol-tech-chosen-nsa-lead-regions-cybersecurity-programs>.

³⁷ “Capitol Technology University Wins National Award for Best Cybersecurity Program,” Capitol Technology University, February 28, 2020, <https://www.captechu.edu/news-events/capitol-technology-university-wins-national-award-best-cybersecurity-program>.

³⁸ “Capitol Technology University Wins National Award for Best Cybersecurity Program,” Capitol Technology University, February 28, 2020, <https://www.captechu.edu/news-events/capitol-technology-university-wins-national-award-best-cybersecurity-program>.

³⁹ This list is for CIP codes under the 2010 taxonomy. The 2010 list was updated in 2020 and included some small changes to our CIP 11+ list.